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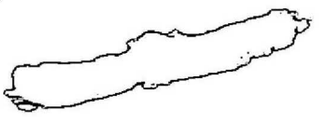
COMMONWEALTH OF AUSTRALIA.



DEPARTMENT OF NATIONAL DEVELOPMENT.
BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1956/95

STRATIGRAPHIC BORE B.M.R. 2 LAUREL DOWNS FITZROY BASIN, WESTERN AUSTRALIA

by

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SUMMARY

A borehole drilled to 4,000 feet at Laurel Downs homestead penetrated Permian, Carboniferous, and Devonian strata. Information was gained regarding lithological correlation of the Upper Devonian sediments in the Fitzroy valley, and a study of microfossils and megafossils from the cores and cuttings provided a more accurate evaluation of their time-ranges.

INTRODUCTION

The borehole was sited 600 yards south of Laurel Downs homestead, at latitude 18°07' South and longitude 125°19' East, and was designated B.M.R. 2 Laurel Downs; it is 152 miles inland by road from Derby. This location was chosen in order to penetrate the Devonian rocks as far from known outcrop as possible, but maintaining a minimum cover of Carboniferous and Permian strata. It was considered necessary to drill the Devonian section because of the difficulty of correlating the various formations present, and to determine if facies variation occurred southwestwards into the deeper parts of the basin; this information would assist in the evaluation of the oil possibilities in this area. The drilling programme required that a hole be drilled to 4,000 feet with 10 feet of coring in each 100 feet.

PREVIOUS WORK

The earliest geological surveying in the Fitzroy Basin was by Hardmann (1884). He collected plant specimens from "a small hill near Brooking Creek" near Fitzroy Crossing, 20 miles east from the bore. Wade (1924, 1936, and 1937) carried out a geological reconnaissance of Devonian strata. Blatchford and Talbot (Blatchford, 1927) collected from localities in the Lower Carboniferous, 12 miles south-west and 12 miles west of Mt. Oscar homestead, in what is now known as the Laurel Beds. A list of fossils obtained is given by Chapman (1924); Prendergast (1935) systematically described Composita subtilita Hall and Camarotoechia pleurodon var. tripla Prendergast from the collection; these forms are known only from the Laurel Beds in the Fitzroy Basin. Teichert (1949) visited Oscar Hill and Brooking Gap (Plate 1) as part of his investigation of the Devonian sediments. He determined the age of the rocks at Oscar Hill as Upper Devonian, and these are now referred to as the Fairfield Beds. Hill (1954) described corals from Oscar Hill and confirmed the Upper Devonian age of the Fairfield Beds. Geologists of the Bureau of Mineral Resources (Guppy et al. 1957) made a detailed regional survey of the Fitzroy Basin. Thomas (1955, 1957) collected and identified numerous marine fossils of Lower Carboniferous age from a belt of outcrops south-west of the Oscar Range. These outcrops were named the Laurel Beds.

WATER SUPPLY

By arrangement with the owner of Laurel Downs station, Mr. G. Rose, it was possible to use the homestead water bore, 0.3 miles from the site. This was very satisfactory, because the aquifer sandstone of the Permian Grant Formation is very irregular and there are several dry bores nearby. The logs of two bores at the homestead are given in Appendix I.

DRILLING

The rig used was a Failing Model "2500" Holemaster drilling unit (Henderson, 1956).

B.M.R.2 was spudded in on 8th December, 1955, and by 21st December had reached a depth of 877 feet, where the torque converters became useless because of perished gaskets (the drillers were using the wrong grade of oil). Replacement parts were obtained from the U.S.A. and drilling was resumed on 4th February, 1956.

Much rain fell during February, and the Great Northern Highway connecting Derby to Fitzroy Crossing became impassible. Circulation of drilling fluid in the borehole was completely lost at 1,455 feet and supplies of drilling mud and lost-circulation material were soon exhausted; the wet roads prevented a replacement of these materials. At very considerable expense to themselves W.A.P.E.T. attempted to haul supplies to the site with Mack trucks, Dodge Power Wagons, and Landrover type 107's; but only the Power Wagons were able to reach the site regularly. The Wheately slush pump bearings were "run" on 1st March resulting in a further shutdown for 3 weeks. After drilling was resumed on 27th March, no further major trouble was experienced and the hole was completed at the planned depth of 4,000 ft. on 10th May, 1956.

Because B.M.R. 1 Jurgurra Creek was abandoned at 1,680 feet instead of 4,000 feet, it was possible to drill $5\frac{3}{8}$" hole to 3,000 feet, as there were sufficient bits of this size.

Although the rig is rated for 4,000 feet of $5\frac{3}{8}$" hole with $2\frac{3}{8}$" Failing exploration drill pipe, it is doubtful if the B.M.R. rig could have reached this depth even with $4\frac{1}{4}$" hole, because of the inadequacy of the Wheately mud pump. The contractor used his own National C.100 mud pump beyond about 3,500 feet.

Beyond 1,900 feet difficulty arose with mud control. The shale and siltstone of the Upper Devonian Virgin Hills Formation have a considerable clay content, and produce a highly viscous mud, which had to be dumped frequently. A bentonite-diesel oil mud was used with success.

A slips failure, loss of the Tro-Pari deviation instrument, and several twist-offs necessitated fishing, but in each case the fish was recovered without great difficulty.

WELLSITE GEOLOGY

Wellsite work was previously described for B.M.R.1 (Henderson, 1956). At B.M.R. 2 the only variation was that ditch samples were taken at 5 feet intervals, and a WAPET geologist was not permanently resident at the wellsite.

Samples had to be taken from the flow-line from 1,000 feet to 3,300 feet because of failures in the shale shaker which the contractor supplied free of charge. Drilling under compression, and the striking of the sides of the hole by the drill pipe at a dogleg at 3,600 feet, caused considerable caving. Below 3,500 feet the samples included 50% caving of siltstone from the Virgin Hills Formation. The inadequacy of the Wheately pump resulted in low annular velocity and poorer samples resulted. With the hole in good condition and sufficient pump pressure, it is quite possible to collect good samples at 5 feet intervals.

RESULTS

Plate 1 shows the location of the borehole on an 8-mile geological map of the Fitzroy Basin. Plate 2 is a

list of symbols and abbreviations used in Plate 3. Plate 3 sets out the Drilling Time Rate, Self-Potential Curve, Percentage Log, Core Details, Resistivity Curve, and Descriptive Log including Specific Gravities. Figure 1 is a sketch map of the geology near Laurel Downs. Figure 2 is a section through B.M.R. 2 to Brooking Gorge (red line on Plate 1). Figure 3 is an alternative section. Figure 4 illustrates the relationship of the various Devonian Formations.

SPECIFIC GRAVITY AND DIP OF STRATA IN CORES

Core No.	Depths	S.G.	Dip	Deviation	True Dip
1	50-60	2.0	?		
2	150-162	2.55	low		
3	250-260	2.22	5°	zero at 250'	
4	350-360	2.65	Poor		
5	450-460	2.29-2.61	2°		
6	548-558	2.56	6°	zero at 500'	
7	650-657	2.65	7°		
8	800-814	2.64	Poor		
9	900-912	2.50	8°		
10	1000-1010	2.51	10°	zero at 950'	
11	1090-1100	2.67	11°		
12	1200-1210	2.55	9°		
13	1300-1310	2.62	5°-7°	2° at 1300'	
14	1400-1410	2.65	7°		
15	1500-1510	2.51-2.64	10°	2° at 1500'	
16	1600-1610	2.72	10°		
17	1697-1707	2.32	11°		
18	1775-1785	2.67	10°-11°	zero at 1725'	
19	1923-1929	2.40	6°		
20	1929-1935	2.42	9°		
21	2033-2041	-	-	1¼° at 2000'	
22	2041-2043	-	10° (Poor	-	
23	2129-2139	2.43	9°		
24	2207-2217	2.42	7°		
25	2294-2304	-	18-12°	2° at 2250'	
26	2391-2401	2.48	5° Poor		
27	2490-2499	2.50	8-10°		
28	2580-2590	2.52	5°	2¼° at 2500'	7°
29	2700-2706	2.45	3°		
30	2800-2810	2.52	10°	2° at 2750'	
31	2890-2896	2.60	6°		
32	2896-2902	2.65	Poor		
33	3000-3010	-	-	1¾° at 3000'	
34	3010-3013	2.57	7°		
35	3100-3110	2.52	Poor		
36	3160-3170	2.49	10°		
37	3255-3265	2.54	10°	2° at 3250'	
38	3344-3354	2.57	10°-16°	Poor	
39	3500-3509	2.58	7° (at base)	4½° at 3500'	
40	3580-3586	2.43	low		
41	3715-3725	2.35	1°	4¼° at 3600'	
42	3800-3810	2.58	0°-6° Poor	3¾° at 3800'	
43	3890-3900	2.62	4°		
44	3980-3990	2.27?	6°		
45	3990-4000	2.56	5°	4° at 4000'	

Although no thermometer was available to measure mud temperature, it was above 100°F., which is high for a depth of 4,000 feet. E-logs were run by the Geophysical Section, B.M.R., at 1684, 3500 and 4000 feet, using the B.M.R. Widco Logging Unit.

STRUCTURE

Before discussing the correlation of the various strata encountered, it is necessary to give an interpretation of the structure from the drilling and coring information, confirmed by the E-log data, and from surface geology.

The dips in cores 3 to 14 vary considerably but the dips in cores 15 to 18 are very good and also consistent between 10° and 11°. (It has been observed that in beds of relatively low dip, there is a tendency for the holes drilled by rotary rigs to pass through these beds at right angles to their inclination. In consequence, the angle of deviation of the hole must be added to the dip of the core to give true dip.) There is a discordance of dip of 3° between 1410 feet and 1500 feet, 2°-4° between 1785 feet and 1923 feet and 2°-5° between 3500 feet and 3580 feet. There are also discordances between 2706 feet and 2800 feet and between 3013 feet and 3100 feet, but these are not of major significance.

The Specific Gravities seem to confirm these changes but the variations within single cores are too wide to give a conclusive result.

The E-log indicates changes at 365 feet, 535 feet, 640 feet, 1010 feet, 1420 feet, 1715 feet, 1885 feet, and 3370 feet.

At 1420 feet there is a decisive change with a variation of dip of 3°, caused by a fault or unconformity. There is a similar change at 1885 feet.

The nearest outcrop of pre-Permian strata is 2 miles north-east of B.M.R.2 and is Carboniferous Laurel Beds. These beds are exposed from at least 5 miles northwest of 12-Mile Bore and extend southeast to Oscar Hill; air-photograph interpretation and field examination show that they are folded, slumped, and faulted. The dips vary from horizontal to 37° and an important fault trending N.W. is known 8 miles northwest of B.M.R.2. This fault probably passes 2 miles northeast from the bore, but its displacement is unknown, although Laurel Beds crop out on both sides of the fault.

Oscar Hill with its known Upper Devonian (Teichert, 1949; Hill, 1954) 8 miles northeast of B.M.R.2 shows a near-horizontal dip for this formation. Southwest from Oscar Hill at a distance of 1 mile a N.W.-trending line can be traced on photographs, separating the disturbed Carboniferous strata from the Devonian. This is apparently a major unconformity.

CORRELATION

The correlation of the formations is probably:-

Surface - 30 feet.	Quaternary Sand. (Qs)
30 feet -178 feet.	Permian: Grant Formation (Pg)
178 feet -1420 feet.	Lower Carboniferous: Laurel Beds. (Cll.)
1420 feet -1885 feet.	Upper Devonian: Fairfield Beds. (Duf.)
1885 feet -3503 feet.	Upper Devonian: Virgin Hills Formation (Dup(v))
3503 feet -4000 feet.	Upper Devonian: Gogo Formation (Dup (g))

Macro-fossils were rare bet een 370 feet and 1775 feet, and a detailed micro-palaeontological study of ostracods by Jones (1957) gave the following results

250-1010	feet	lower Carboniferous (Mississippian)
1090-1707	"	unknown
1775-1785	"	probable Devonian
1923-2043	"	doubtful
2129-3365	"	Devonian.

From 178 feet to 1010 feet is unquestionably Lower Carboniferous and from 1775 feet to 4000 feet is Upper Devonian.

Balme found spores of lower Carboniferous Age from 250-262 feet; and at 1697-1707 feet Devonian spores were found, the "assemblage was extraordinarily diverse and well-preserved... (with) the prevalence of very heavily sculptured trilete types and of forms with a thick reticulate perispore, quite unlike anything found in post-Devonian sediments." More spores were found in the cores down to 4000 feet and some from this footage were "identical with a form occurring... at 1025-1026 in the Kimberly Downs 67 miles Bore".

An alternative correlation, based solely on lithology, was -

30 feet -	178 feet	Permian-Grant Formation (Pg)
178 feet -	850 feet	Lower Carboniferous - Laurel Beds (C11)
850 feet -	1885 feet	Upper Devonian-Oscar Formation (Duo)
1885 feet -	3503 feet	Upper Devonian-Virgin Hill Formation (Dup(v))
3503 feet -	4000 feet	Upper Devonian-Gogo Formation (Dup(g))

This was the original interpretation and is illustrated in Figure 2. It is probably incorrect, as is explained in the description of Laurel Beds and Oscar Formation.

The correlation chart (Figure 3) is mainly derived from the Fitzroy Bulletin (Guppy et al 1957) and shows the stratigraphic relationship of the various Devonian units. The correlation is tentative.

DESCRIPTION OF FORMATIONS (formation names after Guppy et al 1957)

Quaternary Sand: From the surface to 30 feet there is a superficial deposit of medium-grained red-stained quartz sand with quartz silt. At the surface the grains are rounded, but they become more angular at depth. The sand is derived from the weathering of the Permian Grant Formation, which outcrops nearby.

Grant Formation: Outcrops of this formation are widespread within the Fitzroy Basin, and it crops out 1 mile southeast of B.M.R.2. From 30 feet to 178 feet in the bore this formation occurs as sandstone with boulders. Lower Carboniferous fossils in core number 2 were derived from the underlying Laurel Beds. At an exposed unconformity between Grant Formation and Laurel Beds 8 miles northwest of B.M.R.2 boulders of the Lower Carboniferous limestone are common in the Grant Formation. Plant remains found in the Grant Formation near B.M.R.3, Prices Creek, indicate a late Carboniferous or Permian age for the Grant formation (White, 1956).

Laurel Beds: The sequence of shales and calcarenite cropping out north and east of Laurel Downs homestead is very fossiliferous in places, and Thomas (1955, 1957) determined the age as Lower Carboniferous.

Examination of fossils from cores 3 and 4 from B.M.R.2 by Thomas proved them to be from the Laurel Beds, but the cores from 400 feet and below did not yield readily identifiable macrofossils.

Examination of ostracods found in cores 3 to 10 by P. Jones, B.M.R., indicates a Lower Carboniferous age to 1010 feet, but deeper cores did not yield further specimens (Jones, 1957). The S.P. curve of the E-log indicates a decrease in porosity from 1010 feet to 1420 feet caused by an increase of argillaceous material in the calcilutite.

Calcilutite with scattered rounded quartz grains, found in the bore from 695 feet to 1420 feet, and best developed between 800 feet and 850 feet, also crops out in the Laurel Beds 12 miles north of B.M.R.2. The top of Oscar Formation was originally thought to be at 850 feet, but that was wrong. The changes in the E-log observed at 365 feet, 535 feet, 640 feet, and 1010 feet represent alternating calcarenite and calcareous shaley siltstone members of the Laurel Beds.

During the various shutdowns which occurred while drilling the Laurel Downs bore, I examined various outcrops in the vicinity. The similarity of oolitic limestone below 850 feet in the bore to outcrops of Oscar Formation in the Oscar Range, 1 mile northeast of "12-Mile Bore" resulted in the correlation given above as an alternative, but this does not now appear likely. Oolitic limestone from the Oscar Formation is described by Glover (1956).

Oscar Formation: This is probably not present in B.M.R.2, but has been replaced by Virgin Hills Formation and Gogo Formation of the Mt. Pierre Group. As pointed out above, the strata from 850 feet were thought to be Oscar Formation and the bottom of the "Ostracod limestone" at 1890 feet was taken as its base. The loss of circulation from 1455 feet onwards was assumed to be through joints in the Oscar Formation, such open jointing being very prominent in the Oscar Range. But after 1420 feet the oolitic limestone is absent and dolomite and dolomitic sandstone are common. These do not appear to have been recorded in the Oscar Formation, and so it is now thought that the loss of circulation was caused by the porous and probably fractured sediments below the inferred unconformity at 1420 feet.

Fairfield Beds: Outcrops of this formation at Oscar Hill 8 miles to the northeast were found to be of fossiliferous limestone. Similar limestone was not found in B.M.R. 2. However, stratigraphic relationship suggests that the inclined strata between 1420 and 1890 feet belongs to the same sequence as the Fairfield Beds. The "Ostracod Limestone" from 1770 feet to 1890 feet is not yet known in outcrop, but as it dips at the same rate as the overlying strata it is included with them. This limestone also contains the conchostracan genus Rhabdostichus, which is a typically Upper and Middle Devonian form unknown in post-Devonian strata (Jones, 1957).

Fossil Downs Formation: This is the only formation with recorded dolomite exposures (Guppy et al 1957). It was probably deposited at the same time as the Oscar Formation and Mt. Pierre Group.

Mt. Pierre Group: The Mt. Pierre Group consists of the following two formations:

1. Virgin Hills Formation: The lithological similarity of the red and green argillaceous siltstones from the bore to the red and greenish grey calcareous siltstones of this upper formation of the Mt. Pierre Group is striking. A visit to the type section near Needle-Eye Rocks near Mt. Pierre confirmed this. Similar red and green beds are recorded from the Brooking and Copley formations, where they interfinger with limestone and calcarenite, of which they are probably the off-reef equivalents.

Teichert (1949) determined the Upper Devonian age of this unit from its abundant goniatites, including Cheiloceras and Sporadoceras; and Hill (1954) confirmed the presence here of Stages I, II, and III of the Upper Devonian. No goniatites have been found in the cores, but macrofossils, microfossils and plants indicate an Upper Devonian age.

Ostracods in cores 23 to 36 are Devonian (Jones, 1957).

A brachiopod cf. Barroisella was found in core 23 (2129 feet - 2139 feet). A fish plate was recovered at 2598 feet (Dr. A.A. Öpik, B.M.R., personal communication) and the plant genus Leptophloeum (from 2498 feet) is an Upper Devonian to lower Carboniferous form (J. Gilbert-Tomlinson, personal communication).

The discordance of dips between cores 27 and 28 and between cores 32 and 33 does not appear to have major significance. Limestone beds occur between cores 28 and 32 and a very slight change in the siltstone cuttings was observed at 2925 feet. Core 39 is slickensided and jointed, and fine imbrication is seen, and a fault appears to transect the core at 3503 feet.

The strata from 1085 feet to 3503 feet are Devonian, probably Upper Devonian, and are the lithological equivalent of the Virgin Hills formation.

2. Gogo Formation: After 3510 feet the cuttings contain a light brown very-fine-grained slightly micaceous sandstone which gradually increases from 5% to 60%. Because of the high caving content of the samples, the true percentage must be much higher. This tends to confirm a formation change at 3503 feet, allowing for the time lag of sample to surface.

Cyrtospirifer sp. from core 43 (3890 feet - 3900 feet) is probably Upper Devonian (G.A. Thomas, pers. comm.). Plant remains in cores 44 and 45 are too poorly preserved for identification. The formation becomes shaly after 3850 feet, and a very shelly limestone was penetrated between 3925 and 3945 feet.

The strata from 3503 to 4000 feet are tentatively correlated with the Gogo Formation of the Mt. Pierre Group.

CONCLUSIONS

Drilling of Bore B.M.R. 2, Laurel Downs, showed that the offshore equivalents of the Upper Devonian biohermal and biostromal reefs are probably red and green siltstones. Detailed surface mapping in the Brooking Gap area where reefs and siltstones interfinger should confirm this. The lagoonal side of fossil reefs frequently contains evaporites, oolites, and red and green shales (Gardner, 1931). Traces of anhydrite are found in the red and green shaly siltstone of the Virgin Hills Formation.

As the Oscar Formation is a fringing reef and its offshore equivalent is a lagoonal facies, it is probable that a barrier reef existed west of the present Oscar Formation outcrop. If the "Fenton Fault" is not a major fault, the geophysical high south of this feature may be Devonian reef similar to that which is petroliferous in the Western Canadian Sedimentary Basin (1954).

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APPENDIX I

WATERBORE AT LAUREL DOWNS

Total Depth 140 ft.

Water Level 115 ft. 6 inches.

Pump Depth 128 ft.

Capacity of Pump at 22/10/55 240 gal./hour.

Tested capacity of bore 400 gal./hour.

Strata: 0-100' Sandstone

100-123' Varicoloured shales and grey green limestone

123-127' Yellow hard sandstone

135' Blue shale.

Another bore 40 feet away was drilled to 500 ft. through sand and shale with blue shale at 500 ft. No supply of water.

APPENDIX II

Personnel

Resident Geologist	S.D. Henderson, Geological Section, B.M.R.
Geophysicists	S. Gunson, Geophysical Section, B.M.R.
	D. Brown, Geophysical Section, B.M.R.
W.A.P.E.T. Geologists	I. Campbell, V. Pudovskis, E. Kenpin, A.W. Lindner.
Petroleum Engineers	D. Woodward, W.A.P.E.T.
	F. Allen, Jr., "
Toolpushers	A.D. Dale, Brown Drilling Co. for WAPET
	T.P. Igo, " " " " "
	T. Peebles, Loftland ros. " "
Drillers	O. Wilkinson, N. Johanson, O. Danber, H. Huffmann, H. Obleis, J. Lambert.

APPENDIX III

Preliminary determinations of Fossils from Bore B.M.R. 2, Laurel Downs

by

G.A. Thomas

140 - 150'	crinoid stems, crinoid plates and bryozoal fragments. Productid shell fragments, spines and cardinal process; this species is probably the same as one collected from outcrops of the Laurel Formation at approximately one quarter of the section from the top. It could range higher in the section and appears to be definitely of Lower Carboniferous type. (Sample has been derived - S.D.H.)
158'	Small conchostracan of estheriid type.
170 - 180'	Nautiloid fragment.
220 - 230'	Small rhynchonellid sp. cf. Camarotoechia, same species as in outcropping Laurel Beds.
252 - 253'	Ostracods (determined by Miss Crespin) cf. Camarotoechia sp., same forms as in 220-230' cf. Conularia sp. Leiopteriidae sp. nov. (fide J.M. Dickens) Bucanopsis cf. meekana (Swallow) - (fide J.M.D.) intermediate brachiopod species. small apparently chitino-phosphatic shell, possibly a new neotremata brachiopod, small bone or tooth fragments, probably parts of sharks' teeth and black in colour - not coal as suggested.
254'8"	Leiopteriidae sp.
351'4"-351'6"	cf. Camarotoechia sp., small and like forms above
352'	cf. Camarotoechia sp. " " " " " bryozoan fragments cidaroid plates and spines small conchostracan
354' -354'6"	Orthotetacean possibly Schuchertella
357'	Leiopteriidae sp.
360'	cf. Camarotoechia, somewhat larger than forms higher in bore but like those from Laurel Beds outcrop.
1250' - 1255'	cf. Camarotoechia, sp., apparently the same as forms at 220' etc.
1735' - 1740'	cf. Camarotoechia sp. ditto
1775' - 1785'	small ostracods.

Most of the above fossils are not very diagnostic; but some are strongly indicative of Lower Carboniferous age, e.g. some of those at 140' to 150', 252' - 357'. There is nothing lower in the bore to indicate that rocks older than Lower Carboniferous have been reached. The rhynchonellaceans appear to be the same species as the form occurring higher. However rather similar forms occur in the Fairfield Beds. The interpretation that the fossils at 140' to 150' are derived from boulders of Carboniferous rock, incorporated in the Grant Formation, seems to be consistent with the nature of the fossils. The productid species was not observed at the top of the outcropping sequence of the Laurel Beds.

3508' Fine grained, friable, light pink-grey felspathic and calcareous sandstone with few thin chloritic bands; small mica flakes plentiful along bedding planes. Principal minerals are quartz 65%, calcite 15%, felspars 10%. Grain size of quartz and felspar is 0.1 mm. Felspars consist of orthoclase, microcline and oligioclase. Grains of calcite twice size of other grains. Quartz grains irregular in outline. Accessory minerals are muscovite, chlorite, biotite, hematite and rate tourmaline (J.B. Dallwitz, pers. comm.).

3890' Cyrtospirifer sp. The species is indeterminable. This form is indicative of Upper Devonian Age.

FIG 1

SKETCH MAP OF
LAUREL BEDS
NORTH OF LAUREL DOWNS
W. KIMBERLEY - W. A.

SCALE OF MILES
1 1/2 0 1

Reference

- Qs — *Quaternary sand*
- fv — *Post-Triassic leucite intrusives*
- Pg — *Permian Grant Formation*
- Cel — *Carboniferous Laurel Beds*
- Duf — *Devonian Fairfield Beds*
- Duo — *Devonian Oscar Formation*
- ===== *Main road*
- ----- *Track*
- *Strike & dip of strata*
- *Synclinal axis*
- *Anticlinal axis*
- G *Spirifers*

B 12 Mile
POSSIBLE FAULT
Duo
Qs
Cel
To Derby
LENNARD RIVER
NOONKANBAH
18°
Pg
FAULT
PROBABLE EXTENSION OF FAULT
Poor Outcrop
OSCAR HILL
"Laurel Downs"
B.M.R.2
To Fitzroy Crossing
OSCAR PLUG

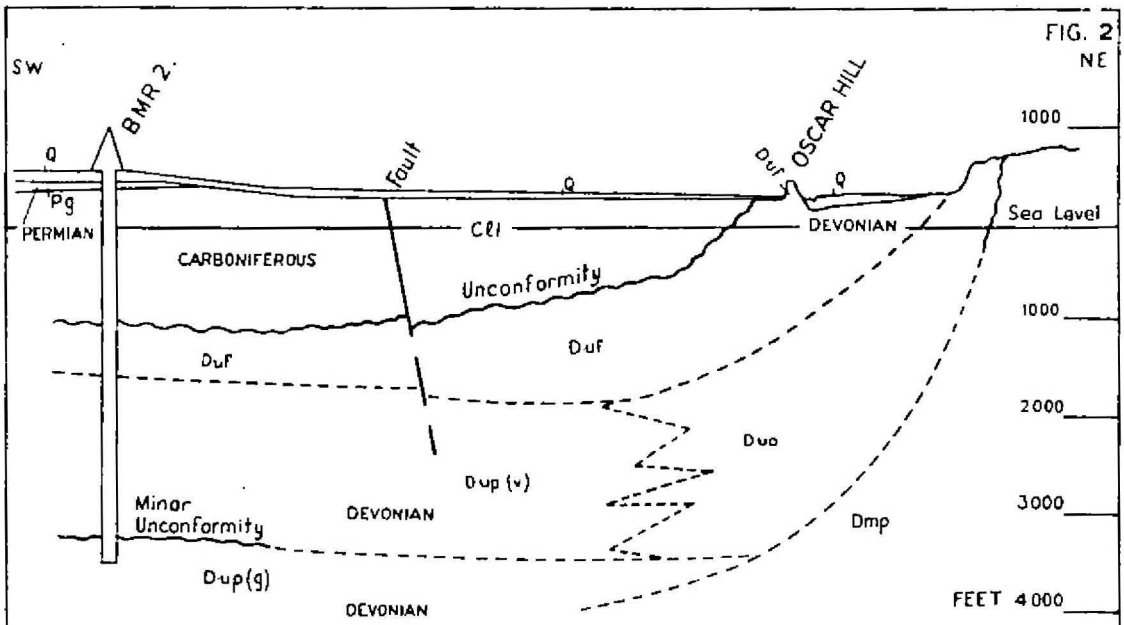
LOCALITY MAP
Derby
Lennard River
AREA MAPPED
Noonkanbah
Mt Anderson
W.A.

Bureau of Mineral Resources, Geology & Geophysics · July 1957.

W.A.3E-46 HS

A — REDUCE "A-B" (7.65") to "A-C" (6") — C — B

FIG. 2



SCALE

2 1 0 2MILES

Reference

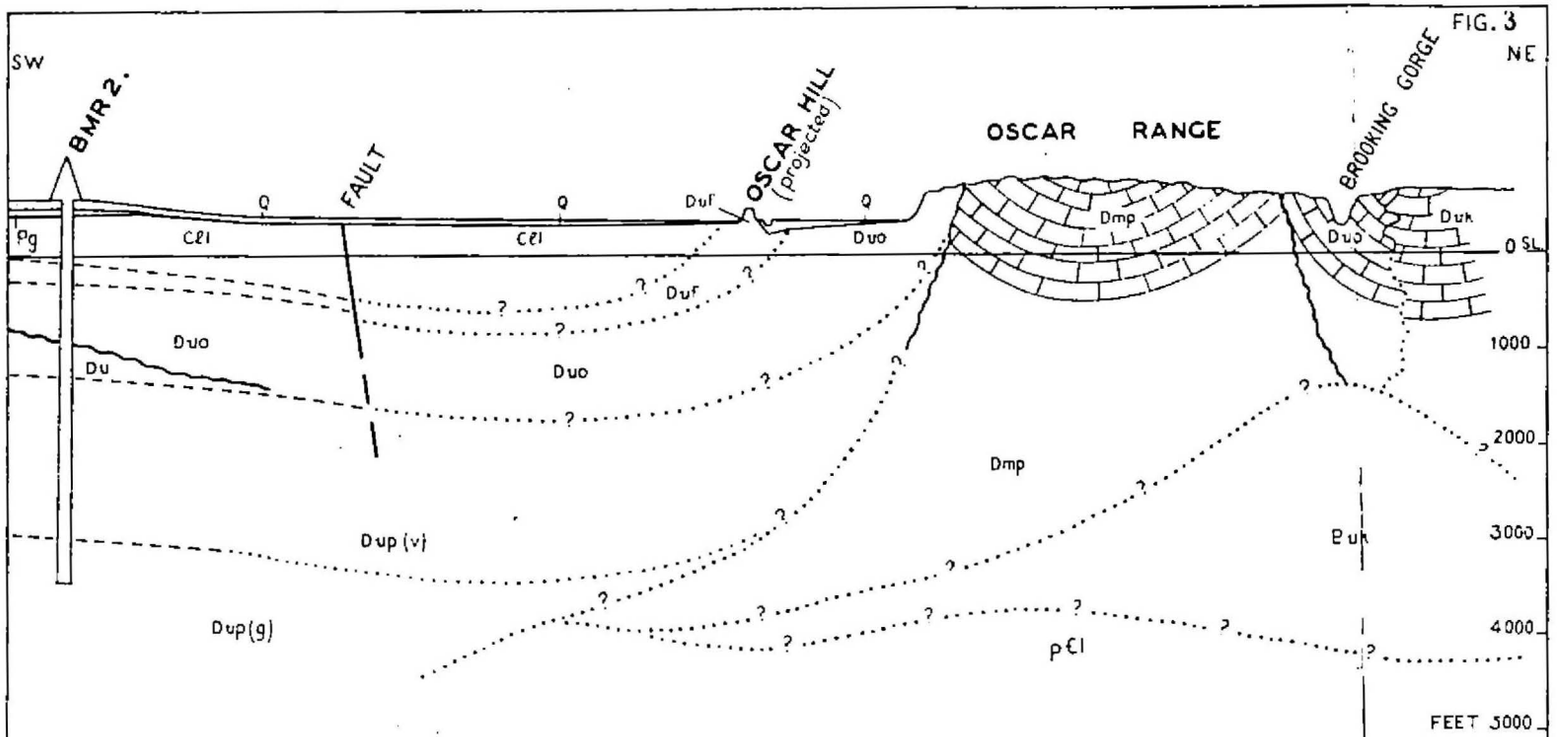
QUATERNARY	Q	
PERMIAN	Pg	Grant Formation
CARBONIFEROUS	Cℓl	Laurel Beds
UPPER DEVONIAN	Duf	Fairfield Beds
	Duo	Oscar Formation
	Dup(v)	Virgin Hills Formation
	Dup(g)	Gogo Formation
MIDDLE DEVONIAN	Dmp	Pillara Formation

GRAPHIC SECTION THROUGH BMR 2

Bureau of Mineral Resources, Geology & Geophysics 1956

WA 3E/49

FIG. 3



Reference

QUATERNARY	Q	
PERMIAN	Pg	Grant Formation
CARBONIFEROUS	Cel	Laurel Beds
UPPER DEVONIAN	Duf	Fairfield Beds
	Duo	Oscar Formation
	Duk	Brooking Formation
UPPER DEVONIAN (Mt Pierre Group)	Du	*Unnamed Formation*
	Dup(v)	Virgin Hills Formation
	Dup(g)	Gogo Formation
MIDDLE DEVONIAN	Dmp	Pillara Formation
UPPER PROTEROZOIC	Puk	King Leopold Beds
PRECAMBRIAN	pEl	Lamboo Complex

SCALE

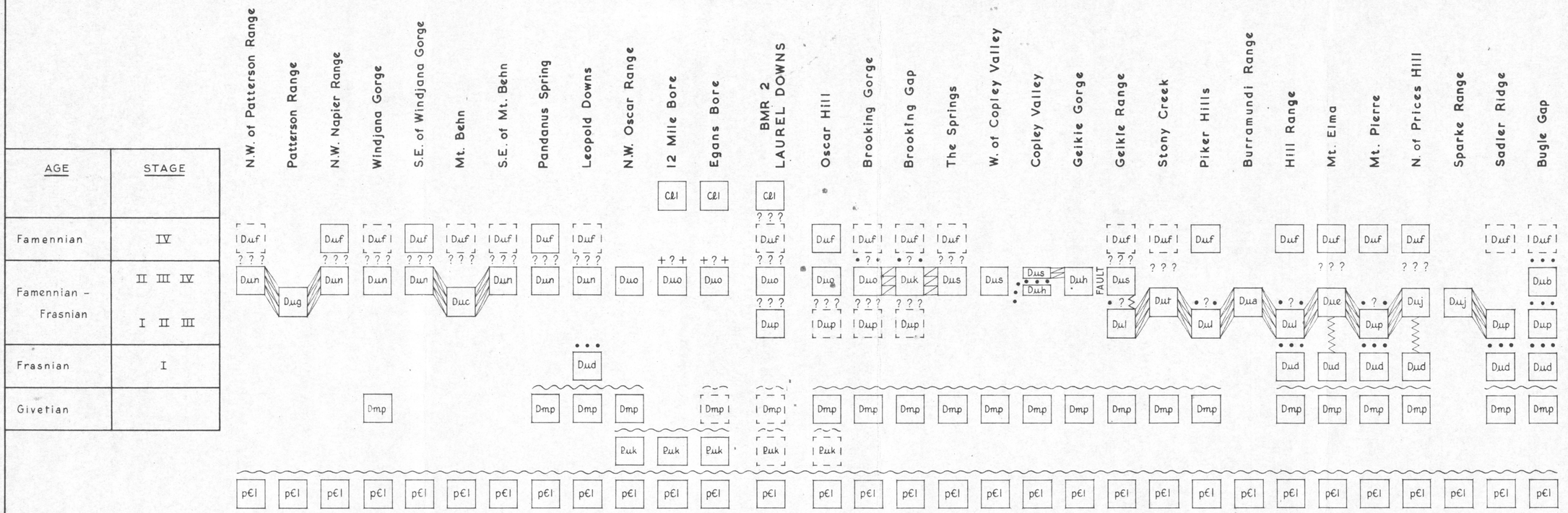
2 1 0 2 MILES

ALTERNATIVE INTERPRETATION OF BMR 2

Bureau of Mineral Resources, Geology & Geophysics, 1956

WA 3E/50 P.B

FIG 4



DISTRIBUTION AND STRATIGRAPHIC RELATIONSHIP OF DEVONIAN FORMATIONS IN THE FITZROY VALLEY

Bureau of Mineral Resources, Geology & Geophysics, Canberra. Sept. 1956.

H.F.D. WA3/26

PLATE 1

FITZROY BASIN
WESTERN AUSTRALIA

SOLID GEOLOGY

Compiled by S.D. Henderson from the following Australian Geological Series 4-Mile Sheets prepared by the Bureau of Mineral Resources;- Mt. Ramsay (unpublished), Derby, Lennard River, Mt. Anderson and Noonkanbah.

Bureau of Mineral Resources, Geology and Geophysics. July 1956.

Printed by Mercury Press, Hobart

WA 3E-17

PLATE 2

EXPLANATION OF LOGS FOR BOREHOLES BMR1, BMR2, BMR3.

WEST KIMBERLEY DIVISION, WESTERN AUSTRALIA

Drilling Time Rate: This is given as number of minutes required to drill each 5 feet. Note that coring time is much greater than open hole drilling time.

S.P. Curve: Details given with log.

Percentage Log: This is compiled from the percentage constituents of samples collected at 10 feet intervals at BMR1 or 5 feet intervals at BMR2 and BMR3. E.g.:-

4125' - 4130': 40% Medium Sandstone, 30% Fine Sandstone, 15% Siltstone, 15% Limestone.

4130' - 4135': 30% Medium Sandstone, 45% Fine Sandstone, 15% Siltstone, 10% Limestone.

Core Details: The actual core recovered is plotted vertically at 5 times the scale of the Percentage Log.

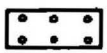
Resistivity Curve: Details given with S.P. curve on Log.

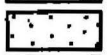
Descriptive Log: This summarises results obtained from percentage log and interprets strata represented by core recovered. Dips are given as plus or minus deviation. Specific gravity has been determined for dry specimens.

Grain Sizes:-

4 mm.	- 2 mm.	Very Coarse.
2 mm.	- 1 mm.	Coarse.
1 mm.	- 1/4 mm.	Medium
1/4mm.	- 1/8 mm.	Fine.
1/8mm.	- 1/16mm.	Very Fine.

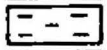
SYMBOLS USED IN PERCENTAGE LOG


Coarse Sandstone Pebbles


Medium Sandstone


Fine Sandstone


Very Fine Sandstone Coarse Siltstone


Silty (overprint)


Sandy Siltstone


Siltstone


Shale


Claystone


Silty or Sandy Claystone


Limestone


Calcarenite

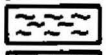

Calcareous (overprint)


Dolomite

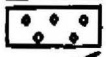

Dolomitic (overprint)

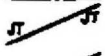

Volcanics


Schist


Schist


Granitic Vein


Hornfels


Joint


?Fault


Marine Fossils


Plant Remains


Pyrites

C Calcite

BUREAU OF MINERAL RESOURCES, GEOLOGY & GEOPHYSICS, AUGUST 1956.

WA 3A-20

PLATE 3

STRATIGRAPHIC DRILLING
WEST KIMBERLEY DIVISION · WESTERN AUSTRALIA
B.M.R.2 · LAUREL DOWNS

for Reference see Plates 2

DRILLING TIME RATE Minutes per 5 ft. 0 50 100

S.P. CURVE

PERCENTAGE CORE RECOVERY 100 Per cent 0

CORE DEPTHS 0 2000'

RESISTIVITY CURVE

CASING SHOE

CASING SHOE

Resistance (Ohms per Square) 75 Ohms per Square

DESCRIPTIVE LOG *Records of Strata*

from feet	to feet	DESCRIPTIVE LOG *Records of Strata*	SPECIFIC GRAVITY
0	5	Orange-brown sandy loam; very well-sorted QUARTZ SANDS. Well sorted.	
5	30	QUARTZ SANDSTONE; orange-brown; very fine-grained; very well sorted; slightly calcareous; loose; very friable. Well sorted QUARTZ SANDS. Very fine-grained QUARTZ SANDSTONE with fine calcareous matrix.	
		Core 1. 5'- 60'. Recovery: 7' (11.6%). Flint float and unconsolidated.	
30	60	Fine to medium-grained, rounded, well-sorted QUARTZ SANDS. Fine to medium-grained, rounded, well-sorted QUARTZ SANDSTONE. Coarse-grained QUARTZ SANDSTONE. Very friable. Trace of feldspar. Trace of ferruginous cement. Poorly consolidated. Porous.	D.S. 2.65
60	135	Fine-grained, light-brown, semi-translucent QUARTZ SANDSTONE, with fine, white, chalky matrix.	
135	150	Fine-grained, light-brown QUARTZ SANDSTONE. Fine-grained, SPECKLED LIGHT-BROWN QUARTZ SANDSTONE.	
		Core 2. 150'- 180'. Recovery: 14'6" (80.6%). Sandstone float.	
150	155	Medium-grained, buff fine-grained QUARTZ SANDSTONE with some white chalky matrix.	D.S. 2.65
155	160	Light brown, coarse SILTSTONE with piece of calcite.	
160	165	Fine-grained light brown QUARTZ SANDSTONE.	
165	170	Fine-grained, light brown, slightly calcareous, very fine-grained light grey SANDSTONE. Fine-grained, light brown, slightly calcareous SANDSTONE.	
170	180	Intermediate light grey-brown, very fine-grained SANDSTONE, grey SILTSTONE and grey SILTY CALCARENITE, with trace of fine-grained QUARTZ SANDSTONE. Trace of Siliceous Concretions.	
		Core 3. 180'- 210'. Recovery: 30'0" (100%) Negative flame test.	
180	210	Finely fissile, very grey shaley SILTSTONE with light grey very fine grained calcareous SANDSTONE. Arenaceous Foraminifera. Dip 5°.	D.S. 2.7
210	250	Intermediate very fine grained light grey SANDSTONE and grey SILTSTONE, grey, calcareous. Abundant Foraminifera. Traces of GREEN GLAUCONITE.	
		Core 4. 250'- 280'. Recovery 6'4" (21%) Negative flame test.	
250	252	Hard grey SILTSTONE. Grey to dark, with thin dark brachiopods.	
252	255	Hard grey SILTSTONE. Grey to dark.	
255	262	Hard grey SILTSTONE with fissile. Dip 5°. Dark.	D.S. 2.65
262	270	Calcareous grey SILTSTONE with brachiopods.	
270	280	Intermediate very fine grained calcareous silty SANDSTONE, grey, shaley, and grey SILTSTONE. Foraminiferal fragments.	
		Core 5. 280'- 310'. Recovery 8'4" (26.5%) Negative flame test.	
280	290	Green Sandy and shaley CLAYSTONE. Dip 5°. Dark.	D.S. 2.79
290	310	Intermediate grey and green shaley CLAYSTONE, green-grey shaley SILTSTONE and grey calcareous coarse SILTSTONE. Trace pyrites.	D.S. 2.61
310	340	Grey very calcareous coarse SILTSTONE and very fine grained SANDSTONE with trace of grey shaley LIMESTONE and trace of green CLAYSTONE. Fine shell traces.	
		Core 6. 340'- 370'. Recovery 10'0" (33%) Negative flame test.	
340	358	Hard, light grey coarse very calcareous SILTSTONE. Grey shaley LIMESTONE with shell fragments and green SILTSTONE bands. Dip 5°. Siltstone 0.0-0.3, Limestone 2.56	
358	370	Light grey very calcareous very fine grained shaley SANDSTONE with beds of silty CALCARENITE, grey SILTSTONE, & dr shaley green SILTSTONE. Per shell fragments.	
		Core 7. 370'- 400'. Recovery 9'6" (31.6%) Negative flame test.	
370	400	Intermediate light grey shaley, slightly m-g SILTSTONE and light grey very calcareous very fine grained poorly sorted SANDSTONE with scattered very coarse QUARTZ grains. Dip 5°. Fairly consolidated.	D.S. 2.65
400	430	Light grey coarse silty CALCILUTITE with scattered coarse subangular QUARTZ grains and beds of grey shaley SILTSTONE with scattered QUARTZ grains.	
430	440	Medium very fine grained very calcareous SANDSTONE with grey SILTSTONE. Trace of medium grained SANDSTONE with scattered very coarse QUARTZ grains.	
		Core 8. 400'- 414'. Recovery 5'- 0" (35.7%) Negative flame test.	
400	414	Medium very fine grained very calcareous SANDSTONE with a few scattered coarse QUARTZ grains. Grey SILTSTONE. Dip 5°. Fairly consolidated.	D.S. 2.64
414	420	Light grey very calcareous coarse SILTSTONE and very fine grained SANDSTONE with scattered very coarse rounded QUARTZ grains. Thin beds of medium grained SANDSTONE and oolitic LIMESTONE.	
		Core 9. 420'- 450'. Recovery 11'6" (38%) Negative flame test.	
420	434	Light grey very fine grained CALCARENITE with thin SILT beds.	
434	445	Intermediate green CLAYSTONE, silty CLAYSTONE, and grey SILTSTONE with scattered QUARTZ grains.	
445	446	Light grey-green SILTSTONE. Dip 5°.	
446	471	Grey very calcareous SILTSTONE, cemented bedding with nodules of very fine grained SANDSTONE. Trace of fine shell fragments.	
471	472	Very fine grained very calcareous SANDSTONE with SILTSTONE.	D.S. 2.50
472	479	Very calcareous very fine grained SANDSTONE with shells and bands of grey SILTSTONE with scattered coarse QUARTZ grains.	
479	497	Intermediate grey calcareous SANDSTONE, shelly and oolitic beds and intermediate grey very fine grained very calcareous SANDSTONE with thin beds of green silty CLAYSTONE.	
497	515	Grey very calcareous coarse SILTSTONE with scattered rounded coarse QUARTZ grains and beds of green-brown oolitic LIMESTONE with CALCITE veins.	
515	520	Grey very calcareous SILTSTONE with scattered QUARTZ grains.	
		Core 10. 500'- 510'. Recovery 7'3" (71.5%) Negative flame test.	
500	506	Intermediate shelly CALCILUTITE, oolitic, with SILT beds.	D.S. 2.57
506	507	Green CLAYSTONE and grey very calcareous SILTSTONE beds. Good dip 10°.	
507	510	Light grey crystalline LIMESTONE with shell fragments and a few calcareous SILTSTONE beds.	
		Core 11. 510'- 520'. Recovery 9'6" (95%) Negative flame test.	
510	515	Intermediate coarse, grey, very calcareous SILTSTONE, light brown silty shelly LIMESTONE and beds of green SILTSTONE and shales and coarse grained SANDSTONE with calcareous matrix.	
515	520	Light brown shelly, oolitic LIMESTONE with beds of light grey very calcareous SILTSTONE and thin layers of green CLAYSTONE.	
		Core 12. 520'- 530'. Recovery 9'- 6" (95%) Negative flame test.	
520	530	Grey very silty LIMESTONE with scattered medium and coarse QUARTZ grains and beds of grey calcareous SILTSTONE and thin layers of mottled red and green CLAYSTONE. Dip near base, 11°.	D.S. 2.67
530	540	Interbedded grey calcareous very fine grained SANDSTONE, with scattered coarse QUARTZ grains and light brown oolitic LIMESTONE with oolites and pisolites and thin beds of light green CLAYSTONE.	
		Core 13. 530'- 550'. Recovery 10'-6" (52%) Negative flame test.	
540	550	Interbedded very fine grained mottled very calcareous SANDSTONE and very calcareous grey SILTSTONE and mottled nodular silty CALCAREOUS Shell fragments. Dip 5°.	D.S. 2.55
550	575	Light grey very calcareous SILTSTONE with beds of mottled very fine grained SANDSTONE and SILTSTONE and beds of medium grained SANDSTONE with calcareous matrix.	
575	580	Light grey-brown fine grained recrystallised CALCARENITE with beds of brown oolitic LIMESTONE, grey very fine grained calcareous SANDSTONE and green silty CLAYSTONE.	
		Core 14. 580'- 610'. Recovery 5'- 6" (35%) Negative flame and fluorescence tests.	
580	610	Whitish fine grained CALCARENITE with scattered QUARTZ grains and beds of calcareous SILTSTONE. Dip 6°.	D.S. 2.60
610	630	Grey-brown and green-tan very fine grained very calcareous SANDSTONE and light brown fine grained CALCARENITE. Thin beds of oolitic LIMESTONE and scattered QUARTZ grains.	
630	640	Light brown sandy LIMESTONE, whitish fine grained CALCARENITE and soft grey SILTSTONE. Scattered QUARTZ grains.	
		Core 15. 640'- 660'. Recovery 7'- 6" (37.5) Negative flame and fluorescence tests.	
640	660	Fine whitish CALCARENITE with scattered QUARTZ grains and thin beds of green SILTSTONE. Dip 7°.	D.S. 2.65
660	670	Fine-grained white CALCARENITE with beds of light brown oolitic LIMESTONE, fine grained very calcareous SANDSTONE, grey SILTSTONE, and coarse rounded QUARTZ grains in calcareous matrix.	
670	675	Light brown fine grained dolomitic QUARTZ SANDSTONE with beds of grey SILTSTONE and thin beds of oolitic LIMESTONE.	
675	675	Lost circulation. No samples.	
675	690	Fine and very fine grained dolomitic light grey-brown subangular QUARTZ SANDSTONE with scattered very coarse QUARTZ grains. Calcite veins and crystals.	
690	700	Lost circulation. No samples.	
		Core 16. 700'- 730'. Recovery 6'-6" (21%) Negative flame and fluorescence tests.	
700	705	Grey and brown fine grained SANDSTONE with DOLOMITE and pyrites.	
705	710	Dark and light grey banded fine grained QUARTZ SANDSTONE with mica flakes and pyrites. Slightly calcareous. Trace of Glauconite. Dip 5°. Fairly consolidated.	D.S. 2.51
710	715	Grey-brown fine grained calcareous SANDSTONE with beds of medium grained fair sorted QUARTZ SANDSTONE. Calcite crystals.	
715	717	Lost circulation. No samples.	
717	720	Fine to medium grained dolomitic QUARTZ SANDSTONE with beds of green CLAYSTONE.	
		Core 17. 720'- 760'. Recovery 17'- 3"(43.2%) Negative flame and fluorescence tests.	
720	760	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
760	770	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
770	780	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
780	790	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
790	800	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
800	810	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
810	820	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
820	830	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
830	840	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
840	850	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
850	860	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
860	870	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
870	880	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
880	890	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
890	900	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
900	910	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
910	920	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
920	930	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
930	940	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
940	950	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
950	960	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
960	970	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
970	980	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
980	990	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
990	1000	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1000	1010	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1010	1020	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1020	1030	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1030	1040	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1040	1050	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1050	1060	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1060	1070	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1070	1080	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1080	1090	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1090	1100	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1100	1110	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1110	1120	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1120	1130	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1130	1140	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1140	1150	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1150	1160	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1160	1170	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1170	1180	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1180	1190	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1190	1200	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1200	1210	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1210	1220	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1220	1230	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1230	1240	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1240	1250	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1250	1260	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1260	1270	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1270	1280	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1280	1290	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1290	1300	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1300	1310	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1310	1320	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1320	1330	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1330	1340	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1340	1350	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1350	1360	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1360	1370	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1370	1380	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1380	1390	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1390	1400	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1400	1410	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1410	1420	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1420	1430	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1430	1440	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1440	1450	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1450	1460	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1460	1470	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1470	1480	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1480	1490	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1490	1500	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1500	1510	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1510	1520	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1520	1530	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1530	1540	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1540	1550	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1550	1560	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1560	1570	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1570	1580	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1580	1590	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1590	1600	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1600	1610	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1610	1620	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1620	1630	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1630	1640	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1640	1650	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1650	1660	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1660	1670	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1670	1680	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1680	1690	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1690	1700	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1700	1710	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1710	1720	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1720	1730	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1730	1740	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1740	1750	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1750	1760	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1760	1770	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1770	1780	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1780	1790	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1790	1800	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1800	1810	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1810	1820	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1820	1830	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1830	1840	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1840	1850	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1850	1860	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1860	1870	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1870	1880	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1880	1890	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1890	1900	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1900	1910	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE and thin beds of green CLAYSTONE. Trace of pyrite. Dip 5°.	D.S. 2.67
1910	1920	Fine grained, light grey-brown, very calcareous SANDSTONE, with beds of grey SILTSTONE