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Petrological Study of Mt Murwin (A.O.G.) No.1 Well Sydney Basin New South Wales

by

S.J. Mayne

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ABSTRACT

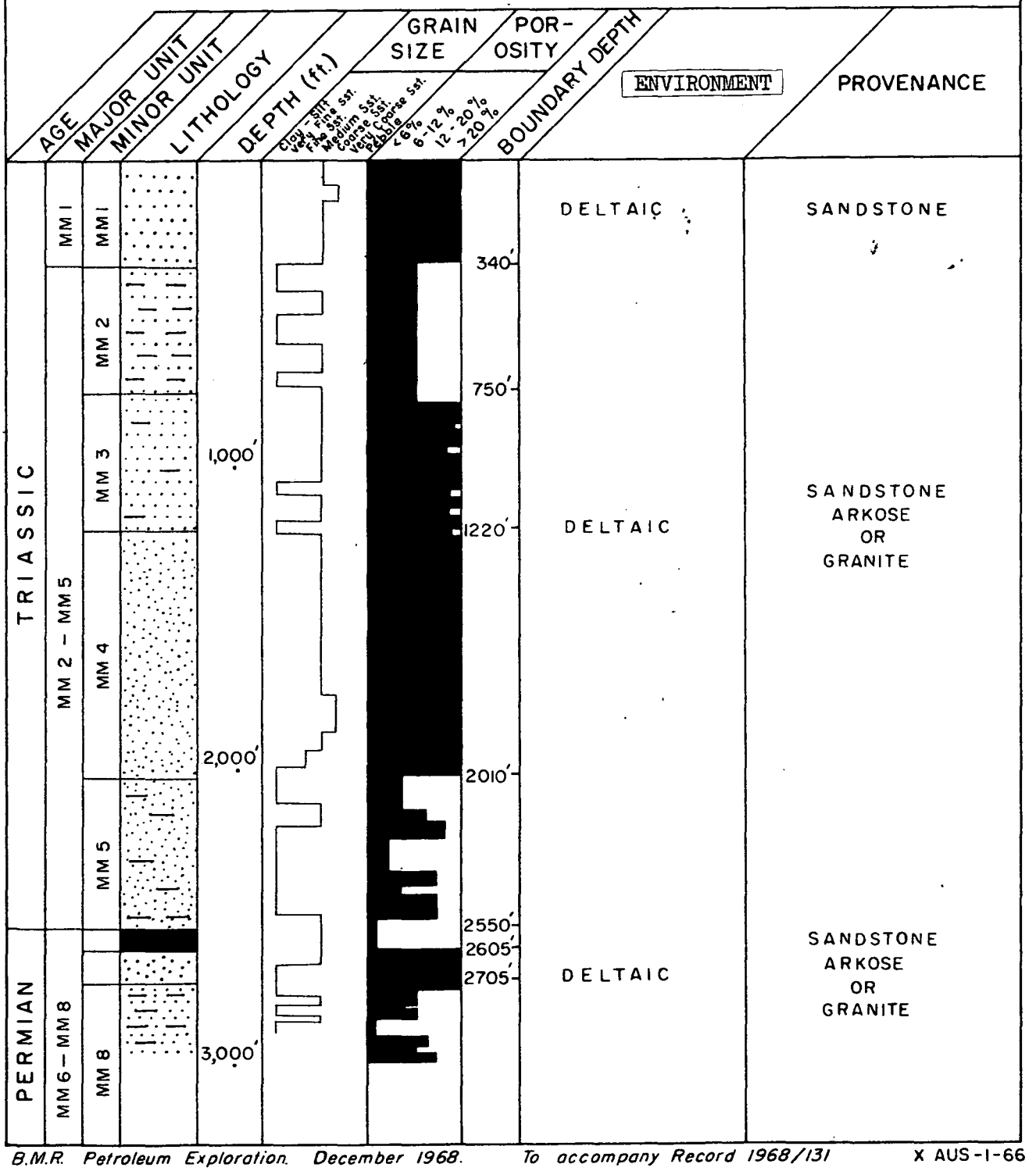
This petrological study of Mt. Murwin (A.O.G.) No. 1 was undertaken as part of a review of the Sydney Basin currently being undertaken by the Basin Study Group of the Petroleum Exploration Branch. It was designed to establish recognizable rock units and to determine the pattern of sedimentation in the area.

Eight lithological units have been defined and have been grouped into three major units. The units are set out in summary form in Fig. 1. The surface outcrop is in Hawkesbury Sandstone and the section penetrates approximately 2500 feet of Triassic rocks and 400 feet of Permian: total depth is at 2910 feet. The evidence of age is provided by spores characteristic of the Permo-Triassic boundary.

It is considered that virtually uninterrupted sedimentation occurred in a deltaic environment of bottomset, foreset, topset and backswamp beds.

Fig. 1

MOUNT MURWIN
No. 1 WELL
Summary of Petrological Results



B.M.R. Petroleum Exploration. December 1968. To accompany Record 1968/131 X AUS-1-66

GENERAL INFORMATION

Well Data

Well Name and Number:	Mt. Murwin No. 1
Operating Company:	Australian Oil and Gas Corporation
Location:	Lat. 32°50'45" South Long. 150°55'20" East 1:250,000 sheet: SINGLETON SI-56/1 General Location: about 24 miles west of Cessnock, and 3½ miles N.W. of Mt. Murwin in the County of Northumberland.
Elevation:	GR. 1453' A.S.L.
Total Depth:	2910' (Driller)
Rig Type:	Percussion
Logs Run:	Nil
Hydrocarbon Shows:	A small amount of methane from a coal seam in the interval 2555'-2562'.
Major Reference used in Present Study:	A.O.G. Corp. Ltd. Mt. Murwin No. 1 Bore, Well Completion Report, 1963, by J. Stuntz and A.J. Wright.
Summary of Major Reference:	The well was drilled in the period 2.3.63 to 20.5.63 to a depth of 2910', penetrating 2533' of Triassic and 377' of Permian strata. The well was located on a N.E. trending anticline 30 miles long by 10 miles wide in the Sydney Basin. It was regarded as "a stratigraphic test of the northern strata" of the Basin, the rocks of which are known to change from a largely shale facies near the coast to a dominantly sandstone facies further inland. "The borehole proved the

existence of a thick section of potential reservoir rocks which nevertheless were lacking in porosity and permeability. The Triassic section does not thin out so soon to the north as previously supposed, and it is suggested that the whole of the Basin has been tilted to the south-west in post Triassic times. A compressive force from the north-east with a strong vertical component, probably related to at least the later stages of the Hunter Thrust movement, is suspected."

The Company did not correlate the units encountered in the Mt. Murwin well with thedefined units in other areas. However, the entire Mt. Murwin section, being dominantly sandstone, is similar to the western and northern part of the Basin, but differs markedly from the shaley coastal section. These sandstones proved to be "tight" with a high proportion of white clayey matrix.

Material Available for Study

Cuttings: 0' to 2910' (Total Depth) at 10' intervals.

Cores: Very poor recovery from six intervals from a total of 30' of strata.

Methods Used

All samples were examined with a low power binocular microscope, and thin sections were made from selected intervals and examined under a petrological microscope. The results were plotted on composite well-log sheets at a scale of 1" = 100' (Plates). Eight units were chosen on lithological characteristics and numbered from the surface. The unit numbers were prefixed with MM, which is the code for this well, and grouped into three major units.

Pettijohn's classification of sedimentary rocks (1957) was used, modified by the use of the term "quartz-greywacke" for rocks containing at least 75% quartz and over 15% of detrital matrix.

GEOLOGY

Unit MM1

This uppermost sandstone extends to 340'. Although it cannot be subdivided, it is sufficiently distinct to warrant the status of a major unit.

Unit MM1

Characteristics: This unit extends from the surface to 340'. It consists wholly of orthoquartzite composed of subangular quartz grains, dominantly medium grained, but ranging in size from very fine to coarse. White and colourless pebbles of quartz up to 15 mm occur sporadically. White clay occurs interstitially and banded stainings due to the deposition of limonite are common. It is possible that this limonite derives from the oxidation of original siderite.

Boundary Criteria: The lower limit of this orthoquartzite is put at 340', at the first appearance of sandy siltstone. The Company has a boundary at 270' (A.O.G. 1963), but there is no significant lithological change detectable at this level. The sandstone above 270' was designated "Hawkesbury Sandstone" by the Company.

Environment and Provenance: The lithology in itself gives no clear indication of provenance; either granite, arkose or sandstone could have been the parent material. The absence of fossils (although moulds are not likely to be revealed in cuttings samples) can be interpreted in so many ways as to be of little value. Environments ranging from fluvial to shallow marine are the most likely.

Units MM2 - MM5

This sequence is 2215' thick, extending from 340' to 2555'. It consists of protoquartzite interbedded with very fine-grained quartz greywacke, the latter predominating in both the lower and upper horizons, whilst the former dominates in the middle horizons.

The protoquartzite contains a distinctive assortment of coloured siliceous lithics, especially green chert, ranging in size from sand to pebbles 20 mm across. The larger lithics are more abundant in the lower horizons of the sequence.

The greywackes are mottled in shades of reddish brown and greyish green. They are very fine-grained and sometimes grade into silt-grade material.

Siderite occurs throughout the sequence: sometimes it is visible to the naked eye, and often it is partly oxidized to limonite.

Unit MM2

Characteristics: This unit is 410' thick, extending from 340' to 750', and consists of very fine quartz greywacke and minor protoquartzite.

The greywackes are mottled in greys and purplish brown, the latter colour predominating. Some are fissile due to fine alternations in grain size and to differing concentrations of mica. The quartz grains often show evidence of corrosion, but the occasional plagioclase grains are fairly fresh-looking. Shreds of muscovite are present, together with occasional graphite flakes and filmy carbonaceous partings.

The protoquartzites have a fine to medium grain-size mode, but range from fine to coarse, resembling in this aspect the sandstone of Unit MM_1. Some grains glimmer, with crystal faces formed by quartz outgrowth. White interstitial clay-material is present in varying amounts.

There are also horizons, probably associated with both the above lithologies, containing abundant coloured siliceous lithics - white quartz, and brown, grey and especially green chert.

Boundary Criteria: The lower boundary is placed at a pebble horizon, in itself no different from other pebble horizons, but occurring at a level where there is a marked change in the relative amounts of greywacke and protoquartzite present: Unit MM2 consists of 75% very fine quartz greywacke and 25% protoquartzite, in contrast to the underlying Unit MM3 which consists of 15% quartz greywacke and 85% protoquartzite.

Environment and Provenance: The well-rounded nature of the siliceous lithics suggests their derivation from a sedimentary source. It seems likely that Unit MM2 was formed by deposition in a deltaic environment from streams with a by no means sluggish current.

Unit MM3

Characteristics: This unit is 470' thick, extending from 750' to 1220'. It consists of protoquartzite and minor very fine quartz greywacke, of the same types as in Unit MM2. There are eight horizons characterized by an abundance of gravel and pebbles of coloured quartz and chert.

Boundary Criteria: The lower boundary of Unit MM3 has been arbitrarily chosen at 1220': the unit thus defined consists of 85% protoquartzite and 15% greywacke, whereas the underlying unit MM4 consists of 97% protoquartzite.

Environment and Provenance: As the rocks in this unit are substantially the same types as those in the fore-mentioned units, it is reasonable to envisage a similar provenance and a similar, i.e. deltaic, depositional environment, with its wide range of sub-environments.

Unit MM4

Characteristics: This unit is 790' thick, extending from 1220' to 2010'. It is essentially a protoquartzite with very minor brownish red mudstone, a trace of coal at 1290' and a few thin pebble horizons. As all the samples now consist of loose sand it is probable that the interval is friable.

Boundary criteria: The lower boundary is arbitrarily chosen at 2010', creating a unit consisting of 97% protoquartzite and 3% of thin, widely separated mudstones. In contrast, the underlying Unit MM5 consists of 30% protoquartzite and 70% greywacke.

Provenance and Environment: These were essentially the same as for the other units.

Unit MM5

Characteristics: This unit is 545' thick extending from 2010' to 2555', and consisting of a sequence of interbedded very fine quartz greywacke and protoquartzite. There are no pebble horizons. The higher intervals of greywacke are mottled in silver-grey and reddish brown, but the lower ones are grey and dark grey, probably due to comminuted carbon. There is a very thin coal seam at 2410'.

The Well Completion Report (A.O.G., 1963) includes an Appendix by R. Helby on the palynology of eight samples from this Unit MM5. He remarks "the lower part of the Narrabeen Group, generally, does not represent conditions which were favourable for the preservation of the contained microflora". From the interval 2371' - 2379' spores indicate a "lower Narrabeen age". A sample from 2486' - 2496' "contains several of the forms which are characteristic of a narrow transitional zone between the Narrabeen Group and the 'Upper Coal Measures'. This sample would appear to be of basal most Narrabeen age." A sample from 2538' - 2544' contains forms "which are characteristic of the 'Upper Coal Measures'". Helby concludes that "the boundary of the Narrabeen Group and the 'Upper Coal Measures' would occur within the interval 2486' - 2544'." The Company puts the boundary at 2533', within a greywacke bed: the reason for this choice is not given.

Boundary Criteria: The lower boundary of Unit MM5 is placed at 2555' at the top of the first major coal seam encountered in the well, thus defining the unit as consisting of 70% very fine quartz greywacke and 30% protoquartzite.

Environment and Provenance: The fine-grained nature of the sediments, their dark colour, and the matrix of the sandstones suggest back-swamp deposition between the distributaries of the delta.

Units MM6 - MM8

This sequence is at least 355' thick, extending from 2555' to the total depth of 2910'. It consists of interbedded protoquartzites, very fine quartz greywackes and grey mudstones, and coal seams. These seams occur a little below the Permo-Triassic boundary of Helby (A.O.G., 1963) and the Company ascribes the sequence to the Newcastle Coal Measures.

Unit MM6

Characteristics: This unit is 50' thick, extending from 2555' to 2605'. It consists mostly of three major coal seams, about 12', 15' and 8' thick in order of depth. These are separated by 3' and 12' interbeds of very fine grained grey quartz greywacke. No signs of seat-earths are to be found.

During the drilling a gas-show was encountered in the uppermost coal seam at 2555'. It yielded less than 500 cubic feet per day and consisted of 95% methane. From the same interval there was a flow of water (20 gallons an hour) with a remarkably high bicarbonate content (1954 p.p.m.), and sodium content (1438 p.p.m.).

Boundary Criteria: The lower boundary of MM6 is placed at 2605', at the base of the lowest major coal seam.

Environment and Provenance: The most likely way for the coals to have accumulated was as drift vegetation in deltaic lagoons and coastal swamps. The apparent absence of seat-earths supports this view.

Unit MM7

Characteristics: This unit is 100' thick, extending from 2605' to 2705'. It consists of protoquartzite with very thin coal seams. As the samples are now mostly disaggregated the rock was probably friable. The protoquartzite is very similar to those occurring higher in the sequence, being sideritic and containing sparse-coloured siliceous lithics.

Boundary Criteria: The lower boundary is arbitrarily chosen at 2705'. where much finer sediments with a greater content of carbonaceous matter are encountered.

Environment and Provenance: As noted above, the protoquartzite of MM7 is very similar to that in Units MM2 - MM5, and it is likely that both were derived from much the same type of provenance and were deposited under similar deltaic conditions.

Unit MM8

Characteristics: This unit is at least 200' thick, as it extends from 2705' to the bottom of the well. It consists chiefly of very fine-grained quartz greywacke, dark grey in colour, which is associated with very thin coal seams, some dark mudstone and intercalated protoquartzite. The greywacke and the protoquartzite are essentially similar to greywacke and protoquartzite higher in the sequence.

Fig.2

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

B.M.R. UNITS		BOUNDARY DEPTHS (ft.)	COMPANY	A.O.G.	
MAJOR	MINOR		FORMATION	GROUP	AGE
MM1	MM1	270	HAWKESBURY SANDSTONE		TRIASSIC
		340		NARRABEEN	
MM2 – MM5	MM2	750			
	MM3	1220			
	MM4	2010			
	MM5	2550			
		2533		NEWCASTLE COAL MEASURES	PERMIAN
MM6 – MM8	MM6	2605			
	MM7	2705			
	MM8				

B.M.R. Petroleum Exploration. December 1968. To accompany Record 1968/131 X AUS-1-67

Boundary Criteria: The lower limit of the unit was not reached before the well was abandoned at 2910'.

Environment and Provenance: Both the provenance and the depositional environment were very similar to those for Unit MM7 - a deltaic backswamp where low energy conditions prevailed.

CONCLUSIONS

Degree of Agreement with Well Report:

Fig. 2 gives a comparison between the rock units described above and those shown in the Well Completion Report (A.O.G. 1963). The two differences are discussed below:

Boundary between MM1 and MM2:

This boundary was not adopted by the Company, although it is clearly marked by

(i) A change in rock type from orthoquartzite in MM1 to very fine quartz greywacke in MM2,

(ii) The prevalence in MM1 of limonite and the absence of siderite,

(iii) The abundance of siderite in MM2,

(iv) The absence of feldspars from MM1 and their presence in MM2,

(v) The absence of green chert lithics from MM1 and their presence in MM2,

(vi) The absence of graphite from MM1 and its presence in MM2.

The Company places the Hawkesbury Sandstone - Narrabeen Group boundary at 270', about 70' above the MM1 - MM2 boundary. There appears to be no significant lithological change at 270', only a local increase in the amount of ferruginous material.

Boundary between MM5 and MM6:

This is also a clear-cut boundary, being the division between the silty sandstone of MM5 and a major coal seam, which is the first member of the Coal Measures.

The Company has a boundary at 2533' which is designated as the boundary between the Narrabeen Group and the Newcastle Coal Measures. It is 22' above the boundary between MM5 and MM6. The Company gives no reason for its choice. There is a greywacke/protoquartzite boundary at 2533' which does not differ essentially, however, from many other such contacts in the sequence, apart from the fact that it lies within the interval 2486' - 2544', wherein also lies the boundary between the Permian and the Triassic, as indicated by spores.

Summary of New Data:

The section consists of 2910' of sediments that appear to be all of non-marine origin. It is postulated that they represent accumulations ranging in type from delta front sands and levee deposits to backswamp and lagoonal deposits. The depositional environment of the uppermost unit, MM1, is rather less certain.

Eight units have been separated out on lithological grounds. There seems no reason to doubt the essential conformity of the sediments of these units. They represent a steady accumulation of fluviatile and vegetable debris over a long period of time which includes the Permo-Triassic boundary.

An orderly variation in sedimentation is indicated below:

Medium-grained clean sands	MM1
Fine Silty sands	MM2 - MM3
Medium-grained clean sands	MM4
Fine silty sands	MM5
Coal	MM6
Coal and silty sands	MM7 - MM8

The abrupt disappearance of the green chert lithics above MM2 reflects the cutting off of the source of supply, probably due to the changing pattern of stream development, or possibly due to some diastrophic factor.

The fact that limonite-bearing rocks (Unit MM1) immediately overlie siderite-bearing rocks (Units MM2-MM8) could indicate that ferrous iron originally present ubiquitously as siderite has been oxidized to the ferric condition as limonite. In other words, the whole of the Permo-Triassic sequence as it exists in Mt. Murwin No. 1 Well was laid down under weakly reducing conditions favouring the precipitation of siderite (or that these developed later), and that the upper levels, now represented by MM1, mark the zone that has been affected by oxidizing conditions related to the present cycle of erosion. On the other hand, as pointed out earlier, there is a marked lithological difference between Units MM1 and MM2 quite apart from the limonite/siderite difference. The hypothesis of change of provenance and possibly of depositional environment seems to account better for the observed features.

The apparent absence of fossils from the sedimentary sequence, except for some spores at lower levels, is to be expected if the depositional environment was anything like that postulated. However, the

lowering of pH due to the presence or organic debris could have destroyed any calcareous shells that may have been present, whilst percussion-drilling would obliterate casts or moulds left after the disappearance of the calcium carbonate.

REFERENCES

Australian Oil and Gas Corporation Limited, 1963 Mount Murwin No. 1 Bore, Sydney Basin, N.S.W. by J. Stuntz and A.J. Wright.

Pettijohn, R, 1957 Sedimentary Rocks, New York, Harper.

WELL NAME, No MT. MURWIN NO. 1 BORE
OPERATING Co. AUSTRALIAN OIL & GAS CORP. LTD.
WELL LOCATION
Lat.: 32°50'45" S. Long 150° 55' 20"
Basin SYDNEY BASIN
State NEW SOUTH WALES
Tenement No. PET EX NO. 10. N.S.W. MINES DEPT.
1:250.000 Sheet No. S-1 56/1

ELEVATION (A.S.L.)
Ground Level 1453 ft.
collar Datum level 1456·4 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

0 / 100 / 200 ft.

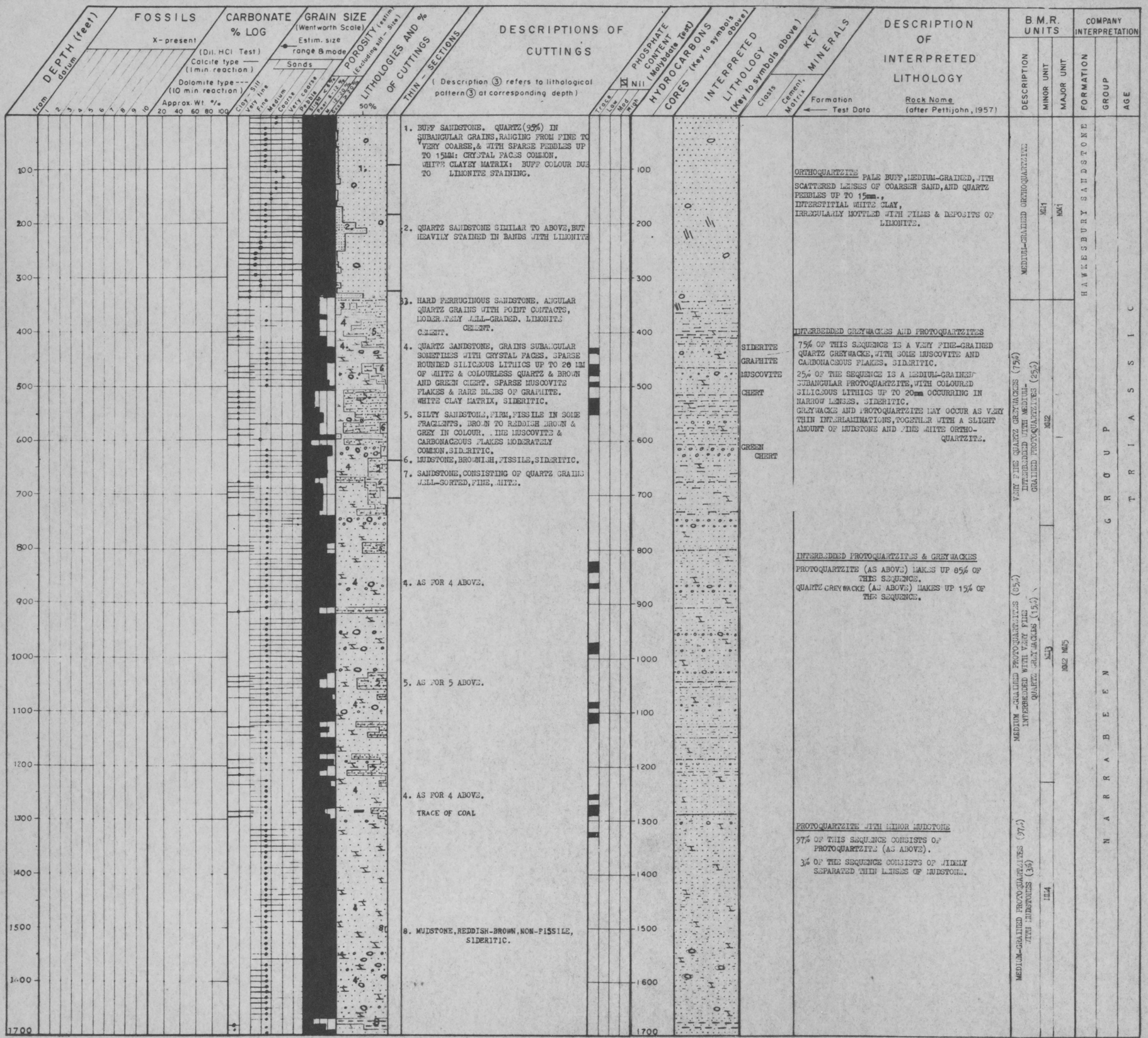
PETROGRAPHIC WELL LOG

MT MURWIN (AOG) No 1

Geology by S.J. MAYNE

Plate 1A

LITHOLOGICAL SYMBOLS
- Coal
- Shale and mudstone
- Iron oxide
- Breccia to conglomerate
- Quartz sand, sandstone
- Siltstone
- Claystone
- Limestone
- Siderite



DEPTH (feet) from Spud 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
Sands
Clay - Silt
Very fine
Fine
Medium
Coarse
Very coarse
Pebble
1/16M - 1/8
1/8 - 1/4
1/4 - 1/2
1/2 - 1
1 - 2
2 - 4

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

HYDROCARBONS

CORES (Key to symbols above)

INTERPRETED LITHOLOGY (Key to symbols above)

KEY MINERALS
Clasts
Cement, Matrix

Formation
Test Data

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

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

COMPANY INTERPRETATION
FORMATION
GROUP
AGE

1800
1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
00

QUARTZ SANDSTONE, AS FOR ON PREVIOUS CHART. BROWN IRONSTAINING. CUTTINGS DISAGGREGATED.

4 AS ABOVE, BUT UNSTAINED.

COAL.

5 SILTY SANDSTONE, AS FOR 5 ON PREVIOUS CHART. MOTTLED IN SILVER GRY, REDDISH GRY AND GREY.

4 AS FOR 4 ABOVE.

5 AS FOR 5 ABOVE, REDDISH BROWN.

4 AS FOR 4 ABOVE.

7 AS FOR 6 ABOVE.

COAL

4 AS FOR 4 ABOVE

5 AS FOR 5 ABOVE, GRY AND DARK GRY.

COAL

4 AS FOR 4 ABOVE, DISAGGREGATED.

5 AS FOR 5 ABOVE, DARK GRY.

7 VERY FINE WHITE SANDSTONE.

GREEN CHERT

CHERT
SIDERITE
FELDSPAR
MICA

2010'

CHERT
SIDERITE
FELDSPAR
MICA

CHERT
SIDERITE
FELDSPAR
MICA

PROTOQUARTZITE WITH MINOR MUDSTONE
(AS FOR PREVIOUS SHEET)
97% OF THIS SEQUENCE CONSISTS OF PROTOQUARTZITE.
3% OF THE SEQUENCE CONSISTS OF WIDELY SEPARATED THIN LAYERS OF MUDSTONE.

COAL

INTERBEDDED AND INTERLAMINATED GREYWACKES AND PROTOQUARTZITES.
70% OF THIS SEQUENCE IS A VERY FINE GRAINED QUARTZ GREYWACKE WITH SOME CARBONACEOUS AND MICA FLAKES.
SIDERITIC.
30% OF THIS SEQUENCE IS A MEDIUM GRAINED SUBANGULAR PROTOQUARTZITE.
NO PEBBLE BEDS.
SIDERITIC.

2550' COAL
CLEAN BLACK SEAMS WITH MINOR VERY FINE QUARTZ GREYWACKES.

PROTOQUARTZITE (AS ABOVE)

GREYWACKES, COAL AND PROTOQUARTZITES
DOMINANT VERY FINE DARK GREY GREYWACKES (AS ABOVE) INTERBEDDED WITH VERY THIN COALS AND PROTOQUARTZITES (AS ABOVE).

MEDIUM-GRAINED PROTOQUARTZITE WITH MUDSTONE AND COAL (3%)

INTERBEDDED VERY FINE QUARTZ GREYWACKE (70%) AND MEDIUM-GRAINED PROTOQUARTZITES (30%)

CLEAN BLACK COAL, VERY FINE QUARTZ GREYWACKE AND MEDIUM-GRAINED PROTOQUARTZITE.

1344
1345
1346
1347
1348
1312 - 1315
1316 - 1318

NARRABEEN
TRIASSIC

NEWCASTLE COAL MEASURES
PERMIAN