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RECORD No. 1968 / 58

PETROLOGICAL STUDY OF WORONORA (A.O.G.) No. 1 WELL, SYDNEY BASIN, NEW SOUTH WALES

by

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ABSTRACT.

This petrological study of Woronora (A.O.G.) No. 1 Well has been carried out as part of a review of the Sydney Basin, currently being undertaken by the Sedimentary Basins Study Group of the Petroleum Exploration Branch, Bureau of Mineral Resources.

Forty-one lithologic units were distinguished in the well and these were grouped into eight lithogenetic units.

Most of the formations described from the Narrabeen Group on the South Coast can be recognised in the well; lithic sandstones commonly rich in volcanic fragments form a large proportion of the sandstones; coal measures were found to be divisible broadly on the basis of interseam lithology; the main porous sandstones are above 1700 feet and are regarded as continental sediments.

The hydrocarbon prospects are considered to be poor but the porous sandstones above 1700 feet may be suitable for fluid storage.

A comparison of unit boundaries chosen in this study with formation boundaries proposed by A.O.G. (1964) is included.

GENERAL INFORMATION

Well Data

Well Name, No.:	Woronora (A.O.G.) No. 1
Operating Co. :	Australian Oil and Gas Corporation Limited
Location:	Lat. and Long. 34° 11'40"S, 150°54'50"E. 1:250,000 sheet: Wollongong, SI/56-9 General location: near Darkes Forest, 35 miles south of Sydney.
Elevation:	Rotary Table: 1172' a.s.l. (datum for well). Ground level: 1160' a.s.l.
Total Depth:	Schlumberger: 7589' Driller: 7587'
Logs Run:	Resistivity - Spontaneous Potential: Run 1: 2998' - 5582' Run 2: 5582' - 6917' Run 3: 6817' - 7589' Microlog - Caliper: Run 1: 2998' - 5581' Run 2: 5581' - 6917' Run 3: 6917' - 7589' Sonic log: Run 1: 2998' - 5570' Gamma Ray: Run 1: 2990' - 5579' Sonic - Gamma: Run 2: 5570' - 6907' Run 3: 6807' - 7580'

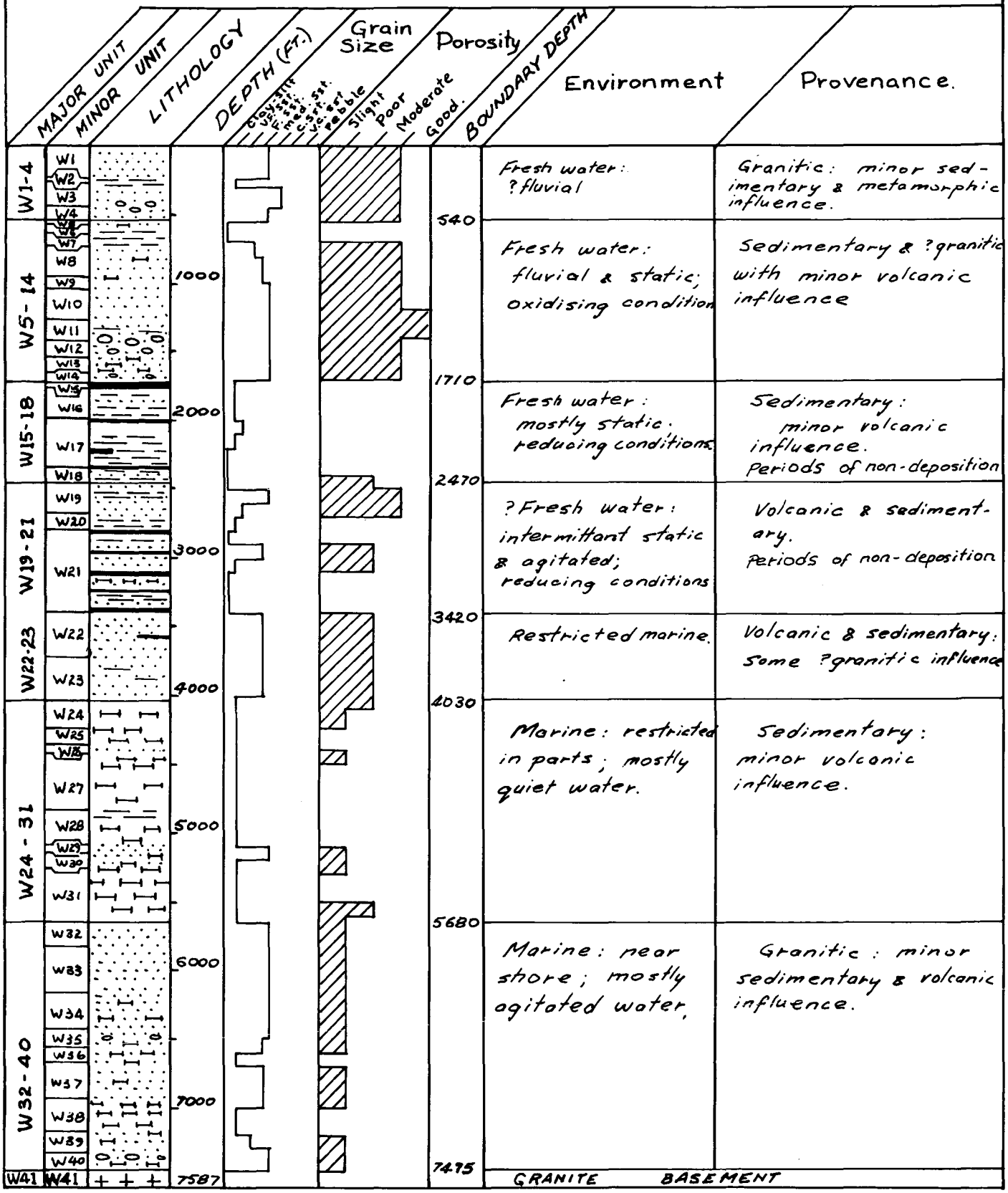
Formation Testing: Nil

Hydrocarbon Shows: Nil

Fig 1

WORONORA (A.O.G.) No 1

Summary of Petrological Results.



To accompany B.M.R. Record No. 1968/58

Major Reference used in Present Study

A.O.G., 1964 - Well Completion Report, A.O.G. Woronora No. 1, Sydney Basin, New South Wales (unpubl.).

Summary of Major Reference

"The well was spudded in Triassic Hawkesbury Sandstone. It penetrated 550' of this unit and 1160' of Narrabeen Group beds before entering Permian sediments at 1710'. It then penetrated 1710' of Permian "Upper Coal Measures" and 4053' of Permian "Upper Marine Series" before encountering granite at 7473'.

"Several minor gas occurrences were recorded while drilling coal and carbonaceous shale sequences, but there was little evidence of porosity within the sandstone units. No significant hydrocarbon shows were detected."

Material Available for Study

Cuttings: 0 - 7587' (T.D.) at intervals of 10' or less.

Cores: All 21 cores were available including 16 cores with a recovery of more than 1'.

Electric Logs: See Well Data.

Methods Used

All the drill cuttings were examined under a low power binocular microscope, and thin sections of cuttings from selected intervals were examined with a petrological microscope. The data obtained were plotted on composite well log sheets at a scale of 1" = 100' (plates 1A, 1B, 1C, 1D,)* The slabbed cores were examined under a binocular microscope and thin sections were cut from each core. The core results were entered on cards, and then plotted on core log sheets at a scale of 1" = 2' (see plates 2A, 2B, 2C, and 2D).*

Forty-one lithologic units were recognised in this well. They have been numbered from the surface and prefixed by the letter 'W' to identify the well in later correlations. These forty one units have been grouped into eight major lithogenetic units (see fig. 1).

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* Plates 1 and 2 were photographically reduced to half their original size, and so appear at scales of 1" = 200' and 1" = 4' respectively.

Fig. 2

WORONORA (A.O.G.) No. 1

COMPARISON OF B.M.R. UNITS WITH COMPANY INTERPRETATION

BMR UNITS		BOUNDARY DEPTHS (Ft.)	COMPANY (A.O.G. 1964)		
MAJOR	MINOR		FORMATION	GROUP	AGE
W1-4	W1		HAWKESBURY SANDSTONE		TRIASSIC
	W2	240			
	W3	270			
	W4	460			
		540			
W5-14	W5	550	NARRABEEN GROUP		
	W6	570			
	W7	630			
	W8	730			
	W9	970			
	W10	1040			
	W11	1280			
	W12	1440			
	W13	1540			
	W14	1660			
		1710			
W15-18	W15	1710	ILLAWARRA COAL MEASURES	UPPER COAL MEASURES	PERMIAN
	W16	1735			
	W17	2000			
	W18	2365	2200		
		2470	CUMBERLAND COAL MEASURES		
W19-21	W19	2690			
	W20	2800			
	W21	3420	3420		
W22-23	W22	3745	BUDJONG SANDSTONE	SHOALHAVEN GROUP	
	W23	4030	3970		
W24-31	W24	4270	BERRY SHALES		
	W25	4380			
	W26	4430			
	W27	4850			
	W28	5100	5105		
	W29	5150	KEDUMBA CREEK SANDSTONE		
	W30	5260	5258		
	W31	5680	5680		
W32-40	W32	5830	NOWRA SANDSTONE		
	W33	6185	6186		
	W34	6440	WANDRAWANDIAN SILTSTONE		
	W35	6570			
	W36	6685			
	W37	6930			
	W38	7180			
	W39	7316	7315		
	W40	7476	CONJOLA FM.		
W41	W41		7473 GRANITE BASEMENT		?CARB

To accompany B.M.R. Record No. 1968/58

The sedimentary rock classification of Pettijohn (1957) was used for specific rock names. However the term "quartz greywacke" was introduced to distinguish those quartz-rich rocks (> 75% quartz) in which detrital matrix was prominent (> 15%).

The present study forms part of a systematic study of selected wells in connection with a review of the Sydney Basin, currently being undertaken by the Sedimentary Basins Study Group of the Petroleum Exploration Branch.

GEOLOGY

UNITS W1-4 (plate 1A)

This major interval is 528' thick extending from the surface to 540' below the R.T. datum. It consists of orthoquartzite and pebbly orthoquartzite with minor grey shale beds; a fluvial environment is proposed for this interval. The unit has been equated with the Triassic Hawkesbury Sandstone by the Company (A.O.G. 1964). (see fig. 2).

UNIT W1

Characteristics: This unit extends from the surface to 240' and consists entirely of orthoquartzite. In parts the sandstone is limonitic and sideritic; pebbles become common towards the base. Graphite is a conspicuous accessory mineral throughout. The sand grains are cemented by clay, iron oxide or quartz overgrowths in places but more commonly the material consists of loose sand: a moderate porosity can be inferred.

Environment and Provenance: The good sorting combined with the presence of pebble beds and absence of marine fossils is suggestive of fluvial deposition for W1 sediments. Their maturity indicates that they formed by recycling of older sediments. The presence of granitic accessory minerals indicates an ultimate plutonic source but these minerals could easily have survived recycling; no feldspar is present. The source of graphite is not known.

UNIT W2

Characteristics: This unit is 30' thick, extending from 240' to 270'; it consists of interbedded sideritic shale and siltstone, and lies between the two sandstone units W1 and W3.

Boundary criteria: The upper boundary is recognized by a sharp lithological change from orthoquartzite of W1 to the shale and siltstone of this unit.

Environment and Provenance: In the fluvial model proposed for Units W1-4, Unit W2 is a fine-grained interval which probably accumulated as overbank deposits during flood conditions. Alternatively the unit may represent a quiet phase of deposition in the same general setting as the overlying and underlying units W1 and W3. It seems likely that the provenance of these units was also the same as for W2.

UNIT W3

Characteristics: This unit is 190' thick extending from 279' to 460': it consists entirely of orthoquartzite and pebbly orthoquartzite. The sediments are very similar to those of Unit W1, but pebbles are common, chert and carbonaceous material are conspicuous and clay matrix is less common. The porosity, like W1, is regarded as being moderate. Graphite is again present.
Boundary criteria: At the upper boundary a sharp lithological change occurs from sideritic shale of W2 to medium grained orthoquartzite.

Environment and Provenance: The clean character of the sediments, the pebble beds and carbonaceous and ferruginous layers all suggest fluvial deposition. Chert contained in this unit demonstrates that the provenance was at least partly sedimentary. The source of graphite is not known.

UNIT W4

Characteristics: This unit is 80' thick extending from 460' to 540'; it consists of pebbly orthoquartzite and inter-beds of grey to brown, laminated sideritic shale.
Boundary criteria: The upper boundary is marked by a change from W3 pebbly orthoquartzite to a thin bed of sideritic shale. While the bulk of unit W4 consists of pebbly orthoquartzite typical of W3, it also contains several shale beds.

Environment and Provenance: The environment of deposition of this unit appears to have been similar to that of the overlying units W1 to W3. That is a fluvial environment. Times of flood or periods of quiescent sedimentation have given rise to intermittant shale horizons in a predominantly sandy unit.

UNITS W5 - 14 (plates 1A, 2A)

This major interval is 1170' thick and contains a variety of rock

types. These are: Quartzose and lithic sandstone, red-brown and grey shales, and minor mudstone and siltsone. This indicates variable hydrodynamic conditions. The presence of red beds and lack of marine fossils indicate continental deposition. Units W5 - 14 have been equated with the Narrabeen Group by the Company (A.O.G. 1964) (see fig. 2).

UNIT W5

Characteristics: Unit W5 is 30' thick extending from 540' to 570'; it consists of very fine lithic greywacke containing abundant sedimentary lithics, underlain by fine silicified protoquartzite. The unit separates pebbly orthoquartzite above, from shale and siltstone below.

Boundary criteria: The upper boundary is marked by the change from W4 pebbly orthoquartzite to a very fine lithic greywacke. Grain size decreases from medium to very fine-grained across this boundary, and porosity decreases from moderate to low. The presence of abundant sedimentary lithics is important as they only occur at or below this depth. The boundary is regarded as a major break between the orthoquartzites of Units W1 - 4 and the more variable sequence, Units W5 - 14.

Environment and provenance: No data relevant to the depositional environment were noted. A sedimentary provenance has been established.

UNIT W6

Characteristics: This unit is 60' thick extending from 570' to 630'; it consists of interlaminated shale and sandy siltstone with minor carbonaceous material.

Boundary criteria: The upper boundary is between fine silicified protoquartzite of W5 and shale of W6. The lamination and fine grain size of W6 sediments indicates deposition in quiet waters. Furthermore, as part of the continental lithogenetic sequence W5 - 14, a likely depositional setting would be the flood plain of a river channel, or in a lake.

UNIT W7

Characteristics: This unit is 100' thick extending from 630' to 730'; it consists almost entirely of red-brown clay-shale* with minor bands of hard white claystone and grey shale. The uppermost bed consists of oolitic ferruginous claystone. The unit is probably the equivalent of the Bald Hill Claystone as recorded from the surface section near Stanwell Park by Hanlon et. al. (1953).

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* A fissile claystone: see Folk (1965)

Boundary criteria: The upper boundary of W7 was picked at the top of the oolitic claystone horizon where there is a striking colour change from grey siltstone and shale containing some carbonaceous material (W6) to red-brown clay-shale of W7. There is an overall slight decrease in grain size from W6 to W7.

Environment and Provenance: These very fine red beds were deposited in quiet waters under oxidising conditions such as occur on a flood plain during times of flood. The presence of these red beds within the lithogenetic sequence W5 - 14 favours the idea of continental deposition for the formation of the sequence.

UNIT W8

Characteristics: Unit W8 is 240' thick extending from 730' to 970'; it consists of interbedded orthoquartzite, lithic sandstone and sandy siltstone. Much of the sandstone is friable and a moderate porosity could be inferred from the abundance of loose grains; however, where beds are silicified or contain silt, low to slight porosities were recorded.
Boundary criteria: The upper boundary is marked by a lithological change from red-brown and grey shale of W7 to orthoquartzite of W8.

Environment and Provenance: The interbedded lithologies of this unit were probably formed under intermittent agitated and quiet water conditions. The sediments were derived from a sedimentary source as indicated by the abundance of chert clasts.

UNIT W9

Characteristics: This unit is 70' thick extending from 970' to 1040'; it consists entirely of grey to red-brown lithic sandstone containing common red and green chert, clay lithics, iron oxides and siderite. The phosphate log shows a moderate reading for much of the unit. From the abundance of loose sand, a moderate porosity was inferred.
Boundary criteria: At the upper boundary there is a sharp increase in the percentage of sedimentary lithics from orthoquartzite of W8 to W9. This is accompanied by a slight change in grain size from fine to medium grained.

Environment and Provenance: This clean sandstone was deposited in agitated or flowing water. The abundance of chert clasts indicates that it was derived from a predominantly sedimentary source.

UNIT W10

Characteristics: Unit W10 is 240' thick extending from 1040' to 1280'; it consists mostly of orthoquartzite, in part sideritic. The sediments are limonitic in part and contain minor bands of grey shale, mudstone and siltstone. Many of the samples consist of completely loose sand and on this basis porosity has been interpreted as ranging from poor to good. The porosity has been reduced in places by siderite and iron oxide cement.

Units W8, W9 and W10 appear to closely correspond to the Bulgo Sandstone as seen in the section near Stanwell Park and described by Hanlon et. al. (1953).

Boundary criteria: The upper boundary corresponds with the change from lithic sandstone of W9 to orthoquartzite of W10.

Environment and Provenance: This clean sandstone unit was deposited in agitated or flowing water. It has been derived at least in part from a sedimentary source.

UNIT W11

Characteristics: This unit is 160' thick extending from 1280' to 1440'; it consists of interbedded protoquartzite, grey and red-brown shale and minor siltstone. The protoquartzite contains plentiful sedimentary lithics. It is mostly friable but in places is cemented with siderite and iron oxide; the interpreted porosity accordingly ranges from slight to good. The unit appears to correlate at least in part with the Stanwell Park Claystone (Hanlon et. al. 1953).

Boundary criteria: The upper boundary is marked by the increase in lithic content of the sandstones, from the orthoquartzite of W10 to the protoquartzite of W11. Unit W11 is further distinguished from the overlying unit by the presence of red-brown shales.

Environment and Provenance: The intercalation of coarse and fine-grained sediment and the presence of red beds (together with the absence of marine fossils) is strongly suggestive of continental deposition. Accummulations of this type may form in a braided stream or meandering stream channel and flood plain. Oxidising conditions apparently prevailed for preservation of the red beds. The rocks were derived from a sedimentary source.

UNIT W12

Characteristics: Unit W12 is 100' thick extending from 1440' to 1540'; it consists of pebbly orthoquartzite and protoquartzite. The sediments contain common red and green chert and are pebbly throughout. Porosity was estimated to range from moderate to high, and in Core 1 porosity was measured as 31% and permeability 1330 millidarcies.

The unit is considered to be equivalent to the Scarborough Sandstone (Hanlon et. al. 1953).

Boundary criteria: The upper boundary was picked at the change from protoquartzite of W11 to pebbly orthoquartzite of W12.

Environment and Provenance: This clean, pebbly unit was deposited under strongly agitated or flowing water. The sediments were derived from a sedimentary source - indicated by the presence of common grains and pebbles of chert.

UNIT W13

Characteristics: This unit is 120' thick extending from 1540' to 1660'; it is an interbedded sequence of calcareous subgreywacke, shale and siltstone. The subgreywacke contains abundant sedimentary lithics. Porosity is lower than in the overlying unit due to the presence of diagenetic carbonate cement and fine detrital matrix. Core 2 appears as a pebbly mudstone but the sample is in very poor condition and may have been broken up during or after coring. However some fragments contain sideritic concretions identical with those seen in surface samples of the Wombarra Shale with which W13 may be correlated.

Boundary criteria: The upper boundary was chosen at the change from orthoquartzite characteristic of W12 to a shale bed - the uppermost of a series of shale beds in W13. Also at this boundary the grain size of the sandstones decreases from medium to fine, and the porosity decreases from moderate to poor.

Environment and Provenance: Like unit W11, this unit consists of intercalated fine and coarse-grained sediment. The depositional setting was probably similar to that of W11 except that conditions were not favourable for the preservation of red beds. Deposition probably took place in a braided or meandering stream with periodic flooding and deposition on the flood plain. The abundance of sedimentary lithics favours a local sedimentary source.

UNIT W14

Characteristics: This unit is 50' thick extending from 1660' to 1710'. It is the lowermost unit of the sequence W5 - 14 and consists almost entirely of calcareous subgreywacke. The subgreywacke is the same as that contained in the overlying unit; it contains abundant sedimentary lithics. The sediment is friable and contains only a small proportion of fine detritus. A moderate porosity could be inferred.

The unit may be correlated with the Coal Cliff Sandstone (Hanlon et. al. 1953).

Boundary criteria: The upper boundary of W14 was chosen at the lowermost shale of W13, below which the sediments become much more sandy. The change is accompanied by an increase in the grain size of the sandstone from W13 to W14.

Environment and Provenance: The low proportion of fines in unit W14 suggests deposition in agitated waters. A local sedimentary source is envisaged because of the abundance of shale grains. There is no evidence to suggest either a marine or continental environment for this unit but its apparent genetic association with the overlying units W1 to W13 supports the idea of continental deposition.

UNIT W15 - 18 (plates 1B, 2A)

This sequence is 760' thick extending from 1710' to 2470'. It consists mostly of interbedded carbonaceous shale, siltstone and chert-rich protoquartzite. Coal seams are conspicuous - particularly at the top of the sequence (W15) - and minor volcanic horizons were recognized. No wireline logs were run over this interval.

UNIT W15

Characteristics: This unit is only 25' thick, extending from 1710' to 1735'. It consists mainly of black vitreous coal seams and carbonaceous shale. The cuttings percentages suggest the presence of two main seams.

Boundary criteria: At the upper boundary of this unit there is a sharp change from subgreywacke of W14 to coal of W15. The coal seams are the highest recorded

in the well and a major unit boundary has been selected here. The boundary separates the sequence of sandstone, shale and mudstone containing red beds (designated as W5 - 14) from the underlying carbonaceous shales and siltstones with coal seams (W15 - 18).

Environment: A swamp environment would be suitable for the accumulation of this predominantly coal unit. There is no evidence of marine influence.

UNIT W16

Characteristics: This unit is 265' thick extending from 1735' to 2000'; it consists mostly of carbonaceous shale, carbonaceous siltstone and minor lithic sandstone. The shale is laminated in part, and the lithic sandstone contains sedimentary lithics. Plant remains are common in places; interpreted porosity of the sandstone ranges from poor to moderate.

Boundary criteria: The boundary with the overlying unit is taken at the bottom of the lower coal seam of unit W15.

Environment and Provenance: Unit W16 was apparently deposited in quiet water in a continental environment such as a lake fed by sluggish streams. This is suggested by the lamination of some of the shales, the presence of plant remains and the absence of marine fossils.

The sediment was derived mostly from a sedimentary source but some volcanic fragments are included in the deposit.

UNIT W17

Characteristics: This unit is 365' thick extending from 2000' to 2365'; it consists of interbedded carbonaceous shale and siltstone with minor chert-rich protoquartzite and two horizons of andesitic volcanics. The unit contains coal seams, but these are dull and partly silty, in contrast to the clean, vitreous coal of unit W15. The protoquartzite is commonly cemented with dolomite, which may account for the slight porosity recorded for these beds.

Boundary criteria: A coal seam was chosen for the upper boundary of Unit W17. Apart from the coal, the sediments are similar to those of the overlying unit - but the sandstone is finer grained and less porous. W17 contains volcanic horizons and coal seams both of which are absent in the overlying Unit W16.

Environment and Provenance: This unit was apparently deposited in a similar environment to W16. However conditions were more favourable for the formation

of coal and some minor andesitic volcanic activity took place. The abundance of chert grains indicates a sedimentary source for the clastic sediments.

UNIT W18

Characteristics: This unit is 105' thick extending from 2365' to 2470'; it consists of laminated siltstone, carbonaceous shale and fine grained, chert-rich protoquartzite. The unit has no unique characteristics but it accounts for the sediments which lie between the coal-bearing, carbonaceous shales and siltstones of W17, and the underlying more sandy sediments of units 19 - 21.
Boundary criteria: The upper boundary was chosen at the base of the lowermost coal seam of Unit W17.
Environment and Provenance: The lamination of the sediments suggests quiet water deposition such as in a lagoon, a lake or on a flood plain. A sedimentary source is indicated by the abundance of chert grains.

UNITS W19 - 21

This major interval is 950' thick extending from 2470' to 3420'; it is predominantly sandy in comparison with the overlying interval (W15 - 18) which has a high shale content. Units W19 - 21 contain numerous coal seams and some shale beds. The sandstones range from orthoquartzite to sub-greywacke composition.

UNIT W19

Characteristics: This unit is 220' thick, extending from 2470' to 2690'; it consists of interbedded friable quartz-rich sandstone, lithic greywacke, siltstone and shale. Plagioclase grains, basic to intermediate volcanic clasts and low grade metamorphic clasts are locally abundant, and rare plant fossils were observed. Quartz-rich sandstone is characteristic of this unit. The porosity of the sandstone ranges from poor to moderate.
Boundary criteria: The upper boundary of this unit is marked by the change from shale of Unit W18 to quartz-rich sandstone at the top of Unit W19. This lithological change is regarded as significant because the overlying units W15 - 18 consist mainly of shale and siltstone with coal seams and minor lithic sandstone, whereas the units W19 - 21 contain abundant medium to coarse-grained quartz-rich to lithic sandstone together with shale,

siltstone and coal seams. The composition of the sandstone is noteworthy. The sandstones of W15 - 18 are mostly rich in chert; some contain volcanic lithics. In units W19 - 21 the sandstone is quartz-rich near the top but changes to subgreywacke rich in volcanic lithics and poor in quartz in the lower part.

Environment and provenance: No positive evidence of the environment of deposition was recorded. That the sediment was derived in part from a local volcanic source is suggested by the abundance of volcanic clasts and euhedral plagioclase grains.

UNIT W20

Characteristics: This unit is 110' thick, extending from 2690' to 2800'; it consists mostly of grey shale, mudstone, siltstone and minor (volcanic) subgreywacke.

Boundary criteria: The upper boundary is marked by the change from quartz-rich sandstone (which characterises W19) to grey shale of W20.

Environment and provenance: These fine-grained sediments were probably deposited in quiet waters and mark the end of a period of prolific coal formation. The sediments were derived at least partly from a volcanic source.

UNIT W21

Characteristics: This unit is 620' thick extending from 2800' to 3420'; it is characterised by numerous coal seams. The interseam sediments are made up of subgreywacke, carbonaceous shale and siltstone. Plant remains occur in the lower part of the unit. The subgreywacke contains abundant basic volcanic lithics and plagioclase grains and is commonly cemented by silica or calcite. The interpreted porosity of the subgreywacke is generally poor (6-12%), rarely ranging to moderate (12-20%). Core 11 is a well-washed sediment containing large wood fragments and pebbles. This highly labile sandstone of Core 11 is typical of the sandstones of Unit W21.

Wire line logs are available for part of this unit. The 18'8" resistivity curve and the sonic log (not shown on plate 1B) were found useful for delineating coal seams.

Boundary criteria: The upper boundary was chosen at the top of the uppermost coal seam at 2800'. The younger units W19 and W20 are both non-carbonaceous, in marked contrast to W21.

Environment and provenance: The unit was deposited partly in a swamp environment favourable for the development of coal. However, periodic influx of clastic sediment gave rise to the interseam subgreywacke and shale. The well-washed nature of the subgreywacke, the presence of large wood fragments and pebbles, the absence of marine fossils and the presence of coal seams indicate fluvial transport and deposition of the clastic sediments. The sediments were derived from a local, basic volcanic source area as basic volcanic lithics and plagioclase grains are abundant.

UNITS W22-23 (plates 1B, 1C, 2B)

This major unit is 610' thick extending from 3420' to 4030'; it is made up mostly of subgreywacke grading downwards to protoquartzite. It could correspond to the Budjong Sandstone Member of the "Berry Shales" (A.O.G. 1964).

UNIT W22

Characteristics: This unit is 325' thick extending from 3420' to 3745'; it consists of dolomitic subgreywacke rich in volcanic lithics, together with minor shale, siltstone and coal. The subgreywacke generally contains less than 10% quartz; compaction and dolomitisation has resulted in porosities ranging from slight to poor. Cores 12 and 13 (plate 2B) appear typical of the sandstone of this unit and show an increase in quartz content downwards. The cores exhibit burrow structures and organic mixing of some beds but no marine fossils were seen in the unit. Some cross bedding was recorded.

The wire line logs show a significant change compared with the overlying unit. The S.P. log moves away from the shale base line and records up to -20 m.v. The resistivity logs read much higher than in the overlying unit and change character. This change reflects the higher sandstone content and near absence of coal seams in Unit W22. The high peaks shown on the gamma log appear to correspond with thin carbonaceous shale and siltstone beds. An extreme reading at 3570' appears anomalous.

Boundary criteria: The base of the coal seam at 3420' was picked as the upper boundary of unit W22. This marks the change from the subgreywacke of W22 to the coal-bearing sequence of shale, subgreywacke and siltstone of W21. Although Unit W22 probably contains at least one coal seam, the

main phase of coal formation did not set in until the beginning of W21 - indicated by the frequency of coal seams in that unit. Furthermore, for the purposes of regional correlation, a solitary coal seam is of doubtful significance.

The main change in electric log characteristics takes place some 50' below the selected boundary and favours an increase in sand downwards, below the major coal bearing sequence.

This boundary has tentatively been chosen as a major unit boundary between the continental, coal-bearing sediments above and marine clastics below. Although the highest marine fossils seen were below Unit W22 (in W23) the units W22 and W23 have much in common lithologically. Furthermore they have little in common with the overlying coaly Unit W21. It seems very likely that Unit W22 represents the transition between marine and continental deposition but no major transition unit has been defined here.

Environment and provenance: The presence of clean, cross bedded sandstones together with greywacke, shale, siltstone and minor coal indicates variable hydrodynamic conditions for the deposition of Unit W22. Deposition on a coastal plain could be envisaged - where the combined effects of river transport and deposition, tidal winnowing and lagoonal or swampy conditions prevailed. The presence of sediment - ingesting organisms but no marine fossil skeletons would be compatible with an estuarine environment for part of the unit. The sediments were derived from a local volcanic source.

UNIT W23

Characteristics: This unit is 285' thick, extending from 3745' to 4030'; it consists of protoquartzite, carbonaceous shale and siltstone. Core 14 is a dolomitic protoquartzite in which one small articulated brachiopod and other casts of probable shell fragments were found. This is the highest marine fossil horizon recorded in the well. As in Unit W22 there are burrow structures and abundant organic churning of some beds. Porosity was interpreted as poor.

The S.P. curve reads low over most of the interval with minor fluctuations away from the base line. The resistivity readings are also low compared with the overlying unit.

Boundary criteria: The upper boundary is marked by a sharp decrease in the

resistivity reading; this corresponds to change from subgreywacke above to shale and protoquartzite below. The porosity of the sandstone increases slightly from slight (<6%) to poor (6-12%).

As noted above, this break could possibly be taken as the major boundary between continental and marine sediments. Unit W23 contains the highest marine fossils recorded in the well. However the major break has been chosen at the base of the coal-bearing sequence (top of Unit W22).
Environment and provenance: The presence of marine fossils together with minor amounts of coal and pyrite suggests a restricted marine environment. The sediments were derived partly from a volcanic source, but the relative abundance of quartz, together with minor potash feldspar and traces of granite accessory minerals, indicates some influence from a granitic source.

UNITS W24 - 31 (plates 1C. 2B, 2C)

This sequence is 1650' thick extending from 4030' to 5680'; it consists mostly of siltstone and sandy siltstone with some beds of fine lithic sandstone, quartz sandstone, shale and mudstone. The sediments have been equated to the "Berry Shales" beneath the Budjong Sandstone Member (A.O.G. 1964).

UNIT W24

Characteristics: This unit is 240' thick, extending from 4030' to 4270'; it consists of interbedded siltstone, protoquartzite and shale. The siltstone is commonly sandy and micaceous; the protoquartzite is fine-grained and contains some feldspar and volcanic lithics. Core 15 exhibits fine laminations in siltstone and shale.
Boundary criteria: The upper boundary of this unit is a gradational one but has been picked at the top of the siltstone which characterises W24. In Unit W23 the protoquartzite becomes silty and very fine towards the base, and appears to grade to the siltstone of Unit W24. The increased siltiness downwards is reflected in the gamma ray curve and to a lesser extent in the S.P. curve.
Environment: The lamination in some of the rocks suggest the unit was deposited in quiet water. As this unit appears continuous with the marine Unit W23 a marine environment is likely also for W24.

UNIT W25

Characteristics: This unit is 110' thick extending from 4270' to 4380'; it consists almost entirely of sandy siltstone with minor sandstone ranging from protoquartzite to subgreywacke composition. These lithic sandstones contain both sedimentary and volcanic lithics. The resistivity log records high values over this unit.

Boundary criteria: At the upper boundary, the lithology changes from thinly interbedded siltstone and fine lithic sandstone of W24 to sandy siltstone of W25. The resistivity log increases sharply from W24 to W25 and the gamma log also increases slightly.

Environment and provenance: This fine-grained sediment was probably laid down in quiet water and was derived from sedimentary and volcanic source rocks.

UNIT W26

Characteristics: This unit is 50' thick extending from 4380' to 4430'; it consists of fine-grained subgreywacke containing abundant volcanic lithics and plagioclase. Porosity has been interpreted as poor. The S.P. curve shifts slightly away from the base line and reads a maximum of -5 m.v. while the resistivity remains high, as in the overlying unit.

Boundary criteria: The upper boundary is marked by the change from siltstone above to fine subgreywacke below. A slight increase in the S.P. reading and a decrease in the gamma ray count accompanies the lithological change.

Environment and provenance: No specific indicators of environment were recorded for this unit. The sediments were derived mostly from a volcanic source area.

UNIT W27

Characteristics: This unit is 420' thick extending from 4430' to 4850'; it consists almost entirely of grey sandy siltstone. There are minor beds of silicified quartz-rich sandstone and shale. Core 16 is a siltstone which is laminated and cross laminated, and exhibits symmetrical, concave upwards scallop structures which may be ripple marks.

The resistivity curve shows an overall decrease from the top to the bottom of the unit.

Boundary criteria: At the upper boundary there is a lithological change from fine subgreywacke of W26 to sandy siltstone of W27. This is accompanied

by a shift in the S.P. reading back to the base line and an increase in the gamma ray log. In effect it is a return to the conditions found in W25.
Environment and provenance: This uniform, fine-grained unit was probably deposited under stable conditions in quiet water. Bottom dwellers have churned the sediment in places. Volcanic and sedimentary rocks have contributed to deposition of this unit.

UNIT W28

Characteristic: This unit is 250' thick and extends from 4850' to 5100'; it consists of siltstone with beds of subgreywacke, shale and mudstone. The siltstone is non-sandy, unlike the siltstone in the overlying units W25 and W27. The subgreywacke is fine-grained, and contains abundant volcanic lithics and plagioclase, and minor amounts of chlorite, dolomite, pyrite and silt.

Core 17 consists of mudstone with lenses showing scallop structure. The origin of these structures is uncertain, but almost identical structures were reported by Alcock (1968) from the Stockyard Mountain (Farmout) No. 1 Well, where they were attributed to "distortion of ripple drift markings". However, the possibility remains that the structures were formed organically.
Boundary criteria: At the upper boundary the lithology changes from siltstone typical of W27 to interbedded subgreywacke, shale and siltstone. There is a decrease in resistivity at this boundary.
Environment and provenance: These sediments exhibit lamination and form part of a uniform lithologic sequence. Stable, low energy conditions are inferred for the depositional environment.

The presence of shell fragments in this unit, coupled with the fact that the adjacent unit contains brachiopods, strongly favours a marine environment for deposition of W28.

Volcanic and sedimentary rocks both contributed to the formation of these sediments.

UNIT W29

Characteristics: This unit is 50' thick extending from 5100' to 5150'; it consists of silicified protoquartzite containing minor plagioclase and potash feldspar

together with pebbles of quartz, meta-quartzite and grey mudstone. Secondary silica in the form of quartz overgrowths has reduced the original porosity to values ranging from slight to poor. Core 18 contains brachiopods up to 5 cm. in length.

The S.P. log shows a marked shift away from the base line, corresponding with a very high resistivity and low gamma ray count.

Boundary criteria: At the upper boundary of this unit there is a marked lithological change from siltstone and subgreywacke rich in volcanic lithics (W28) to protoquartzite rich in quartz, and containing minor sandy siltstone (W29). Besides a change in composition of the sandstones there is a change in grain size from very fine and fine-grained (W28) to medium-grained (W29).

The S.P. log registers a shift away from the base line of about 30 m.v. and the resistivity increases sharply. There is a corresponding decrease in the reading of the gamma ray log.

Environment and provenance: This well-washed sandstone containing pebbles and brachiopods was deposited in agitated marine waters. Its composition suggests that the sediment was derived from granitic and sedimentary source areas.

UNIT W30

Characteristics: This unit is 110' thick extending from 5150' to 5260'; it consists of interbedded fine protoquartzite, subgreywacke and siltstone with minor shale and mudstone beds.

The S.P. log falls back almost to the base line but fluctuates slightly over the unit. The resistivity also decreases, but remains at a moderately high level throughout the unit. The gamma ray log fluctuates but shows an overall increase downwards. This combination reflects the increasing siltiness of the unit downwards.

Boundary criteria: The upper boundary of this unit is characterised by a change in lithology from quartz-rich sandstone of W29 to lithic sandstone and sandy siltstone of W30. The grain size of the sandstones changes from medium-grained to very fine-grained across this boundary.

The electric logs show corresponding changes at this depth.

The S.P. Curve drops by about 25 m.v. and the resistivity curve decreases by about 250 ohms-m2/m.

Environment and provenance: The higher silt content of this unit and finer grain size of the sandstones indicate that less vigorous conditions prevailed than during deposition of the overlying unit W29. Unit W30 was derived partly from volcanic source rocks. Unit W29 and W30 correspond with the Kedumba Creek Sandstone Member of the "Berry Shales" according to the Company Report (A.O.G. 1964).

UNIT W31

Characteristics: This unit is 420' thick extending from 5260' to 5680'; it consists of siltstone and sandy siltstone with interbeds of fine lithic greywacke containing volcanic and sedimentary lithics, silicified quartz-rich sandstone and shale. Core 19 consists of fine quartz greywacke containing pebble beds, and siltstone with greywacke inclusions. The sediment has been churned in places; burrow structures were observed, and brachiopod shells are common. The S.P. log remains featureless over the unit except for small peaks opposite sandstone beds. The resistivity remains low over most of the unit, but there is a relatively high gamma ray count.

Boundary criteria: The change to unit W31 is marked by an increase in the proportion of siltstone, and in the siltiness of the sandstone compared with the overlying sediments of W30. The upper boundary is also marked by a sharp decrease in the resistivity reading downwards.

Environment and provenance: The poor bedding, poor sorting and diverse composition of the sediments demonstrated by Core 19 suggest the sediment was dumped into quiet waters. Marine conditions are indicated by the presence of brachiopods, and bottom dwellers were active in churning the sediment in some parts.

Sedimentary, granitic, basic igneous and metamorphic source rocks appear to have supplied detritus for this unit.

UNITS W32-40 (plates 1D, 2D)

This major unit is 1795' thick, extending from 5680' to 7475'; it is a variable sequence of quartz-rich sandstones, sandy siltstones and greywackes with minor lithic and feldspathic sandstones. According to the Company Report

(A.O.G. 1964), the sequence corresponds with the Nowra Sandstone, Wandrawandian Siltstone and Conjola Formation (see fig. 2).

UNIT W32

Characteristics: This unit is 150' thick extending from 5680' to 5830'; it consists of interbedded orthoquartzite, fine lithic greywacke and sandy siltstone. The orthoquartzite is mostly silicified and contains minor amounts of chert and feldspar; the lithic greywacke contains some volcanic lithics.

Core 20 exhibits a dip of 10°, but this may be due to cross bedding, since adjacent cores show sub-horizontal bedding. The electric logs show uniformly high resistivities, and no distinctive character.

Boundary criteria: The upper boundary is marked by a change from sandy siltstone at the base of W31 to orthoquartzite at the top of W32. Below this boundary is a thick sequence of quartz-rich sandstone (Units 32-40), whereas the overlying sequence (Units W24-31) consists mostly of siltstone.

The electric logs record this lithological change in a predictable manner. The S.P. shifts slightly away from the base line, the resistivity increases (by about 60 ohms-m2/m) and the mean gamma ray count decreases (by about 30 units).

Environment and provenance: The sediment was apparently deposited under low energy conditions and was derived from granitic and volcanic sources.

UNIT W33.

Characteristics: This unit is 355' thick extending from 5830' to 6185'; it consists almost entirely of silicified orthoquartzite which grades to protoquartzite and feldspathic sandstone in parts. There are minor beds of siltstone and subgreywacke containing volcanic lithics. Rare plant fossils occur near the base of the unit. Core 21 exhibits low angle cross-bedding and contains pebbles of quartz and sedimentary lithics. The porosity ranges from slight to poor having been severely reduced by quartz overgrowth.

The electric logs exhibit the same gross features as the overlying Unit W32.

Boundary criteria: At the upper boundary of this unit the lithology changes from the interbedded lithologies which characterise the overlying unit W32, to a clean orthoquartzite. No significant changes in the logs were observed.

Environment and provenance: Both cross bedding and the occurrence of pebble beds in this well-washed sandstone indicate deposition in agitated, flowing water. Plants were the only fossils encountered and suggest near shore or continental deposition.

The sediment was principally derived from sedimentary and granitic source areas, but with some minor volcanic source.

UNIT W34

Characteristics: This unit is 255' thick extending from 6185' to 6440'; it consists of interbedded protoquartzite, fine subgreywacke, arkose and siltstone. The sandstones in this unit have a higher silt content than in the overlying unit. The resistivity and gamma logs exhibit fluctuating patterns because of the interbedding.

Boundary criteria: The lithological change observed at the top of this unit is a gradational one, from orthoquartzite of Unit W33 to silty protoquartzite of Unit W34. The boundary has been chosen on the basis of a marked decrease in resistivity and a corresponding change in the character of the gamma ray curve.

Environment and provenance: Deposition probably took place under low energy conditions. The provenance apparently consisted of granitic, volcanic and sedimentary rocks as the lithic fragments are of these rock types.

UNIT W35

Characteristics: This unit is 130' thick extending from 6440' to 6570'; it consists mainly of pebbly protoquartzite with minor siltstone. The protoquartzite is similar to that in the overlying unit: the siltstone is grey, commonly sandy, and contains carbonaceous stringers and fragments.

The S.P. curve shifts away from the base line over much of the interval; the resistivity increases to a maximum of 500 ohms-m2/m and the gamma ray curve records low values.

Boundary criteria: At the upper boundary there is a lithology change from siltstone above to pebbly protoquartzite below. At this depth there is a corresponding increase in resistivity and a decrease in the gamma ray count.

Environment and provenance: The low proportion of fines suggests that this unit was deposited in agitated water, probably under similar conditions to those postulated for Unit W33.

UNIT W36

Characteristics: This unit is 115' thick, extending from 6570' to 6685'; it consists of sandy siltstone and greywacke. Carbonaceous fragments and pyrite are common, and marine fossils occur in Core 23. Rare oolites were also observed. The S.P. curve follows closely the shale base line while both the resistivity and gamma ray logs record moderate values.

Boundary criteria: At the upper boundary there is a distinct lithological change from protoquartzite of W35 to siltstone of W36. At this depth the S.P. curve drops back to the base line, the resistivity curve decreases by about 200 ohms-m2/m and the gamma ray count increases slightly.

Environment and provenance: The presence of marine fossils and the poor sorting of sediment indicates deposition in quiet marine waters. A granitic provenance is proposed for this unit as both plagioclase and K-feldspar are common and granite accessory minerals including zircon and biotite are present.

UNIT W37

Characteristics: This unit is 245' thick, extending from 6685' to 6930'; it consists of quartz-rich sandstone and quartz greywacke interbedded with sandy siltstone. The proportion of quartz sandstone increases downwards. Brachiopods, bryozoans, and rare plant fossils were observed and minor amounts of coal were recorded. Resistivity is high for this unit and the gamma ray count is moderate.

Boundary criteria: The lithological change from Unit W36 to W37 is probably gradational but the boundary was chosen where there is a sudden increase in the content of quartz sandstone. This corresponds with a small kick on the S.P. curve and an increase in resistivity of about 100 ohms-m2/m. The gamma ray count decreases by about 25 units and is maintained at approximately this level throughout the unit.

Environment of deposition: The fossils recorded throughout this unit indicate marine deposition. The interbedded nature of the sediments suggests intermittant quiet and agitated conditions.

UNIT W38

Characteristics: This unit is 250' thick, extending from 6930' to 7180'; it consists mostly of sandy siltstone with minor beds of quartz-rich sandstone, subgreywacke and feldspathic sandstone. Lithics include volcanic, granitic and siliceous types; rare shell fragments were observed. Core 24 is a sandy laminated siltstone which has been partly churned by organisms. Some burrow

structures have been preserved.

Boundary criteria: At the upper boundary there is a change from quartz-rich sandstone above to sandy siltstone below. This corresponds with a decrease in resistivity and an increase in gamma ray count.

Environment and provenance: The unit was deposited in quiet waters where bottom dwellers at times were active in churning the sediment. The provenance for this unit was probably granitic.

UNIT W39

Characteristics: This unit is 135' thick, extending from 7180' to 7315'; it consists of fine-grained feldspathic greywacke containing common angular feldspar grains with quartz and silt. Rare bryozoan fragments were seen in the cuttings; a trace of gas was detected at 7220'.

Boundary criteria: The boundary between Units W38 and W39 is gradational. The boundary was picked at the change in grain size from silt to very fine sand. Below this level the gamma ray log changes character though it gives the same mean count. The other logs show negligible change at this boundary.

Environment and provenance: The presence of bryozoan fossils indicates deposition in marine waters; the high content of feldspar suggests this unit was derived from local granitic source rocks.

UNIT W40

Characteristics: This unit is 160' thick, extending from 7315' to 7475'; it consists mostly of protoquartzite and feldspathic sandstone. There are some pebbly horizons and siltstone beds. Feldspar becomes abundant in parts and there is an increase in grain size towards the base. Rare spines and (?) foraminifera were observed.

Core 25 contains abundant sodic plagioclase and potash feldspar. The very low porosity appears to be caused by a combination of fine detrital matrix (part chloritised), calcite and silica cement.

The S.P. curve registers a shift away from the base line over most of Unit W40. The resistivity is high in the upper part of the unit but falls markedly opposite a siltstone horizon near the base. This low resistivity is accompanied by an extremely high gamma ray count apparently due to the presence of some radioactive substance in the siltstone bed.

Boundary criteria: The upper boundary is marked by a change from fine-grained feldspathic greywacke to medium-grained protoquartzite and feldspathic sandstone. This lithology change is accompanied by a slight shift of the S.P. curve away from the base line, an increase in resistivity of about 300 ohms-m2/m and a slight initial decrease in gamma ray count.

Environment and provenance: This unit was deposited in marine waters and derived from a local granitic source. ~~According to the Company Well Report (A.O.G. 1964)~~

UNIT W41

Characteristics: 112' of this unit was penetrated from 7475' to the total depth of 7587'; it consists of sheared, coarse-grained granodiorite composed mostly of sodic plagioclase and quartz. The feldspar resembles that encountered in some of the overlying sediments (W40 in particular) and it is suggested that Unit W41 is part of the basement rocks from which the overlying sediments were derived.

Boundary criteria: The upper boundary was picked at the lithological change from feldspathic sandstone of unit W40 to granodiorite (W41). In the cuttings the change is from partly rounded to highly angular fragments of feldspar and quartz. This level is marked on the electric log by a sharp increase in resistivity.

Age: The age of this granitic rock has been given as (?) Carboniferous by the Company; certainly it is a basement feature.

Material available from the bottom core is insufficient for carrying out isotopic age determination; also the sheared nature of the sample would make any results most unreliable.

CONCLUSIONS

Degree of Agreement with Well Completion Report

Fig. 2 shows there is general agreement between major boundaries picked in this study and those given in the Well Completion Report.

One obvious discrepancy however is the choice of a boundary between the two coal-bearing sequences W15-18 and W19-21. The Company has chosen the base of the upper coal-bearing sequence (Illawarra Coal Measures) at a coal seam. However in the present study the boundary between the two sets of coal-bearing strata has been made on the gross composition of the interseam clastic sediments. This is treated more fully in the descriptions of units W15-18 and W19-21.

A second point is that the Budjong Sandstone and the Kedumba Creek Sandstone Members of the Berry 'Shale' as delineated by the Company (A.O.G. 1964) have each been subdivided into two units on the basis of lithology and logs.

Thirdly the sediments described as the Nowra Sandstone, the Wandrawandian Siltstone and Conjola Formation in the Well Report have been attributed to one major unit in this study (units W32-40).

Summary of New Data

1. The Narrabeen Group formations as described by Hanlon et al. (1953) from the South Coast are found to be consistent in thickness and lithological type in the subsurface at Woronora No. 1.

2. The distribution of lithic sandstones as opposed to quartz-rich sandstones has been demonstrated for the succession at Woronora. This distinction was not previously noted by the Company. Besides adding to our knowledge of the provenance of various parts of the section this data has considerable bearing on porosity. Breakdown of the less resistant, labile

fraction in lithic sandstones provides a higher proportion of interstitial matrix (and hence lower porosity) than in quartz-rich sandstones.

3. Some of the sandstones in units W10, W11 and W12 are regarded as having good porosity but no traces of hydrocarbons were found. Sandstones in units W22-W40 (equated by the company to the Shoalhaven Group) are tight.

4. Division of the coal measure section on the basis of inter-seam lithologies was found to be satifactory for this well. It could easily provide a valuable tool in more distant correlations.

Economic Prospects

The tightness of the sandstones in the marine strata underlying the coal-bearing beds (Units W22-40) suggests that the petroleum prospects in this area are not good.

On the other hand some of the sandstones above the coal-bearing sediments - in particular units W10, W11 and W12 - appear to have good porosity and may have potential for underground fluid storage.

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WELL NAME, No. WORONORA No. 1
OPERATING Co. AUST. OIL & GAS CORP. LTD.
WELL LOCATION
Lat. 34°11'40"S S.-Long. 150°54'50"E.
Basin SYDNEY
State NEW SOUTH WALES
Tenement No. P.E.L. 102
1:250.000 Sheet No. SI 56-9

ELEVATION (A.S.L.)
: Ground Level 1160 ft.
: G.L...Datum 1172 ft.

SAMPLE STORAGE
: B.M.R., Canberra
: .....

HYDROCARBON SYMBOLS
- Show of oil
- Trace of oil
- Show of gas
- Trace of gas
- Fluorescence

MISCELLANEOUS
- Interval and Number of Formation Test
- No sample available from interval

PETROGRAPHIC WELL LOG
WORONORA (A.O.G.) No.1

Geology by. P.J. ALCOCK

Plate 1A

Silica
Iron oxide
Siderite
Lithics
Volcanics
Pyrite

Breccia to conglomerate
Quartz sand, sandstone
Siltstone
Claystone
Limestone
Dolomite

LITHOLOGICAL SYMBOLS
Coal
Shale and mudstone
Calcirudite
Calcarenite
Calcilutite

MINERAL ABBREVIATIONS

Fd	Feldspar	Chl	Chlorite
Plag	Plagioclase	Zr	Zircon
K-Fd	K-Feldspar	Rt	Rutile
Mi	Mica	Fe	Iron oxide
Amph	Amphibole	Ck	Kaolin
Ser	Sericite	Si	Silica
Gl	Glauconite	St	Siderite
Gt	Graphite	Ca	Calcite
Py	Pyrite	Dol	Dolomite

DEPTH (feet) from datum

FOSSILS
R - rare C - common
A - abundant X - present

CARBONATE % LOG
(Dil. HCl Test)
Calcite type — (1 min reaction)
Dolomite type --- (10 min reaction)
Approx. Wt %
20 40 60 80 100

GRAIN SIZE (Wentworth Scale)
Estim. size range & mode
Clay - Silt
Very fine
Fine
Medium
Coarse
Very coarse
Granule
Pebble
Sands

POROSITY (estim.) (Excluding silt - size)
Trace 1 - 2%
Low 2 - 5%
Mod. 5 - 10%
High 10 - 20%
Very high > 20%

LITHOLOGIES AND % OF CUTTINGS
50%

THIN - SECTIONS

DESCRIPTIONS OF CUTTINGS
(Descriptions refers to lithological pattern at corresponding depth)

1. FERRUGINOUS QUARTZ SANDSTONE: MOTTLED YELLOW TO RED-BROWN, HARD, WELL-SORTED, GRADES TO FERRUGINOUS QUARTZ GREYWACKE.
2. ORTHOQUARTZITE: WHITE TO FAWN, MASSIVE, WELL-SORTED. IRON OXIDE, SIDERITE, TRACE MICAS, HORNBLENDE; SOME QUARTZ OVERGROWTH.
3. FERRUGINOUS SHALE AND SILTSTONE: PART SANDY, SIDERITIC.
1. ORTHOQUARTZITE TO PEBBLY ORTHOQUARTZITE: WHITE OR SPECKLED, MASSIVE, FIRM. TRACE GRAPHITE, CARBONAC. MATERIAL, GREEN CHERT, QTZ. OVERGROWTH; SIDERITE CEMENT OR CLAY.
2. SHALE: SIDERITIC, LIMONITIC MED. GREY TO BROWN, LAMINATED.
3. VERY FINE LITHIC GREYWACKE: ABUND. SED. LITHICS, SIDERITE.
4. FINE ORTHOQUARTZITE: EXTENSIVE QTZ. OVERGROWTH.
5. SHALE AND SANDY SILTSTONE: INTERLAMINATED, PART CARBONACEOUS.
1. OOLITIC, FERRUGINOUS CLAYSTONE: ABUND. SPHERICAL CLAYSTONE OOLITES.
2. RED-BROWN CLAY-SHALE: THIN INTERBANDS WHITE CLAYSTONE.
2a. GREY SHALE: GRADES TO SANDY SILTSTONE.
3. MICACEOUS LITHIC GREYWACKE.
4. SANDY SILTSTONE: PALE GREY, FIRM, MICACEOUS.
5. ORTHOQUARTZITE: FINE TO MEDIUM GRAINED, PALE GREY, ABUND. LOOSE SAND BUT COM. ONLY HARD & SILICIFIED. LOCALLY ABUND. CHERT, CLAY LITHICS, DETRITAL MATRIX.
1. LITHIC SANDSTONE AND LOOSE SAND: GREY TO RED-BROWN. QTZ., RED & GREEN CHERT, CLAY LITHICS, SIDERITE PATCHES.
2. SHALE AND MUDSTONE: MED. GREY.
3. ORTHOQUARTZITE & SIDERITIC ORTHOQUARTZITE: CONTAINS ABUNDANT CHERT. COMMONLY CEMENTED WITH SIDERITE & IRON OXIDE.
4. SILTSTONE: MED. GREY.
1. PHOTOQUARTZITE & LOOSE SAND: RED & GREEN CHERT, SHALE & SILTSTONE LITHICS SIDERITE & IRON OXIDE.
2. SANDY SILTSTONE: PALE GREY MICACEOUS.
3. SHALE: GREY TO RED-BROWN SIDERITIC IN PART.
4. SANDY SILTSTONE: MINOR CARBONACEOUS SAND & SHALE LAMINATED.
1. PEBBLY ORTHOQUARTZITE: PHOTOQTZITE & LOOSE SAND. ABUND. RED & GREEN CHERT, MINOR CLAY LITHICS.
2. SHALE: GREY TO PALE GREENISH; GRADES TO SILTSTONE. PART SIDERITIC.
3. CALCAREOUS SUBGREYWACKE. CONTAINS ABUND SED. LITHICS, CHERT, MINOR PEBBLES & SILTSTONE BDS.
4. SILTSTONE: GREY TO BROWN, PART SIDERITIC, PART SANDY.

PHOSPHATE CONTENT (Molybdate Test)
Nil
Slight < 0.5%
Fair 0.5 - 2%
Mod. 2 - 5%
Good > 5%

INTERPRETED POROSITY Cores - Cuttings
Trace
Low
Mod.
High
Very high > 20%

S.P. LOG
Millivolts
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700

HYDROCARBONS CORES (Key to symbols above)

INTERPRETED LITHOLOGY (Key to symbols above)

RESISTIVITY
Ohms m²/m

GAMMA RAY LOG
Radiation intensity increases →

KEY MINERALS
Clasts
Cement, Matrix
Formation Test Data

DESCRIPTION OF INTERPRETED LITHOLOGY
Rock Name (after Pettijohn, 1957)

ORTHOQUARTZITE: MEDIUM GRAINED, PART FERRUGINOUS, PART SIDERITIC. MINOR PEBBLES AT BASE.

FERRUGINOUS SHALE AND SANDSTONE: INTERLAMINATED, PART SANDY.

ORTHOQUARTZITE AND PEBBLY ORTHOQUARTZITE. MINOR CARBONACEOUS MATERIAL AND FERRUGINOUS SHALE BEDS.

V. FINE LITHIC GREYWACKE OVERLYING FINE SILICIFIED PHOTOQUARTZITE AND INTERLAMINATED SHALE AND SANDY SILTSTONE.

OOLITIC FERRUGINOUS CLAYSTONE OVERLYING RED-BROWN CLAY-SHALE WITH MINOR HARD WHITE CLAYSTONE.

INTERBEDDED ORTHOQUARTZITE, LITHIC SANDSTONE AND SANDY SILTSTONE: PART FRIABLE, PART SILICIFIED.

LITHIC SANDSTONE.

ORTHOQUARTZITE & SIDERITIC ORTHOQUARTZITE: PART FERRUGINOUS; CONTAINS MINOR SANDS GREY SHALE, MUDSTONE & SILTSTONE.

INTERBEDDED PHOTOQUARTZITE & GREY & RED-BROWN SHALE. MINOR SANDY SILTSTONE.

PEBBLY ORTHOQUARTZITE & PHOTOQUARTZITE.

INTERBEDDED CALCAREOUS SUBGREYWACKE AND SHALE

CALCAREOUS SUBGREYWACKE: ABUND. SED. LITHICS.

B.M.R. UNITS

DESCRIPTION: Orthoquartzite & pebbly orthoquartzite with minor beds grey shale & siltstone. / Sandstones rich in quartz, chert & sedimentary lithics; red-brown & grey shales; minor mudstones.

MINOR UNIT: W1 W2 W3 W4 W5 W6 W7 W8 W9 W10 W11 W12 W13 W14

MAJOR UNIT: W1-4 / W5-14

COMPANY INTERPRETATION

FORMATION: HAWKESBURY SANDSTONE

GROUP: NARRABEEN GROUP

AGE: TRIASSIC

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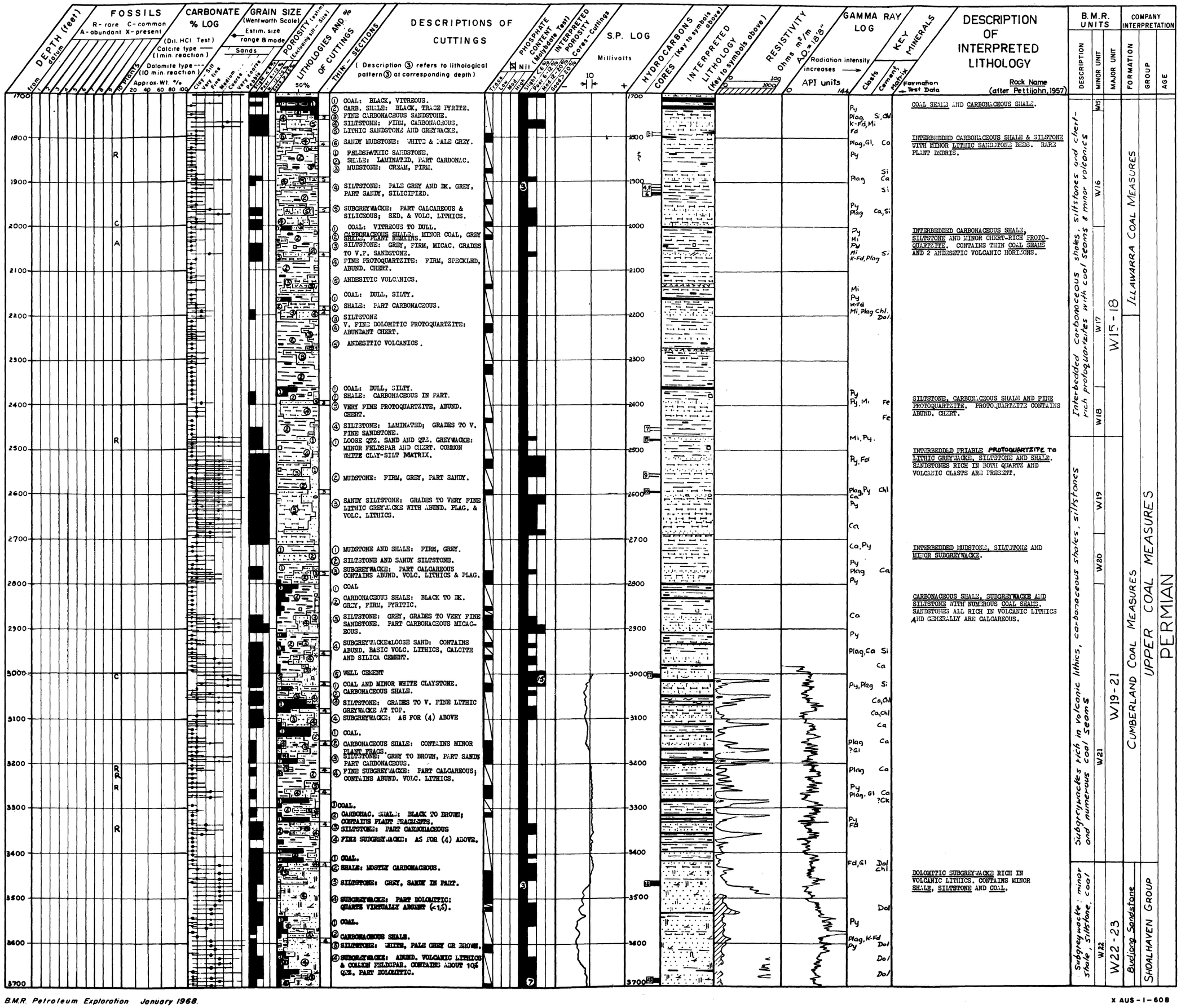
X AUS-I-60A



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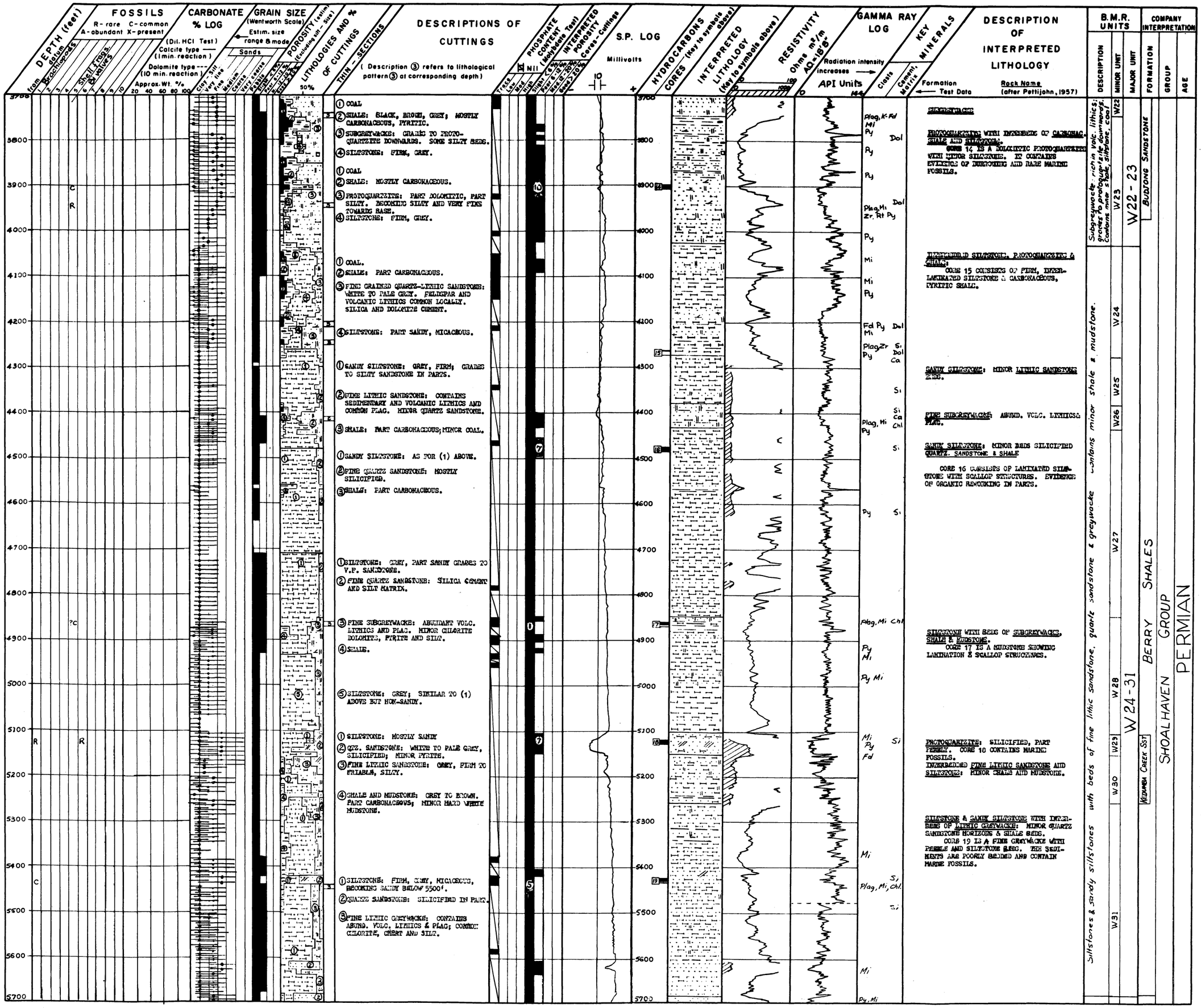
X AUS - 1 - 60B



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X AUS - I - 608

Plate 1D

DEPTH (feet) from datum

FOSSILS
R- rare C- common
A- abundant X- present
1 Brachiopods
2 Spirifer
3 Bryozoa
4 Foraminifera
5 Shell frags.
6
7
8 Plants
9
10

CARBONATE % LOG
(Dil. HCl Test)
Calcite type — (1 min. reaction)
Dolomite type --- (10 min. reaction)
Approx. Wt. %
20 40 60 80 100

GRAIN SIZE
(Wentworth Scale)
Estim. size range & mode
Sands
Clay - Silt
Very fine
Fine
Medium
Coarse
Very coarse
Granule
Pebble <4 cm
Over 4 cm

POROSITY (estim.)
(Excluding silt - size)
50%

LITHOLOGIES AND % OF CUTTINGS

THIN - SECTIONS

DESCRIPTIONS OF CUTTINGS
(Description ③ refers to lithological pattern ③ at corresponding depth)

PHOSPHATE CONTENT (Molybdate Test)
Nil
Trace
Low
Mod.
High

INTERPRETED POROSITY Cores - Cuttings
Slight < 6%
Poor 6-12%
Mod 12-20%
Good > 20%

S.P. LOG
Millivolts

HYDROCARBONS CORES (Key to symbols above)

INTERPRETED LITHOLOGY (Key to symbols above)

RESISTIVITY
Ohms m^2/m
AO = 18'8"
0 10 100 1000

GAMMA RAY LOG
Radiation intensity increases →
API units
Clasts
Cement. Matrix

KEY MINERALS
Formation Test Data
Rock Name (after Pettijohn, 1957)

DESCRIPTION OF INTERPRETED LITHOLOGY

B.M.R. UNITS
DESCRIPTION
MINOR UNIT
MAJOR UNIT

COMPANY INTERPRETATION
FORMATION
GROUP
AGE

Depth	Description	Key Minerals	Interpreted Lithology
5700	① SHALE: GREY, WHITE, BLACK ② SILTSTONE: GREY, SANDY, PART MICACEOUS.	Py, Mi Plag, Chl	INTERBEDDED ORTHOQUARTZITE, FINE LITHIC GREYWACKE AND SANDY SILTSTONE; LITHICS MOSTLY VOLCANIC. CORE 20 IS A LITHIC QUARTZ GREYWACKE WITH UNDULOSE SILT LAMINATIONS.	
5800	③ ORTHOQUARTZITE: CONTAINS MINOR CHERT, FELDSPAR & ALTERED LITHICS. MOSTLY CEMENTED BY QUARTZ OVERGROWTH. SOME LOOSE, ANGULAR QUARTZ GRAINS.	Plag, Mi Py	SILICIFIED ORTHOQUARTZITE: BECOMES SILTY AND GRADES TO PROTOQUARTZITE TOWARDS BASE. MINOR BEDS OF SILTSTONE AND SUBGREYWACKE WITH VOLCANIC LITHICS. SILTSTONE CONTAINS PLANTS NEAR BASE. CORE 21 GRADES FROM ORTHOQUARTZITE TO FELDSPATHIC SANDSTONE. IT CONTAINS DARK LAMINATIONS & PEBBLY HORIZONS, & EXHIBITS LOW ANGLE CROSS-BEDDING.	
5900	④ FINE LITHIC GREYWACKE & SUBGREYWACKE: CONTAINS ABUNDANT VOLCANIC LITHICS & PLAG, COMMON CHLORITE SED. LITHICS & CARBONACEOUS STRINGERS.	Plag, Mi, Chl		
6000				
6100	① SILTSTONE: GREY, PART SANDY, PART MICACEOUS; MINOR CARBONACEOUS FRAGS & PLANT MATERIAL.			
6200	② QUARTZ SANDSTONE: SIMILAR TO (3) ABOVE BUT CONTAINS MINOR SILT, & LITHIC GRAINS ARE MORE COMMON.	Plag, K-Fd Chl; Plag	INTERBEDDED PROTOQUARTZITE, FINE SUBGREYWACKE, ARKOSE AND SILTSTONE. THE SANDSTONES ARE COMMONLY SILTY. CORE 22 IS FINE QUARTZ GREYWACKE.	
6300	③ FINE SUBGREYWACKE AND ARKOSE: COMMON VOLC. LITHICS, FELDSPAR AND SILICEOUS LITHICS. PART SILTY, PART SIDERITIC.			
6400				
6500	① SILTSTONE: GREY, MOSTLY SANDY; CONTAINS CARBONACEOUS STRINGERS & FRACMENTS. ② QUARTZ SANDSTONE: PART SILTY, PART PEBBLY; GENERALLY SIMILAR TO (2) ABOVE.	Py	PEBBLY PROTOQUARTZITE: MINOR SILTSTONE & LITHIC SANDSTONE.	
6600	③ LITHIC SANDSTONE: VARIE-COLOURED, FRIABLE, PART SILTY.	Mi	SANDY SILTSTONE AND GREYWACKE: CONTAINS CARBONACEOUS MATERIAL. CORE 23 CONTAINS COMMON MARINE FOSSILS.	
6700	④ COAL ⑤ SHALE	Mi		
6800	① SILTSTONE: GREY, PART SANDY ② QUARTZ SANDSTONE: MOSTLY SILTY, HARD WITH MINOR LITHICS. ③ LITHIC SANDSTONE ④ CALCITE RHOMBS	Ca Ca, Plag, Mi, Chl, Py	QUARTZ SANDSTONE & QUARTZ GREYWACKE: INTERBEDDED WITH SANDY SILTSTONE. CONTAINS CARBONACEOUS MATERIAL IN PARTS.	
6900	① COAL ② SILTSTONE: PART SANDY, PART LAMINATED. CARBONACEOUS IN UPPER PART. ③ QUARTZ SANDSTONE: PART SILTY. ④ SUBGREYWACKE & FELDSPATHIC SANDSTONE: CONTAINS FELDSPAR AND VOLCANIC, GRANITIC AND SILICEOUS LITHICS.	Py Ca Plag, K-Fd Mi Chl	SANDY SILTSTONE WITH MINOR QUARTZ SANDSTONE BEDS. CORE 24 CONSISTS OF SANDY LAMINATED SILTSTONE AND FINE GREYWACKE. THE SEDIMENT HAS BEEN PARTIALLY CHURNED AND CONTAINS WORM BURROWS.	
7000		Py		
7100		Mi, Py		
7200	① SUBGREYWACKE: CALCAREOUS; CONTAINS ABUND. VOLC. LITHICS & FELDSPAR. ② QUARTZ SANDSTONE. ③ FINE FELDSPATHIC GREYWACKE: GRADATIONAL WITH (2) ABOVE. ④ SILTSTONE.	Plag Mi Chl Ca Py Plag Mi Chl Ca	FINE FELDSPATHIC GREYWACKE: GRADES TO SANDY SILTSTONE ABOVE AND TO MEDIUM PROTOQUARTZITE BELOW.	
7300		Mi, Py		
7400	① PROTOQUARTZITE: CONTAINS COMMON SED. LITHICS & PLAG. PART SILTY. ② LITHIC GREYWACKE. ③ SILTSTONE. ④ ANGULAR FRAGMENTS OF QUARTZ, CLEAR & TURBID FELDSPAR.	Ca Fd, Mi, Ca Plag Si	PROTOQUARTZITE & FELDSPATHIC SANDSTONE: PART SILTY; CONTAINS MINOR PEBBLY BEDS & SILTSTONE BEDS. FELDSPAR ABUND. IN PARTS.	
7500		Plag, Mi Fd, Py Fd	COARSE GRAINED GRANITE: CONSISTS ALMOST ENTIRELY OF SODIC PLAGIOCLASE AND QUARTZ.	
7587				

B.M.R. UNITS

DESCRIPTION	MINOR UNIT	MAJOR UNIT
Quartz sandstones, sandy siltstones & greywackes with minor lithic sandstones. & become rich in feldspar towards the base. The siltstones contain minor carbonaceous horizons.	W32	
	W33	
	W34	
	W35	
	W36	
	W37	W32-40
	W38	
	W39	
	W40	
Granite	W41	W41

COMPANY INTERPRETATION

FORMATION	GROUP	AGE
YOWRA SANDSTONE		
	WANDRAWANDIAN	PERMIAN
CONJOLA FM.	SILTSTONE	
GRANITE	SHOALHAVEN GROUP	
		? CARBONIFEROUS

B.M.R. Petroleum Exploration January 1968.

X AUS-1-608

Plate 2A

WELL NAME, No.: WORONORA (A.O.G.) No.1
OPERATING Co.: AUST. OIL & GAS CORP. LTD.
WELL LOCATION
Lat.: 34°11'40"S. Long.: 150°54'50"E.
Basin: SYDNEY
State: NEW SOUTH WALES
Tenement No. P.E.L. 102
1:250,000 Sheet No. SI56-9

ELEVATION (A.S.L.)
Ground Level 1160 ft.
R.T. Datum 1172 ft

SAMPLE STORAGE
B.M.R., Canberra

PETROGRAPHIC CORE LOG
WORONORA (A.O.G.) No.1

Geology by: P.J. Alcock

Bedding >5cm.
" 1-5cm.
" 0.5-10cm.
" 01-0.5cm.
" <0.1cm.
Crossbedding
Micro-crossbedding
Ripple marks
Undulate bedding
Scallop structure
Burrow structure
Concretion: siderific
Organic reworking

Interval - 1ft: 6540'6" / 6541'6"
Core not recovered
Position of lost core not known

Porosity (estimated)
S - Slight < 6%
P - Poor 6-12%
M - Medium 12-12%
G - Good > 20%

Abundance (estimated)
R - Rare < 1%
C - Common 1-3%
A - Abundant > 3%

Lithics
Siderite
Volcanics
Silica
Pyrite
Feldspar

Breccia to conglomerate
Quartz sand, sandstone
Siltstone
Claystone
* Limestone
* Dolomite
Coa.
Shale and mudstone
* Calcirudite
* Calcarenite
* Calcilutite
* Symbols used to designate carbonate minerals (Calcite, Dolomite etc) in the "Essential Components" column

CORRELATION: AGE, GROUP, FORMN., COMPANY INTERPRET N., B.M.R. UNITS
GENERALIZED DESCRIPTION: CORE No. RECOVERY FOOTAGES, LITHOLOGY, DESCRIPTION, GENERALIZED ROCK NAME, COLOUR (Rock Colour Chart G.S.A. 1963), SEDIMENTARY STRUCTURE, DIP & TECTONIC STRUCTURE (Symbols)
DETAILED DESCRIPTION: DEPTH OF SAMPLE SECTIONED, ANALYZED; SPECIFIC ROCK NAME (After Pettijohn 1957); POROSITY (Slight <6%, Poor 6-12%, Med. 12-20%, Good >20%, where measured); PERMEABILITY Millidarcys (Vertical, Horizontal); ROUNDNESS (Poor, Mod., Good); SORTING; GRAIN-SIZE (Wentworth Scale) Estim size Range & Mode: Clay-Silt, Very Fine, Fine, Medium, Coarse, Very Coarse, Pebbles; SANDS; THIN-SECTION ANALYSIS: % OF ESSENTIAL COMPONENTS (Cross hatched if material clearly present as cement and/or matrix porosity shown as blank); Matrix and/or Cement Estim % of Total Rock (Clay-Undiff, Kaolin Gp); Cement Symbols See Legend; ACCESSORY MINERALS Estim R C-A or Measured % Total Rock: Dark Minerals, "Light Mnrl", TOTAL "DARK", Iron oxide, Hydroxide, Phosphate, Glauconite, Tourmaline; MATURITY INDEX; NOTES (provenance, environment of deposition, diagenesis, palaeontology etc)

TRIASSIC
NARRABEEN GROUP
W5-14
W12
W13

PERMIAN
UPPER COAL MEASURES
CUMBERLAND COAL M.
W19-21
W19
W18
W15-18
W16
ILLAWARRA COAL MEASURES

Core No. / Footages	Lithology	Description	Generalized rock name	Colour	Sed. structure	Dip & tectonic structure	Depth of sample sectioned, analyzed	Specific rock name (After Pettijohn 1957)	Notes
1491'									
1 (4')		PROTOQUARTZITE: GREY TO RED-BROWN, VERY FRIABLE. CONTAINS ABUNDANT CHERT (GREEN, PINK & GREY), CLEAR ANGULAR QUARTZ; MINOR SHALE LITHICS, FELDSPAR & SILICIFIED, FINE GRAINED SED. LITHICS.		Yellow-grey to red-brn Yellow-grey			1492'6"	MED. GRAINED PROTOQUARTZITE.	ABUNDANCE OF CHERT ALONG WITH OTHER SEDIMENTARY LITHICS INDICATES A SEDIMENTARY SOURCE. LOW PROPORTION OF FINES, PRESENCE OF IRON OXIDES, APPARENT MASSIVE BEDDING SUGGESTS DEPOSITION IN AGITATED WATERS; POSSIBLY UNDER OXIDISING CONDITIONS.
1496'									
1597									
2 (7')		PEBBLY MUDSTONE: PALE TO MED. GREY. CONTAINS ABUNDANT ANG. TO SUBROUND PEBBLES OF CLAYSTONE, MUDSTONE; SAND GRAINS & PEBBLES OF CHERT, QTZ., PROTOQTZITE. SET IN FRIABLE MUDSTONE.		Med-grey					
1602									
1604				Med-grey			1603'6"	PEBBLY MUDSTONE WITH SIDERITISED CONCRETIONS. (FORMERLY ? CHAMOSITE PISOLITES).	ORIGIN OBSCURE. PRESENCE OF SIDERITIC CONCRETIONS CONSPICUOUS. IDENTICAL WITH THOSE FROM SURFACE SAMPLES OF TOMBARRA SHALE. SPEC. NO. 3156-9-20c.
1790									
3 (6')									
1795									
1908									
4 (6')									
1913									
1913									
5 (6')									
1917									
1926									
6 (4')		SHALE & CARBONACEOUS MUDSTONE OCCURS AS LARGE FRAGMENTS BROKEN BY THE BIT. NOW IMBEDDED IN SOFT CARB. MUDSTONE, CLAYSTONE.		Dk. grey to black Grey & lt. brn.					DEPOSITED IN QUIET WATER.
1931									
2451									
7 (6')									
2456									
2478									
8 (6'7")		CARBONACEOUS SANDY SHALE: HARD, FISSILE; CONTAINS OCC. FRIABLE PEBBLES; UP TO 10% SAND.		Dk. grey			2478'4"	CARBONACEOUS SANDY SHALE: PEBBLES & SAND GRAINS OF VOLCANIC ROCK, SILLIMANITE SCHIST, QTZ.	CONTAINS MINOR PLANT FRAGS. SOURCE ROCKS INCLUDE BASIC TO INTERM. VOLCANIC ROCKS, LOW GRADE METAMORPHICS.
2480									

CORRELATION

COMPANY INTERPRET N. | B.M.R. UNITS

AGE: PERMIAN

GROUP: SHOALHAVEN GROUP

FORM'N: BERRY SHALES — BUDJONG SANDSTONE MEMBER

UPPER COAL MEASURES

CUMBERLAND COAL MEASURES

W19-21

W19

W21

W22-23

W22

GENERALIZED DESCRIPTION

DETAILED DESCRIPTION

CORE Nº RECOVERY FOOTAGES	LITHOLOGY	GENERALIZED ROCK NAME	DESCRIPTION	COLOUR (Rock Colour, Chart & Name)	SEDIMENTARY STRUCTURE, DIP & TECTONIC STRUCTURE	DEPTH OF SAMPLE SECTIONED & ANALYZED	SPECIFIC ROCK NAME (After Pettijohn 1957)	POROSITY % where measured	PERMEABILITY Millidarcys	ROUNDNESS	SORTING	GRAIN-SIZE (Wentworth Scale) Estim size Range & Mode SANDS	THIN-SECTION ANALYSIS % OF ESSENTIAL COMPONENTS	Matrix and/or Cement Estim % of Total Rock	ACCESSORY MINERALS Estim R-C-A or Measured % Total Rock "Dark Minerals" / "Light Mnrl"	NOTES (provenance, environment of deposition, diagenesis, palaeontology etc)
2558																
9 (6") ?																
2596																
10 (6")			LITHIC GREYWACKE: SLIGHTLY FISSILE, HARD. ABUNDANT LITHICS, FELDSPAR. MINOR QTZ., CHERT. UP TO 40% CLAY-SILT MATRIX	Med. grey		2596'3"	FINE GRAINED LITHIC GREYWACKE									FELDSPAR PARTLY ALTERED TO CARBONATE. SUBORAL SHAPES COMMON. LOCAL VOLCANIC SOURCE. DEPOSITION IN QUIET WATER.
2598							ABUNDANT VOLCANIC ROCK FRAGS., PLAGIOCLASE.									
3000			COARSE GRAINED SUBGREYWACKE: VERY FIRM, WELL COMPACTED. SHOWS GRAIN SIZE LAYERING.													ABUNDANCE OF ANGULAR VOLCANIC ROCK FRAGMENTS TO THE EXCLUSION OF QUARTZ INDICATES A LOCAL VOLCANIC SOURCE. PRESENCE OF LARGE WOOD FRAGMENTS & PEBBLES, TOGETHER WITH AN OVERALL LACK OF FINES SUGGESTS DEPOSITION IN AGITATED WATERS CLOSE TO LAND. ORIGINAL POROSITY SEVERELY REDUCED BY COMPACTION & CALCITE CEMENTATION.
11			COARSE GRAINED CALCAREOUS SUBGREYWACKE: CONTAINS LARGE CARBONISED WOOD FRAGMENTS. SHOWS GRAIN SIZE LAYERING.													
(9'4")			COARSE GRAINED SUBGREYWACKE: GRAIN SIZE LAYERING. CALCITE CEMENT CONCENTRATED IN COARSER BEDS.													
			COARSE GRAINED SUBGREYWACKE: AS ABOVE.	Med. lt. grey		3005	VOLCANIC SUBGREYWACKE.	18	Nil	Nil						0.06
3008			CALCAREOUS SUBGREYWACKE: CONTAINS CARBONACEOUS STRINGERS.													
			CALCAREOUS SUBGREYWACKE: STRONGLY CALCAREOUS.	Med. lt. grey		3009	CALCAREOUS VOLCANIC SUBGREYWACKE.									0.01
3010																
3465			DOLOMITIC SUBGREYWACKE MIXED WITH CARBONACEOUS MUDSTONE.	Lt. to dk grey		3465'8"	DOLOMITIC VOLCANIC SUBGREYWACKE.									0.08
			DOLOMITIC SUBGREYWACKE.	Pale yell. grey		3466'2"	AS ABOVE.									0.07
			DOLOMITIC SUBGREYWACKE MIXED WITH CARBONACEOUS MUDSTONE. ORGANIC MIXING OF THE TWO LITHOLOGIES.	"		3467'2"	DOLOMITIC VOLCANIC CARBONACEOUS SUBGREYWACKE.	21	Nil	Nil						0.33
				Lt. grey-black												
12 (9'1")				Lt. yell-grey & dk grey												
				"												
				"												
			DOLOMITIC SUBGREYWACKE FINELY INTERLAMINATED WITH CARBONACEOUS SILTSTONE.	"		3472'3"	DOLOMITIC SUBGREYWACKE.									0.08
3474																
3475																
3681																
			DOLOMITIC SANDSTONE: ABUNDANT PLAGIOCLASE & VOLCANIC ROCK FRAGMENTS. CONSPICUOUS "SWIRL" TEXTURE PROBABLY CAUSED BY ORGANIC MIXING.	Med. lt. grey & dk grey		3682'4"	FINE DOLOMITIC ARKOSE.									0.75
			DOLOMITIC SANDSTONE: UNDISTURBED.													
			DOLOMITIC SANDSTONE: DISTURBED, ? WORM TUBES AT 3685' 5".	"												
13 (7'4")			DOLOMITIC SANDSTONE: UNDISTURBED, WELL-BEDDED.	Pl. yell-grey												
			DOLOMITIC SANDSTONE MIXED WITH CARBONACEOUS, PYRITIC MUDSTONE (4INCH). ? WORM TUBES COMMON.													
3688			LITHIC SANDSTONE & GREYWACKE: ABUNDANT INTERMEDIATE VOLCANICS; MODERATE BEDDING.	Pl. yell-grey & dk grey		3687'9"	VOLCANIC SUBGREYWACKE.	17	Nil	Nil						0.13
3691																
3900			DOLOMITIC SANDSTONE: BEDDING DISTURBED BY ORGANIC MIXING.	Med. lt. grey												
3902			DOLOMITIC SANDSTONE: BEDDING POOR. SCATTERED CARBONACEOUS FRAGMENTS.	"		3901'11"	VERY FINE DOLOMITIC PROTOQUARTZITE.	10	Nil	Nil						1.0
14 (7'6")			DOLOMITIC SANDSTONE MIXED WITH MINOR SILTSTONE. ABUNDANT ORGANIC REWORKING, BURROWING AT 3904' 5"-8".	"		3904'4"	FINE DOLOMITIC PROTOQUARTZITE.									3.3
			DOLOMITIC SANDSTONE MIXED WITH SILTSTONE. WORM TUBES AT 3905' 6" - 3905'.													
3907				Yell-grey & Med grey		3907'4"	VERY FINE DOLOMITIC PROTOQUARTZITE.									4.3
3910																

1 SMALL ARTICULATED BRACHIOPOD & OTHER CASTS OF ? SHELL FRAGMENTS. THIS IS THE HIGHEST MARINE FOSSIL HORIZON RECORDED IN THE WELL. ABUNDANCE OF QUARTZ, WITH MINOR K-FELD. & TRACES OF GRANITE ACCESSORY MINERALS SUGGESTS A GRANITIC SOURCE. ENVIRONMENT OF DEPOSITION: MARINE, MOSTLY QUIET WATERS WITH COMMON SEDILIENT-CHURNING ORGANISMS. SIMILARITY WITH CORES 12 & 13 SUGGESTS THESE LATER SEDIMENTS MAY ALSO BE MARINE TO MARGINAL MARINE.

CORRELATION

COMPANY INTERPRETN.

AGE: PERMIAN

GROUP: SHOALHAVEN GROUP

FORMN.: Kedumba Creek Sandstone; BERRY SHALES; W24-31

B.M.R UNITS: W24, W27, W28, W29, W31

GENERALIZED DESCRIPTION

CORE Nº RECOVERY FOOTAGES	LITHOLOGY	DESCRIPTION — GENERALIZED ROCK NAME	COLOUR (Rock Colour Chart GSA 1963)	SEDIMENTARY STRUCTURE (see symbols)	DIP TECTONIC STRUCTURE
4265					
15 (0'3")		DOLOMITIC SILTSTONE & PYRITIC SHALE. INTERLAMINATED, HARD, COMPACT, QUARTZ, PLAGIOCLASE & UNIDENTIFIABLE SILT.	Lt. & dk grey		
4275					
4478					
		SILTSTONE: FIRM, LAMINATED & CROSS-LAMINATED. RANDOM SCALLOPED STRUCTURE. ABUNDANT QUARTZ SILT, MINOR PLAG.	Lt grey & med grey		
4480		SILTSTONE: FIRM, LAMINATED. SCALLOP STRUCTURE POORLY DEVELOPED.			
16 (10')		SANDY SILTSTONE: LAMINATED CONCAVE-UPWARD SCALLOP STRUCTURE (? RIPPLE MARKS).	Lt grey & med grey		
		SANDY SILTSTONE: FINELY LAMINATED WITH WELL DEVELOPED REGULAR CONCAVE UPWARDS SCALLOP STRUCTURE (? RIPPLE MARKS).	Lt grey & med grey		
4486		SANDY SILTSTONE: AS ABOVE. THE ? RIPPLE MARKS ARE SYMMETRICAL.			
4488					
4860					
17 (5')		MUDSTONE: SLIGHTLY CARBONACEOUS, PYRITIC. SOME SUBHORIZONTAL LENSES UP TO 1 cm THICK WITH SCALLOP STRUCTURE (? DISTORTION OF RIPPLE DRIFT MARKINGS).	Med. dk grey		
		MUDSTONE: CALCAREOUS. LENSES WITH SCALLOP STRUCTURE MORE COMMON THAN ABOVE.	Med. dk grey		
4865		MUDSTONE: CALCAREOUS. ABUNDANT SUB-HORIZONTAL LENSES WITH SCALLOP STRUCTURE THROUGHOUT.			
4870					
5120					
		QTZ. SANDSTONE: SILICIFIED WITH SCATTERED PEBBLES OF SILICEOUS LITHICS. PYRITE IN VEINS.	Lt. grey		
		QTZ. SANDSTONE: SILICIFIED, WITH CARBONACEOUS STRINGERS.	Lt. grey		
18 (8'1")		QTZ. SANDSTONE: SILICIFIED, PEBBLY. QUARTZ GRAINS OVERGROWN. PEBBLES OF QTZ., SILIC. LITHICS, QTZ. SST. & FIRM GREY MUDSTONES; MOSTLY FLATTENED OR ELONGATE.	Lt. grey		
		QTZ. SANDSTONE: SILICIFIED. OCCASIONAL FLATTENED SHALE PEBBLES.	Lt. grey		
		PEBBLY QTZ. SANDSTONE: PEBBLES QTZ., SILIC. LITHICS, GREY SHALE. CONTAINS CHERT, IRON OXIDES, SILIC. CEMENT.	Lt. grey		
5128					
5130					
5425					
		GREYWACKE: FIRM, CONTAINING INTERLAMINATED, DARK GREY LENSES OF SILTSTONE (15%).	Med. grey		
		SILTSTONE: FIRM, CONTAINING INCLUSIONS OF GREYWACKE AS ABOVE.	M. grey		
19 (6')		PETROLOGIC PARACONGLOMERATE	M. grey		
		GREYWACKE: FIRM, CONTAINING SAND GRAINS & PEBBLES OF QUARTZ, CHERT, SILICEOUS LITHICS & SILTSTONE WITH 30% SILT MATRIX.	M. grey		
		SILTSTONE: FIRM, LAMINATED WITH INCLUSIONS OF GREYWACKE	M. grey		
5430		GREYWACKE: BEDDING DISTURBED BY ORGANIC ACTIVITY. MIXED WITH MINOR PYRITIC SILTSTONE.	M. grey		
5435					

DETAILED DESCRIPTION

DEPTH OF SAMPLE SECTIONED, ANALYZED	SPECIFIC ROCK NAME (After Pettijohn 1957)	POROSITY (% where measured)	PERMEABILITY (Millidarcys)	ROUNDNESS	SORTING	GRAIN-SIZE (Wentworth Scale) Estim Size Range & Mode — SANDS	THIN-SECTION ANALYSIS — % OF ESSENTIAL COMPONENTS (cross hatched if material clearly present as cement and / or matrix; porosity shown as blank)	Matrix and/or Cement Estim % of Total Rock (Clay-undiff; Kaolin Gp; Chlorite)	ACCESSORY MINERALS Estim R C A or Measured % Total Rock — Dark Minerals: Pyrite, Iron Oxides, Biotite, Muscovite, Glauconite; Light Var.: Plagioclase, K-Feldspar, Quartz	TOTAL CLAY	MATURITY INDEX	NOTES (provenance, environment of deposition, diagenesis, palaeontology etc)
4265'	DOLOMITIC SILTSTONE & PYRITIC SHALE.								A A C			FINE LAMINATIONS SUGGEST DEPOSITION IN QUIET WATERS.
4479'6"	FINELY LAMINATED SILTSTONE.								C C A			PRESENCE OF CHERT, ROUNDED SILICEOUS PEBBLES SUGGESTS REWORKING OF EARLIER SEDIMENT. PRESENCE OF PLAGIOCLASE & MINOR VOLCANIC LITHICS POINTS TO SOME VOLCANIC INFLUENCE NEAR THE DEPOSITIONAL SITE. LOW ENERGY HYDRODYNAMIC CONDITIONS. IF THE CONCAVE UPWARD SCALLOP STRUCTURES ARE RIPPLE MARKS THIS SUGGESTS GENTLY OSCILLATING WATER. APPARENTLY SOME CHURNING OF SEDIMENT IN PARTS.
4482	VERY FINE SANDY SILTSTONE.								C R C C			
4487	FINELY LAMINATED SILTSTONE.								C R C C A			
4861'6"	MUDSTONE								C C C A			ORIGIN OF SCALLOP STRUCTURES OBSCURE. DEPOSITION UNDER LOW ENERGY CONDITIONS, PROBABLY IN RESTRICTED MARINE WATERS.
												? DISTORTED SHELL FRAGMENTS COMMON.
5120	SILICIFIED PROTOQUARTZITE. MINOR PLAG. & K-FELD.	Nil	Nil						C R C R R C C	7·0		PROPORTION OF SILICA CEMENT NOT ACCURATELY KNOWN BECAUSE LARGELY IN FORM OF QUARTZ OVERGROWTHS. THIN & THICK SHELLED BRACHIOPODS UP TO 5 cm IN LENGTH; OTHER SHELL FRAGMENTS COMMON. SEDIMENTARY & GRANITIC PROVENANCE. DEPOSITION IN AGITATED MARINE WATERS.
									C C			
5124'4"	FINE QUARTZ GREYWACKE: CONTAINS MINOR PLAG. (ALBITE-OLIG) CHLORITIC & KAOLINITIC MATRIX.								C C R R C C	6·8		
									C C C			
									C R C			
5425'6"	FINE QUARTZ GREYWACKE & CARBONACEOUS, PYRITIC SILTSTONE.								C C C A C	5·2		SEDIMENTARY & GRANITIC PROVENANCE WITH MINOR INFLUENCE FROM BASIC IGNEOUS & ? METAMORPHIC ROCK. DIVERSE COMPOSITION & LARGE RANGE IN GRAIN SIZE. BRACHIOPOD SHELLS COMMON, SEDIMENT CHURNED IN PLACES BY BOTTOM DWELLERS.
									C C			
		5	Nil	Nil					C C			
									C A			
									C C			
									C C			
5429'5"	FINE QUARTZ GREYWACKE. SOME QTZ. OVERGROWTH, EMBAYED BOUNDARIES. CONTAINS MINOR PLAG. (ALBITE) & MICROCLINE.								A A C C C	3·5		DEPOSITION IN QUIET MARINE WATERS. POROSITY SEVERELY REDUCED BY SECONDARY QTZ. OVERGROWTH.

CORRELATION / GENERALIZED DESCRIPTION / DETAILED DESCRIPTION

AGE	GROUP	FORMN	B.M.R UNITS	CORE Nº RECOVERY FOOTAGES	LITHOLOGY	GENERALIZED ROCK NAME	DESCRIPTION	COLOUR (Rock Colour Chart G.S.A. 1963)	SEDIMENTARY STRUCTURE	DIP & TECTONIC STRUCTURE	DEPTH OF SAMPLE SECTIONED, ANALYZED	SPECIFIC ROCK NAME (After Pettijohn 1957)
PERMIAN	SHOALHAVEN GROUP	NOWRA SANDSTONE	W32	5780								
				20 (6')			GREYWACKE WITH INTERBEDDED SANDY MICACEOUS SILTSTONE (40%)	Med. grey	ULIII	T10°	5780'2"	FINE QUARTZ GREYWACKE. SOME QTZ. OVERGROWTH EMBAYED BOUNDARIES. CONTAINS MINOR PLAG. (ALBITE) & MICROCLINE.
				5784								
			W33	6083			QUARTZ SANDSTONE: SILICIFIED, CONTAINS RARE PEBBLES, MINOR DARK, MICACEOUS LAMINATIONS.	Lt. grey	II			
				21 (3'8")			PEBBLY QUARTZ SANDSTONE: SILICIFIED. CONTAINS PEBBLES OF QUARTZ, CHERT, SILICIFIED LITHICS, GREY SHALE.		DIVI	T15°	6085'2"	FELDSPATHIC SANDSTONE: GRAINS OVERGROWN.
				6088								
			W34	6372			GREYWACKE: SILICIFIED. CONTAINS COMMON PATCHES & STRINGERS OF DARK GREY SILT.	Med. lt. grey	III		6372'9"	QUARTZ GREYWACKE, GRAINS THOROUGHLY OVERGROWN. FELDSPAR (ALBITE & MICROCLINE) BOTH FRESH AND WEATHERED.
				22 (1'8")								
				6374								
				6670			SILTSTONE: FIRM, PART SHALY, PART SANDY, CONTAINS 1% SAND-MOSTLY IN PATCHES.	Med. grey	II			
			W36	23 (4'5")			GREYWACKE: FIRM, PYRITIC, FOSSILIFEROUS. BEDDING POORLY DEVELOPED.		III		6671'10"	QUARTZ GREYWACKE; CALCAREOUS. RARE OOLITES — CALCAREOUS OR CHLORITIC WITH QUARTZ CENTERS.
							GREYWACKE: AS ABOVE, WITH LENSES OF CLEAN, SILICIFIED SANDSTONE.	Med. grey				
				6677								
				7016			SANDY SILTSTONE WITH DARK GREY, IRREGULAR LAMINAE OF SILTSTONE (25%)	Med. grey	III	T5°	7017'6"	VERY FINE SANDY SILTSTONE.
				7018			SANDY SILTSTONE: FIRM, LAMINATED, CONTAINS DARK GREY, UNDULATING LAMINAE & SMALL STRINGERS OF SILTSTONE (25%)	Med. grey	III			
			W32 - 40	24 (9'9")			SILTSTONE: FIRM, LAMINATED.	Med. grey	III			
							SANDY SILTSTONE: PART LAMINATED. BEDDING DISTURBED BY BURROWING ORGANISMS.	Med grey	III	T3°		
				7024			GREYWACKE: BEDDING DISTURBED. MIXED WITH DARK GREY SILTSTONE (25%)	Med. grey	II		7024'2"	FINE QUARTZ GREYWACKE.
							SILTSTONE: LAMINATED, SLIGHTLY SANDY, FIRM. BEDDING PARTLY DISRUPTED BY BURROWING ORGANISMS.	Med. grey	III			
				7029								
			W38	7368								
		CONDOLA FM.	W40	25 (2'0")			PEBBLY GREYWACKE: SILICIFIED. VERY SILTY AT TOP, BED OF SILICIFIED ARKOSIC SANDSTONE AT BASE. CONTAINS STRINGERS OF DARK GREY PYRITIC SILTSTONE.	Med lt. grey	DVI		7368'2"	FELDSPATHIC GREYWACKE; FRESH & WEATHERED FELDSPAR (MICROCLINE ALBITE, ? ORTHOCLASE)
				7370							7369'10"	ARKOSE; ABUNDANT FRESH & WEATHERED FELDSPAR (MOSTLY ALBITE). GRAINS PRESSURE WELDED.
				7585								
? CARBONIFEROUS		GRANITE	W41	26 (2'0")			GRANITE: COARSE GRAINED, SHEARED. CONTAINS ABUNDANT WHITE & GREEN FELDSPAR.	V. lt. grey & green.			7585'	GRANITE; SODIUM RICH, COARSE — GRAINED, ABUNDANT ZONED, TURBID ALBITE EUHEDRA. MINOR CALCITE REPLACING FELDSPAR.
				7587								

DETAILED DESCRIPTION

SAMPLE	POROSITY % (Visual / Measured)	PERMEABILITY Millidarcys (Horizontal / Vertical)	ROUNDNESS	SORTING	GRAIN-SIZE (Wentworth Scale) Estim size Range & Mode: SANDS	THIN-SECTION ANALYSIS: % OF ESSENTIAL COMPONENTS (cross hatched if material clearly present as cement and/or matrix; porosity shown as blank)	Matrix and/or Cement Estim % of Total Rock: CLAY-UNDIFF; KAOLIN Gp; CHLORITE	Cement Symbols See Legend	ACCESSORY MINERALS Estim R C-A or Measured % Total Rock: TOTAL "DARK"	"Dark Minerals": Tourmaline, Zircon, Pyrite, Biotite, Muscovite, Sericite	"Light Mnrl": Plagioclase, K-Feldspar	OIL STAIN	FLUORESCENCE	MATURITY INDEX	NOTES (provenance, environment of deposition, diagenesis, palaeontology etc)
5	Nil	Nil							A	R	A			5.5	MOSTLY GRANITIC PROVENANCE.
4	Nil	Nil							C		R		C		GRANITIC PROVENANCE WITH SOME SEDIMENTARY INFLUENCE. CROSS — BEDDING & PEBBLE BEDS INDICATE DEPOSITION IN AGITATED, FLOWING WATER.
									C	R			C	7.0	
															GRANITIC PROVENANCE. LOW ENERGY CONDITIONS.
3	Nil	Nil							C		C		A	8.7	
															GRANITIC PROVENANCE. SMALL / LARGE BRACHIOPODS COMMON UP TO 7CM LONG. RARE OOLITES. DEPOSITION IN INTERMITTANT LOW & HIGH ENERGY MARINE WATERS. POROSITY REDUCED BY QUARTZ OVERGROWTHS.
									C		C				
									A	R	A		R	3.4	
2	Nil	Nil							A		A				
															MOSTLY GRANITIC PROVENANCE. DEPOSITION IN QUIET WATERS. SEDIMENT AT TIMES CHURNED BY BOTTOM DWELLERS.
									C	R	C		C		
									C		C		A		
									C		C				
									C		C				
									C		C				
									C		C		C		
									C		C				
1	Nil	Nil							C	R	C		C	2.2	LOCAL GRANITIC SOURCE. DEPOSITION IN INTERMITTANT AGITATED & QUIET WATER.
									C		C		R	1.0	
									Qtz.	Albite euhedra					