

## 1981/28. Summary of limestone investigations in the Lune River area.

T.G. Summons

## Abstract

The Gordon Limestone in the Lune River area can be classified into the upper, middle, and lower sequences, with an aggregate thickness in excess of 700 m. The upper and lower sequences were deposited under intertidal/subtidal conditions, whereas the middle sequence was formed under supratidal/intertidal conditions. The lower sequence (and perhaps the middle and upper sequences) appears to have lithostratigraphic correlates in the Florentine Valley. Major geochemical trends between the upper and middle sequences are indicated by the concentration of  $\text{CaCO}_3$ ,  $\text{MgCO}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{SrO}$ , and  $\text{P}_2\text{O}_5$ , which (excepting the  $\text{P}_2\text{O}_5$  trend), are regarded as due to the effects of hypersaline dolomitising brines, which originated in the middle sequence. An unusual lithotype referred to as birds eye calcisiltite occurs mainly in the middle sequence, and has probably been formed by the natural beneficiation of 'ordinary' intertidal/subtidal calcisiltites. All limestone quarries in the area (including the currently operated Newlands quarry), are located in the upper sequence, with the exception of Blaneys quarry which is in the middle sequence. High grade limestone intervals occur in the middle sequence, and are centred on several units of birds eye calcisiltite. Large tonneages of high grade limestone are inferred to exist in the middle sequence between Newlands and Blaneys quarries.

## INTRODUCTION

An investigation into the distribution of the various grades of limestone in the Newlands quarry commenced in February 1980 by the Tasmania Department of Mines using a Mindrill F20 drilling rig. This programme of drilling was funded by Benders Spreading Services (1964) Pty Ltd via a grant of \$20 000 under the Aid to Mining Act, 1927, and was interspersed with a separate program of stratigraphic drill holes which were drilled at the expense of the Tasmania Department of Mines.

The Benders drilling program consisted initially of four diamond drill holes which were collared at various points along the topographic saddle at the top of Newlands quarry, between Lune Sugarloaf and Marble Hill.

Subsequent to the collation and interpretation of the analytical data relating to the limestone drill core, the Benders program was extended to include two additional drill holes (one rotary, one diamond) in the area immediately north of Newlands quarry. In addition, two further stratigraphic drill holes were put down by the Tasmania Department of Mines.

All samples (grab, chip, and split diamond drill core) were analysed by Electrona Carbide Industries Pty Ltd.

A program of defect mapping was also done in Newlands quarry, in an attempt to recognise those defects most likely to be clay filled, and thus to reduce the contamination of the limestone during quarrying operations by such clay.

Previous investigations of the limestone have been made by Nye (1926), Dickenson (1945), Everard (*in* Hughes, 1957), Forsyth and Green (1976), and

Sharples (1979).

RESULTS

General

The initial Benders drilling program consisted of diamond drill holes DLR-1 (65 m), DLR-3 (60 m), DLR-4 (61.3 m), and DLR-5 (120 m), with total depths shown in brackets. All holes were drilled with NQ wireline equipment, with holes DLR-1 and DLR-4 successfully drilled to the target horizon referred to as the 'Grey Band', located near the base of Newlands quarry. Drill hole DLR-3 was abandoned in broken ground, while DLR-5 intersected a sequence of low grade shaly limestone in which the probable correlate of the Grey Band was located in a down-faulted position.

The second phase of the Benders drilling program consisted of a rotary drill hole DLR-8 (30 m) and a diamond drill hole DLR-9 (46 m), both drilled with a Mayhew 1000 rig. Hole DLR-8 was abandoned at 30 m in orange-brown clay, while hole DLR-9 was terminated at 46 m after passing through a fault zone.

The stratigraphic drill holes were DLR-2 (418 m), DLR-6 (39 m), and DLR-7 (506 m); hole DLR-2 was drilled with NQ, BQ, and AQ wireline equipment, and was abandoned at 418 m due to the drilling incapacity of the Mindrill F20 rig. Hole DLR-6 was abandoned in broken and cavernous ground, and DLR-7 was drilled with the Mayhew 1000 rig (NQ wireline) to 393 m, and from 393 m to 506 m with the Edeco Stratadrill 36 rig (BQ wireline).

The locations of all drill hole collars are shown in Figure 1.

Drill hole logs and analyses (single and composite) are combined in Appendices 1 and 2.

STRUCTURE

The limestone in Newlands quarry dips at approximately 5-10° SE while in Blaneys quarry to the west, it dips at approximately 5-10° to the west and north. The massively bedded nature of most of the limestone, in conjunction with the presence of concentric shear joints (Dr E. Williams, pers. comm.) subparallel to the bedding, make recognition of the bedding difficult. Mesoscopic-scale folds are visible in both the drill core and in the quarry faces, but insufficient exposures prevented a comprehensive study of these folds.

The limestone sequences in Blaneys and Newlands quarries appear to be related by means of a broad anticlinal fold which strikes north, with Newlands quarry on its eastern limb.

Mapping in the quarry showed three main types of defect to be present - joints, crushed zones (including some intraformational breccias with calcite matrices) and sheared zones. Because the majority of the joints show some solution effects, it was impractical to differentiate joints from solution features (planes, cavities, etc.).

The poles of 105 joints were contoured on an equal area stereogram, and this information, in conjunction with the rose diagram of the joints, enabled five joint sets to be recognised (figs. 2, 3).

However, although it was observed that clay-filled joints could occur

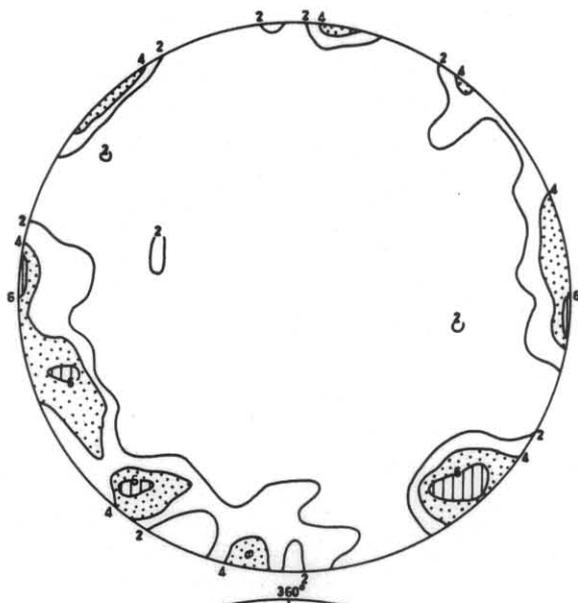


Figure 2a. Contour diagram, poles to joints, Newlands quarry.

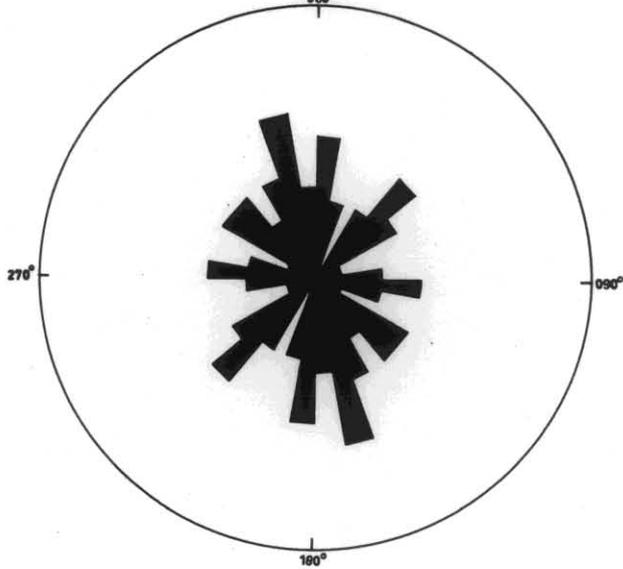


Figure 2b. Rose diagram, total joints, Newlands quarry.

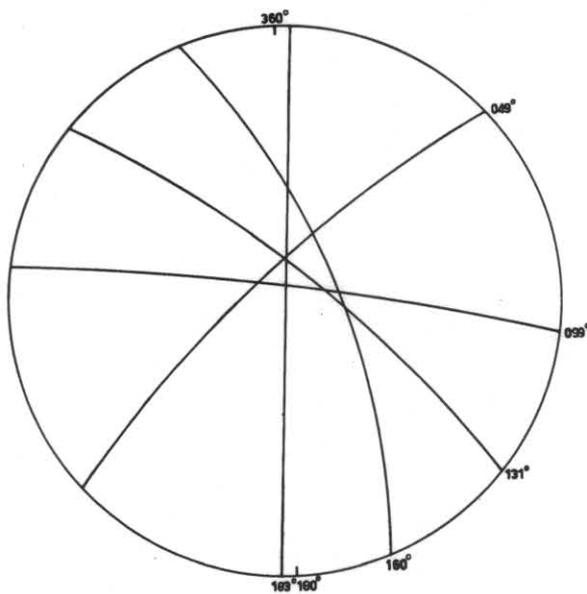


Figure 3. Synoptic diagram of total joints, Newlands quarry.

5 cm

in any of the five joint sets, no distinct pattern with respect to clay filling emerged.

The clay is derived from two sources:

- (i) the insoluble residue from dissolved limestone, or
- (ii) the weathering of Permian mudstone immediately overlying the limestone.

It was decided to examine the joints in terms of their width and length parameters, on the basis that the widest, longest joints would be most prone to solution effects, and hence to clay infilling. Using a method of trial and error, it was found that the joints occurred in reasonably discrete groups dispersed either side of width values of 10 mm (fig. 4) and length values of 15 m (fig. 5).

This data was then compared with the total joint orientations, as shown below:

Joint set	Strike (°)	Dip (°)	Width (>10mm)	Length (>15 m)	Approximate probability of clay filling
1	049	81 NW	Present	-	Minor
2	099	86 N	-	Present	Minor
3	131	81 NE	-	Present	Major
4	160	74 E	Present	Present	Major
5	183	90	Present	Present	Major

It would therefore appear that joint sets 4 and 5 are the most susceptible to the solution effects/clay filling phenomena, with the consequence that if contamination of the limestone by clay during mining operations is to be minimised, the quarry benches should be re-orientated to strike 160-183° (magnetic).

Considerable faulting of the limestone in Newlands quarry has occurred, and is represented by both thrust, and ?later normal faults.

The most readily recognisable normal fault in the area occurs immediately west of Lune Sugarloaf (the Lune Sugarloaf fault), and has a strike of approximately 180°, with an east block down movement (approximately 100 m throw). This fault defines the eastern extremity of future quarrying operations in Newlands quarry. An inferred normal fault is thought to exist between drill holes DLR-2 and DLR-5, with a west block down movement (fig. 6).

#### LITHOLOGIES AND STRATIGRAPHY

Information provided by stratigraphic drill holes DLR-2 and DLR-7 enables three formations to be recognised as follows:

##### *Upper sequence*

This sequence is incomplete, being disconformably overlain by Lower Parmeener Super-Group sedimentary rocks in Newlands quarry. This erosional contact occurs approximately 31 m above the collar of DLR-2, and the sequence continues to a depth of 112.2 m in DLR-2. It consists of lithotypes deposited predominantly (>90vol%) in intertidal to subtidal environments, and is represented by calcisiltites, calcarenites, and calcirudites

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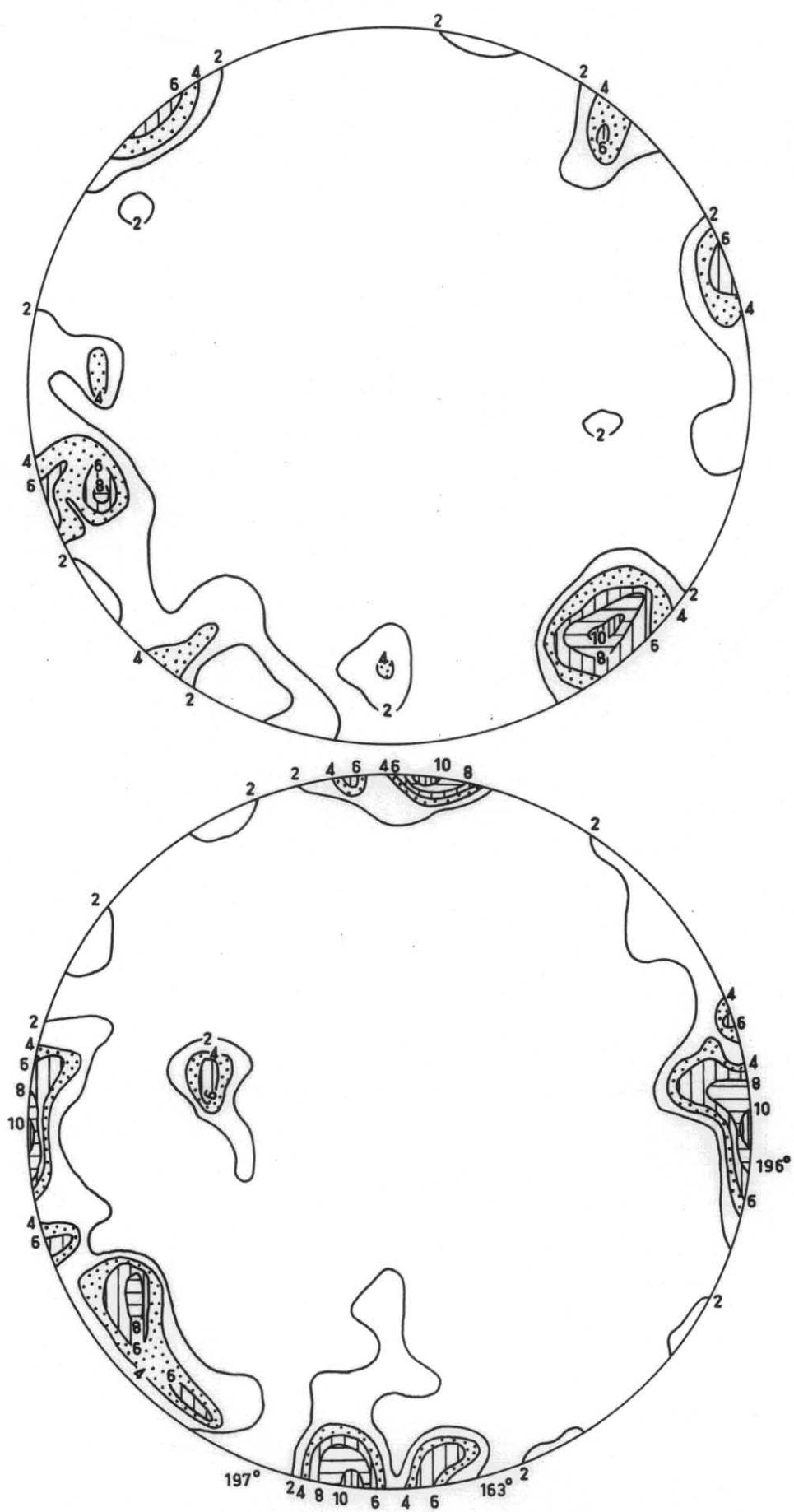


Figure 4. Contour diagram of poles to joints, Newlands quarry; <10 mm width (upper), >10 mm width (lower)

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5 cm

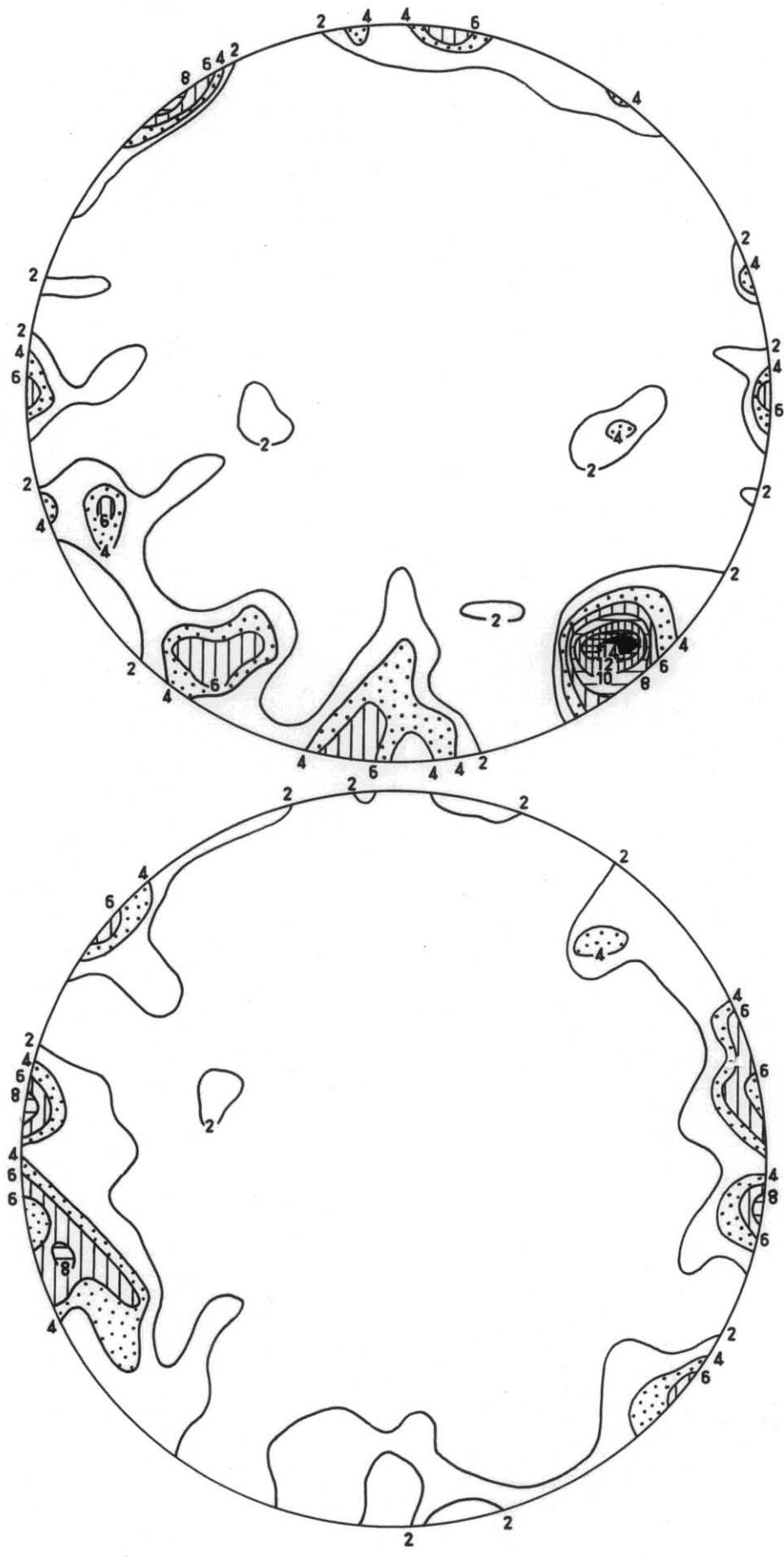


Figure 5. Contour diagram of poles to joints, Newlands quarry; <15 m length (upper), >15 m length (lower).

Table 1. PERCENTAGE OF LITHOTYPES IN UPPER AND MIDDLE SEQUENCES, DLR-2 and DLR-7.

Sequence	DLR-2 Interval	DLR-7 Interval	Width (m)	Birds eye micrite (vol%)	Algal laminated micrite (vol%)	Birds eye micrite (silty bands) (vol%)	Birds eye calcisiltite (vol%)
Upper	0 - 71.6	-	71.6	6	1	-	2
	71.6-112.2	-	40.6	8	2	-	-
	112.2-153.0	-	40.8	23	11	9	-
	153.0-193.5	-	40.5	36	15	-	-
Middle	(193.5-236.2)	44.4- 87.1	42.7	43	-	2	21
	(236.2-267.9)	87.1-118.8	31.7	35	10	18	22
	(267.9-306.5)	118.8-157.4	38.6	4	26	15	16
	(306.5-349.4)	157.4-200.3	42.9	65	4	16	14
	(349.4-389.4)	200.3-240.3	40.0	39	14	21	-
	(389.4-436.9)	240.3-287.8	47.5	25	34	7	-
Upper sequence average volume%				6.7	1.2	-	1.2
Middle sequence average volume%				33.9	14.5	10.7	8.6

- Note (i) Intervals shown in brackets under drill hole DLR-2 are the equivalent of those used from drill hole DLR-7;
- (ii) The base of the middle sequence occurs at a depth of 301.4 m in DLR-7 (equivalent 450.5 m in DLR-2); although the basal 13.6 m of the middle sequence has been dolomitised, the data presented in the table is taken as representative of the complete middle sequence (112.2-450.5 m).
- (iii) Included in the category of birds eye micrite with silty bands are the 'flat pellet breccias' in DLR-2 between 112.2 and 153.0 m.

(Table 1). The upper sequence includes local marker beds such as the upper and lower chert zones (fig. 6), the Grey Band (birds eye micrite, fig. 6) and the Upper Oncolite Horizon (figs. 7, 8) from 109.5-112.2 m in DLR-2.

*Middle sequence*

This sequence extends for 338 m from 112.2-450.5 m (equivalent DLR-2), and consists of lithotypes deposited generally (~70vol%) in supratidal to intertidal environments. It is represented by birds eye micrites, algal laminated micrites, birds eye micrites with silty bands, and birds eye calcisiltites (Table 1). The remaining 30vol% consists of intertidal (?and subtidal) lithotypes similar to those in the upper sequence. The middle sequence contains several high grade limestone intervals, referred to as high grade 1, 2, and 3 (figs. 7, 8).

*Lower sequence*

This sequence extends from 450.5-655 m (equivalent DLR-2) and consists of lithotypes deposited predominantly under intertidal to subtidal conditions, which range from calcisiltite to calcarenite. The upper 32 m (450.5-482.8 m equivalent DLR-2) consists of dolomitised oncolitic calcarenite (the Lower Oncolite Horizon) shown in Figure 8, and is interpreted as the lithological correlate of the Cashions Creek Limestone in the Florentine

# EAST - WEST SECTION BETWEEN NEWLANDS & BLANEYS QUARRIES

## LUNE RIVER

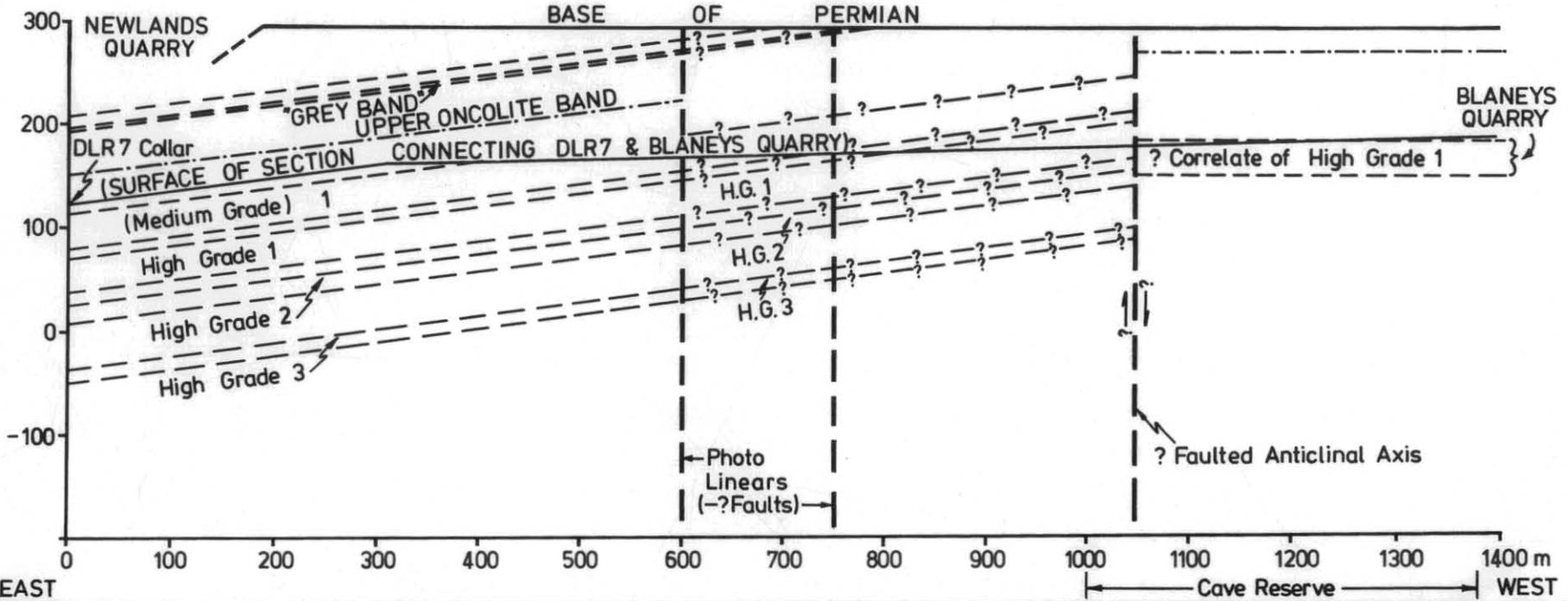
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0 100 200 300 400 metres

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GEOLOGIST: T. G. SUMMONS DEC. 1980

ELEVATION - metres RL



28-8

Figure 7.

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Valley. Further down in this sequence, from 527.3-549.2 m (equivalent DLR-2), occurs a bedded and nodular chert zone (the Bedded Chert Zone) which has been partially dolomitised, and which is regarded as the lithological correlate of the Wherretts Chert Member in the Florentine Valley. Generally the lower sequence has been extensively dolomitised, and the interpretation of the original depositional environment is based partly on the recognition of relict burrows and other features characteristic of the intertidal/subtidal conditions better preserved in the upper sequence.

Table 2 depicts the salient aspects of the above described classification at Lune River, with tentative chrono- and biostratigraphic correlations.

Table 2. TENTATIVE CORRELATIONS, GORDON LIMESTONE, LUNE RIVER

North American stages	Lune River		Florentine Valley*	
Cincinnatian	Permian			
Trentonian		Upper sequence (>143 m)	Upper member	Benjamin Limestone
	Upper Oncolite Horizon		Lords Siltstone	
Blackriveran		Middle sequence (338 m)	Lower Member	
Chazyan	Lower Oncolite Horizon		Cashions Creek Limestone	
	Bedded Chert Zone	Lower sequence (>200 m)	Wherretts Chert Member	Karmberg Limestone
Whiterockian				

\* From Corbett and Banks (1974).

Forsyth and Green (1976) obtained ages from fossil assemblages for the Lune River area, namely that Newlands quarry ranges from Trentonian to Cincinnatian, and that the beds beneath Newlands quarry, and those present in Blaneys quarry, were Blackriveran in age. C.F. Burrett (pers. comm.) using conodonts obtained a Blackriveran age from DLR-2 and DLR-7 in approximately the same horizon 50 m above the Lower Oncolite Horizon, and it appears likely that this latter interval is of Chazyan age.

Above the Grey Band, Newlands quarry (fig. 6) may be divided into two broad areas, separated by the inferred fault between drill holes DLR-2 and DLR-5. The eastern area consists predominantly of calcisiltite with subordinate calcarenite, while the western area consists of an upper section with predominantly calcirudite and calcarenite, with minor calcisiltite. The western area lower section (below RL245 m) consists of shaly calcisiltite and calcarenite in approximately equal proportions, interbedded with black shale and intraformational breccia which typically have a black shale matrix. The eastern area above the Grey Band includes two chert zones (upper and lower) ranging in thickness from 5-15 m. The chert is blue in colour and frequently occurs as agate, and is a likely source for the agate gemstones found in the Lune River district.

The area adjacent to Newlands quarry contains several abandoned limestone quarries, namely Blaneys [DM873877], Lune Sugarloaf (2) [DM893882] and the EZ [DM894885].

The sequence exposed in Blaneys quarry consists mainly of birds eye micrite, indicating a supratidal environment, and is correlated with the high grade 1 interval of the middle sequence at Newlands quarry (fig. 7).

The Lune Sugarloaf quarries contain blue chert nodules in calcisiltite, and are identical to the chert nodules in both the Upper and Lower Chert Zones of the upper sequence (fig. 6). The EZ quarry has a sequence of calcisiltite, and is inferred to fall within the upper sequence.

Correlation of limestone units within the general area of Newlands quarry can be made using lithological, chemical, and structural parameters, as summarised below:

- (i) *Upper and Lower Chert Zones* - one or both of these units can be traced for one kilometre from Newlands quarry across the Lune Sugarloaf fault to the western Lune Sugarloaf quarry.
- (ii) *Grey Band* - this can be traced continuously across Newlands quarry for approximately 500 m.
- (iii) *Upper Oncolite Horizon* - Sharples (1979) traced this unit discontinuously from Newlands to Blaneys quarry, representing a distance of approximately 1.5 km.
- (iv) *High grade limestone intervals* - these were first discovered in drill hole DLR-2, and subsequently located in DLR-7 using a combination of lithostratigraphy and 'chemistratigraphy'. The same intervals in each drill hole are lithologically broadly similar but are not identical, whereas their compositions are very similar in both major and trace element contents (e.g.  $\pm 1\%$  CaCO<sub>3</sub>). In addition, individual lithotypes within these intervals are typically higher in CaCO<sub>3</sub> and lower in other elements than identical lithotypes not constituting high grade intervals. Numerous intra-interval facies changes occur, as shown in Figures 8, 9, 10, and 11, and in Appendices 1 and 2.

Correlation of the sequences in Newlands and Blaneys quarries is shown in Figure 7, where lithostratigraphic, chemistratigraphic, and structural parameters were utilised.

- (v) *Lower Oncolite Horizon and the Bedded Chert Zone* - these have only been intersected in DLR-7; however, the lithological (?and chronological) similarity to part of the Florentine Valley sequence implies that these units may be useful in regional studies of the Gordon Limestone.

As indicated previously, much of the lower sequence (and part of the middle sequence in DLR-2) has been dolomitised; the dolomite grain size ranges from about 0.1 mm-2 mm, and averages about 0.5 mm, and is similar to the dolomite in the lower Gordon River described by Rao and Naqvi (1977). The dolomite is consistently granular, often porous and vuggy, and often has a relict fabric derived from the original limestone (e.g. 'fuzzy' stylolites, burrows).

The dolomite is considered to have been formed during diagenesis, when hypersaline fluids (generated in the supratidal middle sequence) moved out of the middle sequence and down to the lower sequence, selectively replacing permeable lithotypes (e.g. the Lower Oncolite Horizon).

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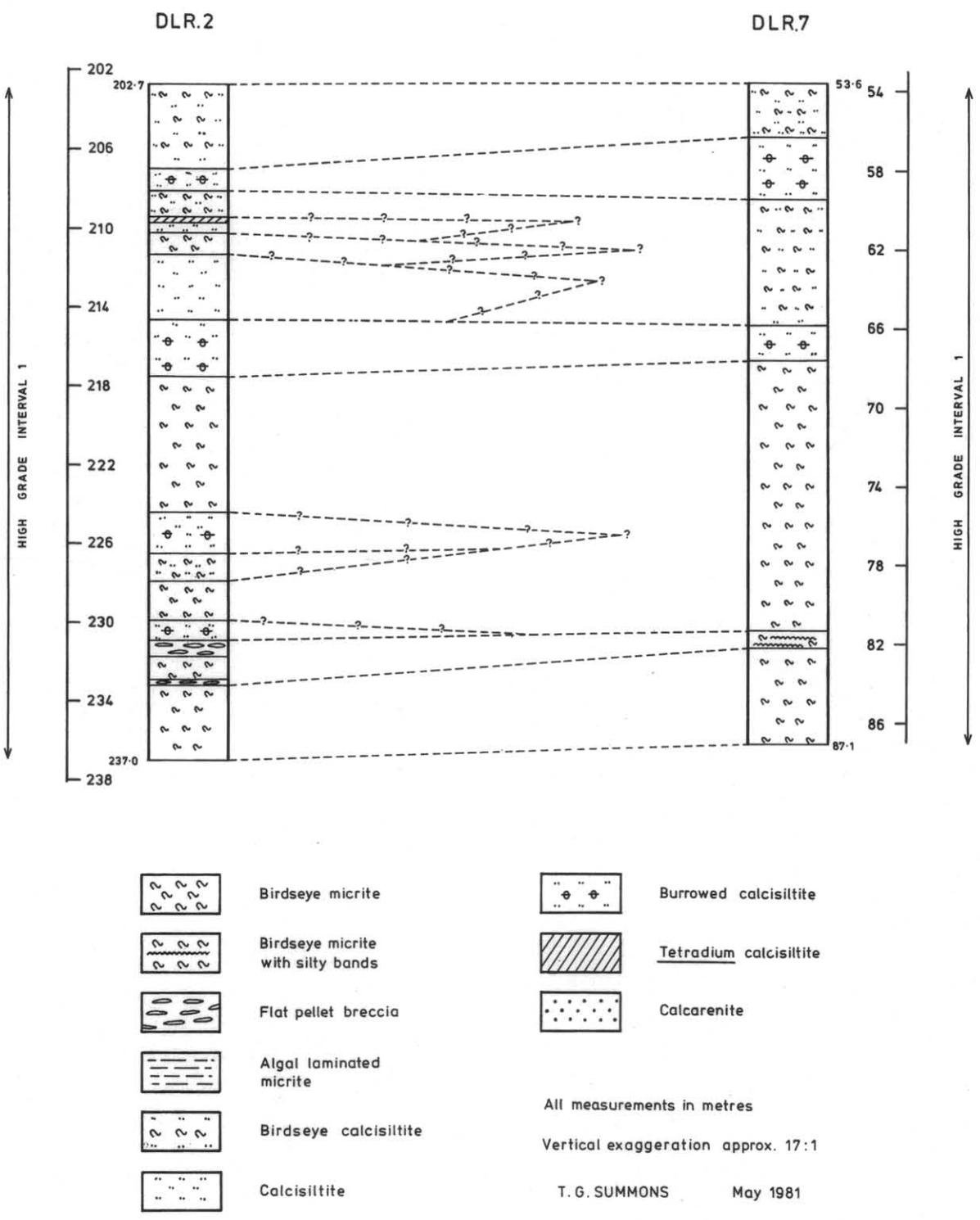


Figure 9. Correlation of High Grade Interval 1 in the middle sequence between diamond drill holes DLR-2 and DLR-7.

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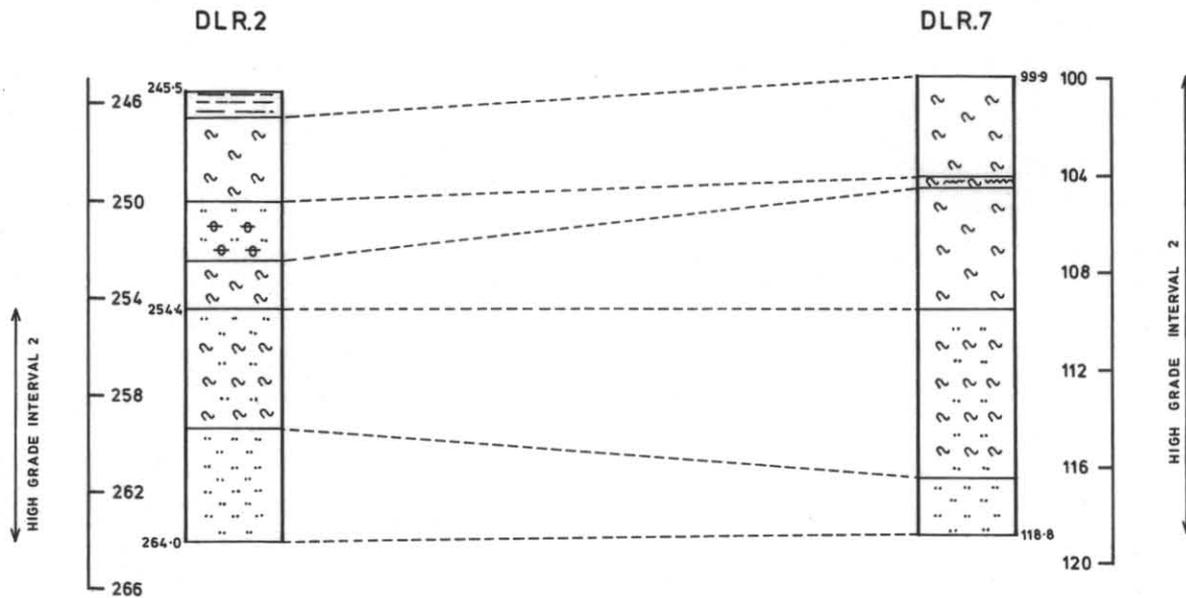


Figure 10. Correlation of High Grade Interval 2.

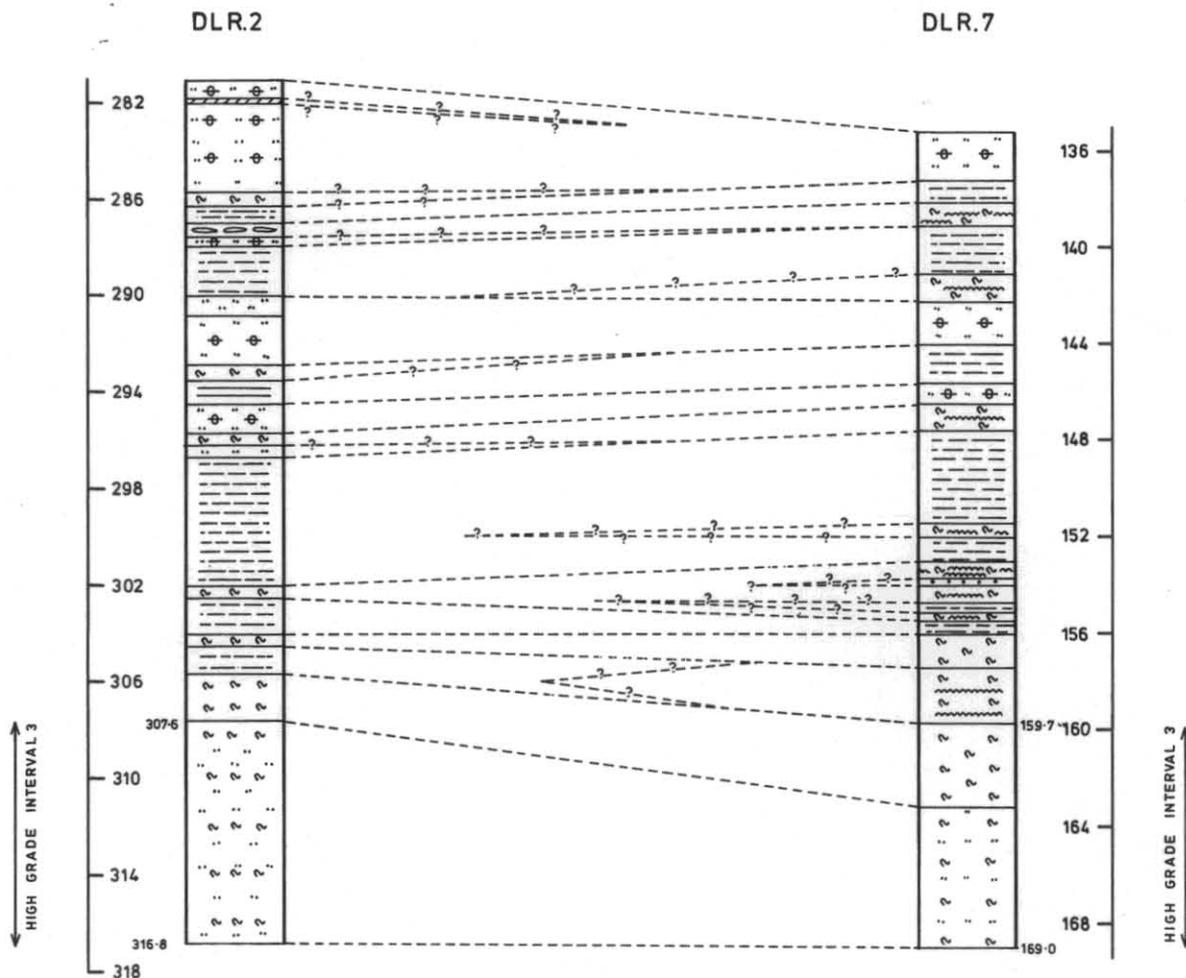


Figure 11. Correlation of High Grade Interval 3.

LIMESTONE GRADES

The analyses of the limestone core from drill holes DLR-1, 2, 3, 4, and 5 indicated an appreciable range in the levels of concentration of phosphorus and silicon, which were expressed as P<sub>2</sub>O<sub>5</sub> and SiO<sub>2</sub> respectively, and are shown on the longitudinal section (fig. 12). It was found that limestone with a high level of CaCO<sub>3</sub> was often contaminated with either high P<sub>2</sub>O<sub>5</sub> or SiO<sub>2</sub>, or both.

High grade limestone (suitable for use in the manufacture of calcium carbide) is defined as limestone containing >92% CaCO<sub>3</sub> (preferably >94% CaCO<sub>3</sub>), <0.02% P<sub>2</sub>O<sub>5</sub>, and <4% SiO<sub>2</sub>. The silicon has two modes of occurrence, as follows:

- (a) Alumino silicates chlorite and clay minerals (illite and mixed layer clays);
- (b) Chert nodules.

The phosphorus appears to have two modes of occurrence as follows:

- (a) Phosphatic shelly fragments (e.g. apatite in trilobites);
- (b) Phosphatic black shale.

The longitudinal section (fig. 12) shows that the amount of high grade limestone available for quarrying in Newlands quarry is limited to the upper 10-15 m of the eastern area.

The only other high grade limestone in Newlands quarry of any significance occurs in a 10 m thick interval immediately above the Grey Band, and which may be accessible to quarrying in an alternative site west of Newlands quarry. The composition of these two high grade limestone intervals is shown in Table 3.

Table 3. HIGH GRADE LIMESTONE - NEWLANDS QUARRY

Interval	Hole	From (m)	To (m)	Thickness (m)	Grade (%CaCO <sub>3</sub> )	Average interval grade (%CaCO <sub>3</sub> )
Eastern area ) - top of the ) quarry )	DLR-1	0	12	12	95.0 )	96.0
	DLR-4	0	8.6	8.6	96.6 )	
	DLR-2	0	17.6	17.6	95.5 )	
Eastern area ) - immediately ) above Grey ) Band )	DLR-1	48.8	58.45	9.65	93.6 )	95.0
	DLR-4	48.8	57.5	8.70	94.2 )	
	DLR-2	57.0	68.5	11.50	96.0 )	

Stratigraphic drill hole DLR-2 intersected a major high grade limestone interval from 200.4-237 m, which is approximately 100 m below the floor of Newlands quarry. Additional high grade limestone was intersected from 254.4-264 m, and from 307.65-316.8 in hole DLR-2. These discoveries

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prompted further investigation to determine their strike continuities and potential outcrop positions in the area north of Newlands quarry, and stratigraphic drill hole DLR-7 was collared approximately 500 m north of DLR-2 to achieve this objective.

This hole was successful in locating all three of the high grade limestone intervals (which are within the limits for P<sub>2</sub>O<sub>5</sub> and SiO<sub>2</sub> referred to above) seen in DLR-2 (Table 4).

Table 4. HIGH GRADE LIMESTONE LOCATED IN STRATIGRAPHIC DRILL HOLES DLR-2, 7

DLR-2				
Limestone interval	From (m)	To (m)	Thickness (m)	Weighted average grade (%CaCO <sub>3</sub> )
MG (1)	153.0	187.3	34.3	93.40
	(202.7	212.8	10.1	96.50
HG (1)	(202.7	223.5	20.8	95.08
	(200.4	237.0	36.6	93.19
	-	-	-	-
HG (2)	254.4	264.0	9.6	96.10
HG (3)	307.65	316.8	9.15	97.00
DLR-7				
	(53.6	65.8	12.2	95.72
HG (1)	(53.6	73.0	19.4	95.47
	(51.4	87.1	35.7	94.85
HG (2)	( 99.85	118.8	18.95	95.50
	(109.5	118.8	9.3	96.67
HG (3)	159.7	169.0	9.3	95.89

There is a good correlation (using litho- and chemistratigraphy) of the high grade (HG) intervals between the two drill holes, with two notable exceptions;

- (a) The major high grade limestone interval in hole DLR-2 improves in grade north to hole DLR-7 from approximately 93% CaCO<sub>3</sub> to approximately 95% CaCO<sub>3</sub>;
- (b) The second high grade limestone interval (2) in hole DLR-2 both doubles in thickness and improves in grade (109.5-118.8 m in DLR-7) northward from hole DLR-2 to DLR-7.

Figure 7 depicts these high grade limestone intervals, as well as the high grade limestone in Blaneys quarry (chip sampling of this quarry returned an average grade of 94.85% CaCO<sub>3</sub> over a 35 m vertical interval); the high grade limestone in Blaneys quarry is considered to be the correlate of High Grade Interval-1 seen in holes DLR-2 and 7. Faulting appears to have disrupted the limestone sequence between the two quarries, and further investigation of this area is necessary before the sense of movement on the faults can be determined. Chip sampling in the EZ quarry returned an average grade of 90.2% CaCO<sub>3</sub> over a 12 m vertical interval.

Table 5 gives representative analyses of the major limestone lithotypes at Lune River, with the exception of calcirudite which only occurs

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in the upper sequence.

Several major geochemical trends are apparent in Table 5, namely that  $MgCO_3$  and  $Fe_2O_3$  increase, while  $CaCO_3$ ,  $SrO$ , and  $P_2O_5$  decrease from the upper to the middle sequence. The trend in  $SiO_2$  concentration is a slight increase from the upper to middle sequence, while the variation in  $Na_2O$  concentration is apparently not significant.

$CaCO_3$ . The variation in concentration is due mainly to the increase in  $MgCO_3$  in the middle relative to the upper sequence, due to the action of hypersaline dolomitising brines, (i.e. the trend is one of downgrading of the limestone lithotypes due to dolomitisation).

$MgCO_3$ . The variation in concentration from upper to middle sequence is very distinct and ranges from 60% (birds eye micrite) to 580% (calcarenite) higher in the middle sequence, with an average value of 220%.  $MgCO_3$  values in the calcisiltite are an average 150% higher, while the algal laminated micrite is an average 290% higher in the middle sequence. These percentage increases in  $MgCO_3$  concentration indicate a crude order of increasing permeability/porosity from birds eye micrite → calcisiltite → algal laminated micrite → calcarenite. The  $MgCO_3$  concentrations in the middle sequence provide good evidence for the presence of a hypersaline dolomitising fluid which originated in the supratidal/evaporite environment of the middle sequence, and percolated down to the lower sequence, dolomitising permeable lithotypes such as the Lower Oncolite Horizon (originally an oncolitic calcarenite, fig. 8).

Table 5. REPRESENTATIVE ANALYSES OF LIMESTONE LITHOTYPES

Lithotype		$CaCO_3$ (%)	$MgCO_3$ (%)	$SiO_2$ (%)	$Fe_2O_3$ (%)	$SrO$ (%)	$Na_2O$ (%)	$P_2O_5$ (%)
Birds eye micrite	(US)	91.7	1.5	5.1	0.39	0.03	0.04	0.030
	(MS)	92.5	2.4	2.9	0.54	0.02	0.04	0.011
Algal laminated micrite	(US)	90.5	1.7	5.5	0.35	0.04	0.03	0.081
	(MS)	83.4	6.6	6.1	0.64	0.01	0.05	0.013
Calcisiltite								
(i) Black stylolites	(US)	93.6	1.9	3.2	0.23	0.03	0.05	0.020
	(MS)	91.0	4.7	3.5	0.38	0.02	0.03	0.011
(ii) Orange stylolites	(US)	94.1	1.3	3.4	0.26	0.04	0.04	0.020
	(MS)	91.5	3.6	4.0	0.37	0.02	0.02	0.010
(iii) Black & orange stylolites	(US)	94.9	1.5	2.7	0.20	0.04	0.04	0.020
	(MS)	93.0	3.5	2.6	0.48	0.02	0.03	0.008
(iv) Birds eye	(US)	≈97.0	1.0	2.0	0.04	0.03	0.04	0.014
	(MS)	95.2	2.5	2.1	0.22	0.02	0.02	0.005
Calcarenite	(US)	95.4	1.1	3.0	0.35	0.03	0.04	0.040
	(MS)	86.7	7.5	3.8	0.71	0.02	0.07	0.014

US = average of all composite samples from the upper sequence.

MS = average of all composite samples from the middle sequence (112.2-436.9 m equivalent in DLR-2).

$Fe_2O_3$ . The variation in concentration from upper to middle sequence is also distinct, and ranges from 38% (birds eye micrite) to 450% (birds eye calcisiltite) higher in the middle sequence with an average value of 130%. The same pattern of increasing permeability as discussed for  $MgCO_3$  is not apparent, presumably because only approximately 50% of the Fe is present

in carbonate lattice sites in limestones (Veizer, 1978), the remainder occurring as sulphide and oxide phases. The increased  $Fe_2O_3$  values in the middle sequence are interpreted as the result of:

- (a) Fe being carried in the dolomitising brines, and;
- (b) bacterial reduction of sulphate (from the dolomitising brine) to sulphide with consequent precipitation of pyrite.

$SrO$ . The variation in concentration of Sr from upper to middle sequence is consistent, and averages approximately 100% higher in the upper sequence. The reason(s) for this trend is not known, but it may be due to leaching of Sr from the middle sequence (prior to the deposition of the upper sequence) by the hypersaline brines, or it may reflect a change in the sea water composition.

$P_2O_5$ . The variation in concentration of  $P_2O_5$  between sequences is also consistent, and averages 200% higher in the upper sequence. This trend is regarded as having been due to a change in one or all of the following: palaeoclimate, palaeosalinity, faunal diversity, or in the tectonic stability at the time.

$SiO_2$ . The variation in  $SiO_2$  concentration is a general increase from upper to middle sequences, presumably a by-product of the dolomitising hypersaline fluids which would have been buffered (to pH <9.0) by local concentrations of organic acids formed from decaying algal mats present in the middle sequence, with a consequent precipitation of chalcedony.

$Na_2O$ . The variation in Na from upper to middle sequence does not indicate any particular trend; however, as the middle sequence would have held more non-silicate Na than the upper sequence (Veizer and Garrett, 1978), it is likely that disproportionate amounts of Na would have been leached by the dolomitising fluids. Limited data on the dolomite in DLR-2 indicates an  $Na_2O$  content of 0.05-0.06%, and it is suggested that the original trend in  $Na_2O$  would have increased from the upper to the middle sequence.

#### BIRDS EYE CALCISILTITE

A significant proportion of all the high grade limestone intervals (with the possible exception of Blaneys quarry) consists of birds eye calcisiltite, which is usually pale brown in colour, has rare orange sutured stylolites, and <15vol% of tubular and irregular shaped birds eyes infilled with sparry calcite (figs. 9, 10, and 11; Appendix 1).

This lithotype frequently contains >98%  $CaCO_3$ , although the average for all composite samples in the middle sequence is 95.2%  $CaCO_3$  (Table 5). It is relevant to note that other lithotypes such as 'ordinary' calcisiltite, calcarenite, and calcirudite in Newlands quarry (upper sequence) may also analyse as >98%  $CaCO_3$ ; the main difference lies in the significantly lower  $MgCO_3$ ,  $SiO_2$ ,  $Fe_2O_3$ , and  $P_2O_5$  concentrations in the birds eye calcisiltite and the average of all composite samples of 'ordinary' calcisiltite (i.e. calcisiltite with black and orange stylolites) is lower at 93.0%  $CaCO_3$  in the middle sequence. The same general comments as regards geochemistry apply to birds eye calcisiltites (compared to 'ordinary' calcisiltites) in the upper sequence.

The origin of birds eye calcisiltite in terms of palaeoenvironments is not fully understood, but several features are apparent from Table 5

which may be relevant;

- (1) The main interval for the formation of birds eye calcisiltite extends for 155 m from 193.5-349.4 m (equivalent DLR-2), and reaches a maximum over 74 m from 193.5-267.9 m (equivalent DLR-2).
- (2) The consistent increase in the proportion of birds eye calcisiltite upward from 349.4-267.9 m (equivalent DLR-2) is associated with a general increase in the volume of birds eye micrite, a general decrease in the volume of algal laminated micrite, and an overall decrease in the proportion of birds eye micrite with silty bands.
- (3) The apparent antipathetic relationship between birds eye and algal laminated micrite in the middle sequence is well illustrated in the interval containing the birds eye calcisiltite, where the two highest birds eye micrite maxima coincide with the two lowest algal laminated micrite minima. Thus the formation of birds eye calcisiltite appears to have been facilitated when the volume of birds eye micrite being formed attained local maxima (with coincident algal laminated micrite local minima), suggesting the superimposition of a supratidal on an intertidal environment. This concept is not inconsistent with the general sequence at Lune River, where intertidal/subtidal facies (lower sequence) are overlain by supratidal/intertidal facies (middle sequence), which are overlain by intertidal/subtidal facies (upper sequence). This vertical sequence represents a prograding tidal flat situation, and the formation of birds eye calcisiltite may have been optimised during a strong pulse of shoreline progradation.

Comparison of the composition of 'normal' intertidal calcisiltite with supratidal/intertidal birds eye calcisiltite indicates that the latter have been relatively 'enriched' in  $\text{CaCO}_3$  (2%), and relatively 'depleted' in  $\text{MgCO}_3$  (31%),  $\text{SiO}_2$  (22%),  $\text{Fe}_2\text{O}_3$  (67%), and  $\text{P}_2\text{O}_5$  (34%) and virtually unchanged in Sr and Na. However, the absence of any dolomitising brines (due to lack of evaporites, or minimal development of algal mats) could also explain initial lower values of  $\text{MgCO}_3$ ,  $\text{SiO}_2$ , and  $\text{Fe}_2\text{O}_3$ .

Extensive periods of subaerial exposure are implied to allow the preservation of the viscous sediment with its dessication cracks, burrows, and other gas escape channels. The net effect of the palaeoenvironment was to induce a type of natural beneficiation of the 'normal' intertidal calcisiltite by the following mechanisms:

- (1) Oxidation of the organic matter (e.g. pale brown colour, orange stylolites);
- (2) Loss of gases (from decaying organic debris) via the different escape channels referred to above;
- (3) Precipitation of calcite in these gas escape channels, to form birds eyes;
- (4) Limited precipitation of evaporites in the immediate vicinity so as to minimise local dolomitisation.

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LIMESTONE RESOURCES

Newlands quarry

The amount of high grade limestone accessible for quarrying operations (fig. 13) has been defined by diamond drilling, and totals 736 000 t at an average grade of 96.00% CaCO<sub>3</sub>; this figure has the status of an indicated ore reserve.

The area between Newlands and Blaneys quarries

Several high grade and one thick medium grade limestone intervals occur in this area; however, as direct information from this area is not available, the following figures are only of inferred ore status, and should not be interpreted as ore reserves. As shown in Figure 7, the thickness of these intervals is based on data obtained from the stratigraphic drill holes DLR-2 and 7. The maximum strike length of approximately one kilometre occurs between DLR-7 and the eastern boundary of the Entrance Cave Reserve, and assuming an average quarry width of 100 m along the side of the range connecting the two quarries, the inferred limestone figures are as follows:

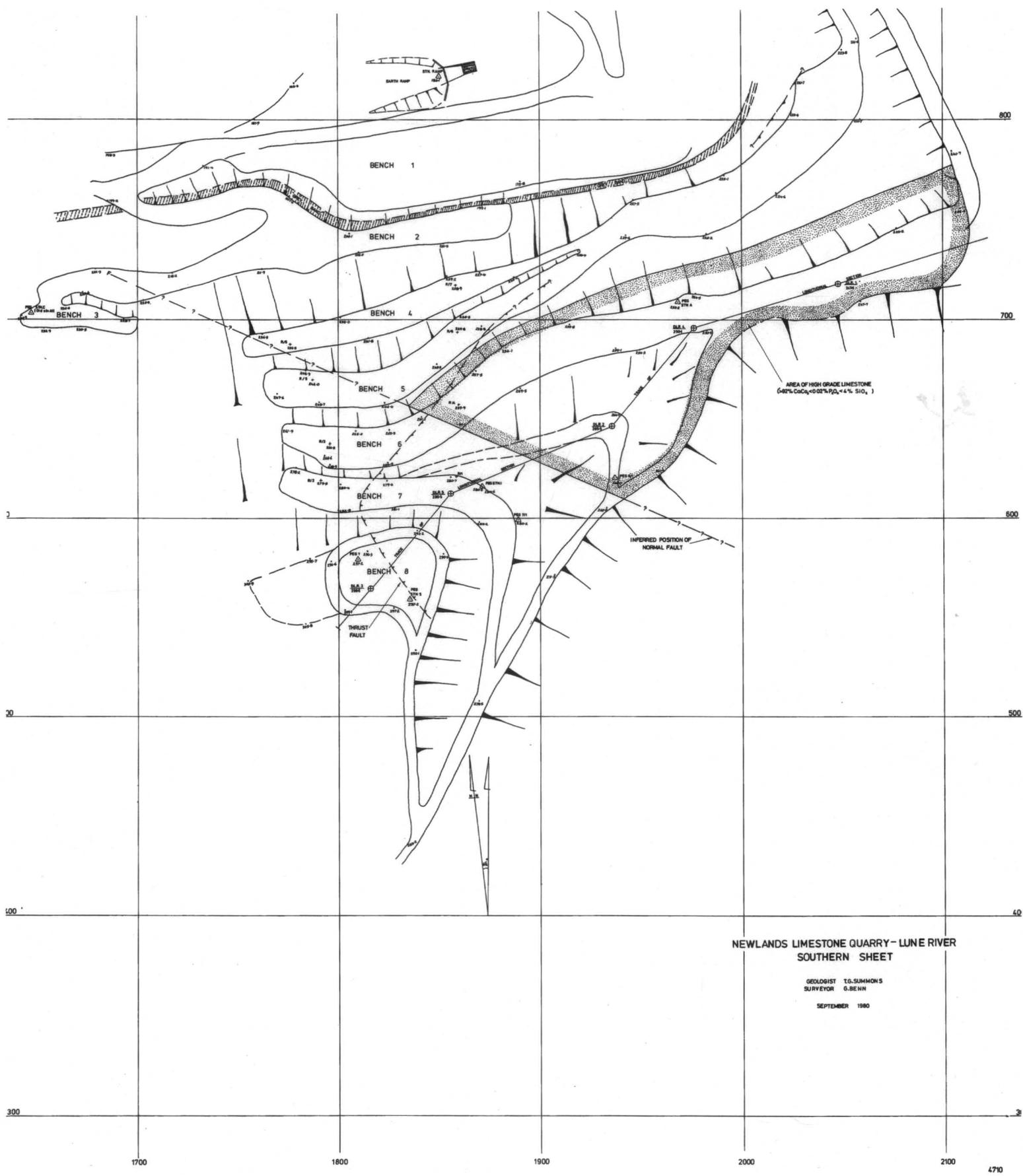
- (i) Medium Grade (1) = 1000 x 34.3 x 100 x 2.72  
                           ≈ 9.3 x 10<sup>6</sup> tonnes @ 93.0% CaCO<sub>3</sub>
- (ii) High Grade (1) = 1000 x 35.7 x 100 x 2.72  
                           ≈ 9.7 x 10<sup>6</sup> tonnes @ 95.0% CaCO<sub>3</sub>  
     including 1000 x 12.2 x 100 x 2.72  
                           ≈ 3.3 x 10<sup>6</sup> tonnes @ 96.0% CaCO<sub>3</sub>
- (iii) High Grade (2) = 1000 x 18.95 x 100 x 2.72  
                           ≈ 5.1 x 10<sup>6</sup> tonnes @ 95.0% CaCO<sub>3</sub>  
     including 1000 x 9.3 x 100 x 2.72  
                           ≈ 2.5 x 10<sup>6</sup> tonnes @ 97.0% CaCO<sub>3</sub>
- (iv) High Grade (3) = 1000 x 9.3 x 100 x 2.72  
                           ≈ 2.5 x 10<sup>6</sup> tonnes @ 96.0% CaCO<sub>3</sub>

However, the amount of high grade limestone available for quarrying may only be 50% of the above tonnage figures, so that more realistic estimates of the 'potentially extractable inferred limestone' are as follows:

- Medium Grade (1) - ≈ 4.5 x 10<sup>6</sup> tonnes @ 93.0% CaCO<sub>3</sub>.
- High Grade (1) - ≈ 4.5 x 10<sup>6</sup> tonnes @ 95.0% CaCO<sub>3</sub>.  
     including ≈ 1.5 x 10<sup>6</sup> tonnes @ 96.0% CaCO<sub>3</sub>.
- High Grade (2) - ≈ 2.5 x 10<sup>6</sup> tonnes @ 95.0% CaCO<sub>3</sub>.  
     including ≈ 1.2 x 10<sup>6</sup> tonnes @ 97.0% CaCO<sub>3</sub>.
- High Grade (3) - ≈ 1.2 x 10<sup>6</sup> tonnes @ 96.0% CaCO<sub>3</sub>.

FOOTNOTE: Personal communication with H. Murdoch of Electrona Carbide Industries Pty Ltd (who were responsible for the analyses of the limestone core and chip samples) reveals the order of accuracy of the CaCO<sub>3</sub> analyses to be ± 1.5% CaCO<sub>3</sub> at the 95% confidence level.

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NEWLANDS LIMESTONE QUARRY - LUNE RIVER  
SOUTHERN SHEET

GEOLOGIST T.G. SIMMONS  
SURVEYOR G. BENN  
SEPTEMBER 1960

Figure 13. Southern section, Newlands quarry (scale 1:2500)

5 cm

28-18(b)

CONCLUSIONS

*Stratigraphy*

- (1) Three sequences are recognised in the Lune River area, namely the upper, middle, and lower sequences; the upper and lower sequences represent intertidal to subtidal environments of deposition, while the middle sequence represents supratidal to intertidal conditions of formation. The three sequences represent an aggregate thickness of original limestone in excess of 700 m.
- (2) Locally significant marker units include the Upper Oncolite Horizon, the three High Grade Intervals, the Lower Oncolite Horizon, and the Bedded Chert Zone.
- (3) The Lower Oncolite Horizon and the Bedded Chert Zone in the lower sequence are regarded as probable lithostratigraphic correlates of Cashions Creek Limestone and the Wherretts Chert Member respectively in the Florentine Valley.

*Lithologies*

- (1) The upper sequence consists mainly of calcisiltite, calcarenite, and calcirudite amounting to 90% by volume.
- (2) The middle sequence consists mainly of birds eye micrite (and variants), algal laminated micrite, and birds eye calcisiltite, amounting to 70% by volume.
- (3) The lower sequence consists mainly of calcisiltite, with minor calcarenite and bedded chert.
- (4) Birds eye calcisiltites, which are an unusual minor constituent of the middle sequence, are probably naturally beneficiated 'ordinary' calcisiltite. This beneficiation is the result of oxidation, loss of gases, and infilling of the gas escape channels by calcite to form birds eyes; birds eye calcisiltites appear to have been formed during extremes of tidal flat/shoreline progradation.

*Geochemistry*

- (1) Major geochemical trends between the upper and middle sequences are indicated by the concentrations of CaCO<sub>3</sub>, MgCO<sub>3</sub>, Fe<sub>2</sub>O<sub>3</sub>, SrO, and P<sub>2</sub>O<sub>5</sub>; CaCO<sub>3</sub>, SrO, and P<sub>2</sub>O<sub>5</sub> decrease, while MgCO<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> increase from the upper to the middle sequence.
- (2) The geochemical trends represented by CaCO<sub>3</sub>, MgCO<sub>3</sub>, and Fe<sub>2</sub>O<sub>3</sub> (and possibly SrO) are considered to be due to the effects of hypersaline dolomitising brines which were generated in the middle sequence.
- (3) The geochemical trend represented by P<sub>2</sub>O<sub>5</sub> is probably the result of several factors, including changes in palaeoclimate, palaeosalinity of the Ordovician sea, faunal diversity and abundance, and the tectonic setting.
- (4) Birds eye calcisiltite is the most superior limestone lithotype in terms of overall composition, containing more CaCO<sub>3</sub> and less MgCO<sub>3</sub>, SiO<sub>2</sub>, Fe<sub>2</sub>O<sub>3</sub>, and P<sub>2</sub>O<sub>5</sub> than 'ordinary' calcisiltite.

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Resources

- (1) Large tonneages of high grade limestone are inferred to exist in the area between Newlands and Blaneys quarries (within the middle sequence); selective quarrying in this area (e.g. within High Grade Intervals (1) and (2)) should enable appreciably higher grades of limestone than those quoted in the section on limestone resources to be extracted.

Birds eye calcisiltite constitutes a significant proportion of all three high grade limestone intervals.

- (2) Before any further decisions are made concerning the future viability of the Lune River area as a source of high grade limestone, the area between Newlands and Blaneys quarries should be subjected to more detailed exploration, involving geophysical (seismic) and drilling programs.

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[20 May 1981]

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## APPENDIX 1

### Summary of diamond drill hole logs - Newlands Limestone Quarry, Lune River

#### Diamond drill hole DLR-1

- 0 - 4.9 m : Medium grey calcisiltite, minor fossil debris, cave from 4.2-4.43 m.
- 4.9-11.9 m : No core - cave partly filled with orange-brown clay.
- 11.9-27.4 m : Medium grey-brown calcisiltite, blue SiO<sub>2</sub> (chert, agate) has replaced stromatoporoids and other fossil fragments (e.g. single polyp corals), (Upper Chert Zone).
- 27.4-32.9 m : Medium grey micrite with fossiliferous calcisiltite bands.
- 32.9-33.2 m : Intraformational breccia, calcite matrix.
- 33.2-37.1 m : Pale grey-brown calcirudite and calcarenite, 20% calcite veins.
- 37.1-40.0 m : Dark grey calcisiltite with carbonaceous shale bands and minor fossil debris.
- 40.0-45.8 m : Medium grey calcisiltite, minor pyrite nodules, 5% calcite veining.
- 45.8-46.5 m : As for 37.1-40.0 m.
- 46.5-58.5 m : Medium to dark grey calcisiltite with ?*Tetradium* corals; cave from 55.7-57.7 m. Intraformational breccias at 47.4 m, 49.1 m, and 57.9 m, all with calcite matrix.
- 58.5-62.1 m : Birds eye micrite (pale grey colour) with algal laminations, ('Grey Band').
- 62.1-65.0 m : Medium-dark grey calcisiltite.
- End of hole - 65.0 m.

## Diamond drill hole DLR-2

- 0 - 2.0 m : No core - cave filled with orange clay.
- 2.0- 13.0 m : Pale grey-brown calcisiltite.
- 13.0- 23.0 m : Grey-brown calcisiltite, cave from 17.6-21.6 m.
- 23.0- 28.2 m : Grey-brown calcarenite, fossiliferous; caves from 23.0-24.0 m, 24.4-24.9 m, and 26.0-26.7 m.
- 28.2- 30.7 m : Pale grey calcisiltite, fossiliferous.
- 30.7- 37.0 m : Grey-brown calcisiltite (Upper Chert Zone).
- 37.0- 40.7 m : Medium grey calcisiltite with carbonaceous seams (either thick non-sutured stylolites, or black shale bands).
- 40.7- 46.6 m : Medium brown calcarenite with blue SiO<sub>2</sub> (chalcedonic) having replaced stromatoporoids (Lower Chert Zone).
- 46.6- 54.1 m : Medium grey calcisiltite, richly fossiliferous, with numerous blue SiO<sub>2</sub> (minor agate) nodules (Lower Chert Zone).
- 54.1- 55.5 m : Pale brown calcisiltite.
- 55.5- 57.0 m : Dark grey calcisiltite, rich in trilobite fragments.
- 57.0- 68.5 m : Grey-brown calcisiltite.
- 68.5- 71.6 m : Pale grey birds eye micrite with algal laminae from 70.8-71.6 m, ('Grey Band').
- 71.6- 73.5 m : Dark grey calcisiltite, trace pyrite, ?*Tetradium* at base.
- 73.5- 89.1 m : Grey-brown calcisiltite.
- 89.1- 90.1 m : Pale grey birds eye micrite.
- 90.1- 94.2 m : Medium grey-brown calcisiltite with *Tetradium*.
- 94.2- 94.9 m : Pale grey birds eye micrite.
- 94.9- 96.1 m : Medium brown calcisiltite with *Tetradium*.
- 96.1- 96.7 m : Pale grey algal laminated micrite.
- 96.7- 97.2 m : Pale grey birds eye micrite with ?*Tetradium*.
- 97.2-100.1 m : Brown calcisiltite, *Tetradium* fragments.
- 100.1-101.1 m : Pale grey birds eye micrite with ?*Tetradium*.
- 101.1-109.5 m : Medium brown calcisiltite, *Tetradium* horizon from 105.2-105.7 m (?wave baffle).
- 109.5-112.2 m : Oncolitic calcisiltite-calcarenite.
- 112.2-117.6 m : Pale grey birds eye micrite, minor algal laminae.
- 117.6-120.0 m : Pale grey ?flat pellet breccia.
- 120.0-121.3 m : Medium brown calcisiltite.
- 121.3-122.3 m : Pale grey birds eye micrite.
- 122.3-123.3 m : Pale grey ?flat pellet breccia.
- 123.3-124.0 m : Pale grey birds eye micrite.

- 124.0-126.1 m : Medium brown calcisiltite with *Tetradium*.
- 126.1-126.8 m : Pale grey birds eye micrite.
- 126.8-135.2 m : Medium grey calcarenite, oncolitic from 129.0-130.4 m and <5% pyrite nodules from 130.4-134.2 m. Minor *Tetradium* at 135.1 m.
- 135.2-137.2 m : Intensely disced ?calcisiltite and calcarenite.
- 137.2-137.9 m : Medium grey calcarenite.
- 137.9-138.4 m : Grey algal laminated micrite.
- 138.4-140.0 m : Grey calcisiltite with *Tetradium*.
- 140.0-140.9 m : Grey algal laminated micrite.
- 140.9-143.2 m : Medium grey calcisiltite, minor algal laminated micrite with *Tetradium*.
- 143.2-143.6 m : Grey ?flat pellet breccia.
- 143.6-144.8 m : Grey algal laminated micrite with birds eyes.
- 144.8-146.8 m : Grey-brown calcisiltite with *Tetradium*.
- 146.8-148.5 m : Dark brown calcisiltite with dolomitised burrows.
- 148.5-150.1 m : Grey birds eye micrite, *Tetradium* from 149.8-150.1 m.
- 150.1-152.1 m : Grey-brown algal laminated micrite.
- 152.1-153.0 m : Medium brown burrowed calcisiltite.
- 153.0-154.6 m : Medium brown calcisiltite with algal laminae and *Tetradium*.
- 154.6-155.7 m : Pale grey birds eye micrite.
- 155.7-156.9 m : Medium brown burrowed calcisiltite.
- 156.9-158.0 m : Grey-brown algal laminated micrite.
- 158.0-163.2 m : Pale grey birds eye micrite.
- 163.2-164.2 m : Dark grey algal laminated micrite.
- 164.2-165.8 m : Core loss.
- 165.8-174.4 m : Medium grey calcisiltite with calcarenite bands and burrows.
- 174.4-180.8 m : Pale grey birds eye micrite.
- 180.8-183.3 m : Pale brown algal laminated micrite and medium brown silty laminae (?algal).
- 183.3-185.3 m : Grey birds eye micrite.
- 185.3-185.8 m : As for 180.8-183.3 m.
- 185.8-187.3 m : Grey-brown burrowed calcisiltite.
- 187.3-191.5 m : Dark grey pseudonodular calcisiltite, some burrows, the nodules (<50 mm) are defined in part by black (carbonaceous) non-sutured stylolites and partly by carbonaceous and dolomitic silt.
- 191.5-192.1 m : Dark grey burrowed calcisiltite, fossiliferous (corals etc.).
- 192.1-194.2 m : Dark grey pseudonodular calcisiltite, (similar to 183.3-191.5 m).

- 194.2-196.7 m : Dark grey burrowed calcisiltite, minor trilobites.
- 196.7-200.4 m : Dark grey pseudo nodular calcisiltite, (similar to 187.3-191.5 m).
- 200.4-202.7 m : Dark grey burrowed calcisiltite, and ?*Tetradium*.
- 202.7-207.0 m : Medium grey birds eye calcisiltite.
- 207.0-208.1 m : Medium grey burrowed calcisiltite with calcarenite band (80 mm).
- 208.1-209.4 m : Pale grey birds eye calcisiltite, minor fossil debris.
- 209.4-209.7 m : Pale grey calcisiltite with *Tetradium*.
- 209.7-210.2 m : Pale grey calcisiltite.
- 210.2-211.3 m : Pale grey birds eye micrite.
- 211.3-214.6 m : Pale grey-brown calcisiltite.
- 214.6-217.5 m : Medium grey burrowed calcisiltite (pale brown and khaki coloured burrows).
- 217.5-224.4 m : Pale grey birds eye micrite.
- 224.4-226.5 m : Medium grey-brown burrowed clacisiltite (similar to 214.6-217.5 m).
- 226.5-227.9 m : Pale brown calcisiltite/arenite, minor birds eyes.
- 227.9-229.9 m : Pale grey birds eye micrite.
- 229.9-230.9 m : Medium grey-brown burrowed calcisiltite.
- 230.9-231.7 m : Pale grey ?flat pellet breccia, minor birds eyes.
- 231.7-232.9 m : Pale grey birds eye micrite, ?fossil debris.
- 232.9-233.2 m : Pale grey ?flat pellet breccia.
- 233.2-237.0 m : Pale grey-brown birds eye micrite, orange (dolomitic) algal laminae from 235.75-235.85 m.
- 237.0-237.35 m : Pale-medium grey algal laminated micrite, minor birds eyes.
- 237.35-237.7 m : Medium grey ?flat pellet breccia.
- 237.7-245.5 m : Medium brown burrowed calcisiltite (burrows are pale brown to khaki coloured, similar to 214.6-217.5 m), interbedded with medium grey ?flat pellet breccias from 241.7-241.9 m, 242.1-242.35 m, 243.5-244.0 m.
- 245.5-246.6 m : Medium grey-brown, algal laminated micrite.
- 246.6-250.0 m : Pale-medium brown birds eye micrite, ?remnant burrows in calcisiltite 248.7-249.2 m.
- 250.0-252.5 m : Medium grey-brown burrowed calcisiltite.
- 252.5-254.4 m : Pale grey birds eye micrite.
- 254.4-259.3 m : Pale grey birds eye calcisiltite.
- 259.3-264.0 m : Medium-pale grey silty calcarenite.
- 264.0-268.1 m : Medium brown calcarenite (?in part dolomitised).
- 268.1-271.0 m : Dark grey pseudo nodular calcisiltite.
- 271.0-274.0 m : Medium-dark grey calcisiltite.

- 274.0-278.0 m : Dark grey silty calcarenite.
- 278.0-280.1 m : Dark grey pseudo nodular calcisiltite.
- 280.1-281.0 m : Medium grey burrowed calcisiltite, minor birds eyes.
- 281.0-285.7 m : Medium grey burrowed calcisiltite, *Tetradium* boundstone from 281.8-282.0 m.
- 285.7-286.3 m : Pale grey-brown birds eye micrite, minor algal laminae.
- 286.3-287.0 m : Pale grey-brown algal laminated micrite.
- 287.0-287.6 m : Pale grey ?flat pellet breccia.
- 287.6-288.0 m : Medium grey-brown burrowed calcisiltite.
- 288.0-290.0 m : Medium brown algal laminated micrite (irregular laminae).
- 290.0-290.8 m : Medium grey-brown calcisiltite with dolomitic silt bands.
- 290.8-292.8 m : Medium brown burrowed calcisiltite.
- 292.8-293.5 m : Pale grey birds eye micrite.
- 293.5-294.5 m : Medium grey algal laminated micrite (irregular laminae).
- 294.5-295.7 m : Medium brown burrowed calcisiltite.
- 295.7-296.2 m : Pale-medium grey birds eye micrite.
- 296.2-296.7 m : Medium brown calcisiltite.
- 296.7-302.0 m : Medium grey algal laminated micrite (irregular laminae).
- 302.0-302.5 m : Pale grey birds eye micrite.
- 302.5-304.0 m : Medium grey algal laminated micrite (irregular laminae).
- 304.0-304.5 m : Pale grey birds eye micrite.
- 304.5-305.6 m : Medium grey algal laminated micrite (irregular laminae).
- 305.6-307.6 m : Pale grey birds eye micrite.
- 307.6-316.8 m : Pale brown birds eye calcisiltite.
- 316.8-320.8 m : Pale brown calcarenite ( $\Delta$  319.2 m = 80°).
- 320.8-321.5 m : Medium grey granular dolomite.
- 321.5-323.2 m : Pale-medium brown calcarenite, irregular dolomite (orange coloured) masses.
- 323.2-324.5 m : Medium grey calcisiltite, minor burrows.
- 324.5-343.9 m : Medium grey granular dolomite,  $\leq$ 10% calcite (and dolomitised calcite) veining, carbonaceous laminae appear to define bedding; poorly defined 'fuzzy' stylolites suggest post stylolitisation dolomitisation. ?Intraformational breccia 333.5-333.7 m with dolomitised calcite matrix, bleached 333.3-333.5 m, 333.7-335.1 m, 339.3-340.3 m, 342.5-343.7 m and strongly oxidised from 340.3-342.5 m (with ?burrows); at 337 m the dolomitised calcite veins are overgrown by granular dolomite and transected by some carbonaceous laminae. All granular dolomite has an average grain size of  $\leq$ 0.5 mm. Average 1-2% pyrite (or goethite ex pyrite).

- 343.9-344.4 m : Pale grey birds eye micrite.
- 344.4-344.5 m : Medium grey granular dolomite (dolomitisation incomplete).
- 344.5-345.1 m : Pale grey birds eye micrite.
- 345.1-345.5 m : Medium grey granular dolomite, ?remnant burrows, (dolomitisation incomplete).
- 345.5-346.9 m : Pale grey birds eye micrite.
- 346.9-347.4 m : Medium grey granular dolomite ex calcisiltite, (dolomitisation incomplete).
- 347.4-348.0 m : Pale grey birds eye micrite.
- 348.0-349.0 m : Medium grey granular dolomite, calcite vein 348.05-348.2 m, (dolomitisation incomplete).
- 349.0-349.8 m : Pale grey birds eye micrite.
- 349.8-361.2 m : Medium grey granular dolomite, with remnant burrows 351.5-352.7 m, 354.9-356.9 m, and 359.4-361.2 m; ?remnant algal laminae 357.5-358.2 m, poorly defined 'fuzzy' carbonaceous stylolites similar to 324.5-343.9 m.
- 361.2-361.4 m : Medium grey calcisiltite (partly dolomitised).
- 361.4-364.0 m : Medium grey granular dolomite (irregularly bleached).
- 364.0-365.0 m : Medium grey calcisiltite, gradational to algal laminated micrite (partly dolomitised).
- 365.0-365.6 m : Dark grey granular dolomite, carbonaceous laminae.
- 365.6-367.0 m : Medium grey calcisiltite, (partly dolomitised) with remnant burrows 366.6-367.0 m.
- 367.0-367.5 m : Medium grey algal laminated micrite.
- 367.5-368.6 m : Medium grey calcisiltite-granular dolomite (dolomitisation incomplete).
- 368.6-369.4 m : Medium grey calcisiltite (partly dolomitised) with remnant burrows.
- 369.4-369.9 m : Dark grey algal laminated micrite (carbonaceous laminae ≈50vol%).
- 369.9-371.2 m : Medium grey calcisiltite (partly dolomitised), fossil debris.
- 371.2-371.6 m : Medium-dark grey algal laminated micrite.
- 371.6-372.9 m : Medium grey granular dolomite, minor remnant burrows (coarse grained dolomite rhombs in the inter burrow regions, fine grained in the burrows).
- 372.9-375.9 m : Medium grey calcisiltite (partly dolomitised).
- 375.9-380.8 m : Medium grey granular dolomite, remnant burrows, partly oxidised 377.9-380.8 m, with oxidised dolomitised burrows having a dark brown colour, (?reflecting original impurities).
- 380.8-381.5 m : Medium grey granular dolomite with dolomitised calcite bands/veins representing ≈40vol%.
- 381.5-383.8 m : Brown-grey granular dolomite (i.e. partly oxidised).

- 383.8-386.7 m : Crushed zone/intraformational breccia, fragments (?porphyroclasts) consist of grey granular dolomite (remnant burrows), matrix appears to be dolomitised calcite 383.8-385.6 m, and predominantly calcite 385.6-386.7 m.  $\Delta 386.7 \text{ m} = 40^\circ$ .
- 386.7-393.0 m : Medium grey granular dolomite, minor remnant burrows and poorly defined 'fuzzy' carbonaceous stylolites.
- 393.0-393.8 m : Medium grey granular dolomite with dolomitised calcite bands/veins  $\approx 40\text{vol}\%$  (similar to 380.8-381.5 m).
- 393.8-402.2 m : Medium grey granular dolomite, minor remnant burrows, remnant algal laminae 399.0-400.0 m, numerous poorly defined 'fuzzy' carbonaceous stylolites.
- 402.2-402.6 m : Medium grey granular dolomite, with irregular dolomitised calcite bands/veins (vuggy),  $\approx 30\text{vol}\%$ .
- 402.6-403.2 m : Medium grey granular dolomite, remnant burrows.
- 403.2-403.8 m : Medium grey granular dolomite, with irregular vuggy dolomitised calcite bands/veins  $\approx 30\text{vol}\%$ .
- 403.8-407.2 m : Medium grey granular dolomite, remnant burrows and remnant algal laminae 404.0-405.0 m (similar to 399.0-400.0 m), poorly defined 'fuzzy' stylolites.
- 407.2-410.1 m : Medium grey granular dolomite, remnant burrows, with irregular vuggy dolomitised calcite bands/veins.
- 410.1-418.0 m : Medium grey granular dolomite, remnant burrows, remnant algal laminae 412.8-413.4 m, 'fuzzy' stylolites, ?original calcarenite 413.8-414.1 m, dolomitised calcite veins 414.1-418.0 m.

End of hole - 418.0 m.

Diamond drill hole DLR-3

- 0 - 2.4 m : Permian (Lower Parmeener Supergroup) tillite.
- 2.4- 8.2 m : Medium grey calcisiltite, with orange clay filled caves from 4.2-5.4 m, and 6.7-7.8 m.
- 8.2- 11.3 m : Medium grey calcarenite-calcirudite, fossiliferous with stromatoporoids, corals, trilobites, minor carbonaceous shaley matrix.
- 11.3- 12.0 m : Dark grey calcisiltite with ?burrows.
- 12.0- 12.4 m : No core - cave filled with orange clay.
- 12.4- 16.4 m : Medium-dark grey calcirudite, fossiliferous (as for 8.2-11.3 m) with distinct carbonaceous shaley matrix.
- 16.4- 17.5 m : Medium grey calcisiltite, calcite veins.
- 17.5- 21.9 m : Medium-dark grey calcirudite (similar to 12.4-16.4 m).
- 21.9- 23.9 m : Dark grey calcisiltite.
- 23.9- 28.7 m : Medium-dark grey calcisiltite with minor calcarenite horizons (similar to 4.6-7.3 m in DLR5).
- 28.7- 30.0 m : Medium grey interbedded calcisiltite and calcarenite (similar to 4.6-14.7 m in DLR5).

- 30.0- 36.0 m : Medium grey calcarenite, minor calcite veins.
- 36.0- 38.3 m : Medium-dark grey calcisiltite with calcarenite at base.
- 38.3- 38.9 m : Crushed zone/intraformational breccia? with calcite matrix and pale green coloured clay;  $\Delta_{top} = 65^\circ$ ,  $\Delta_{base} = 40^\circ$ .
- 38.9- 43.4 m : Pale-medium grey calcarenite-calcirudite, fossiliferous with carbonaceous shaley matrix; crushed zone? from 42.7-42.8 with calcite matrix,  $\Delta_{base} = 50^\circ$ .
- 43.4- 44.7 m : Crushed zone/intraformational breccia? with calcite matrix and pale green clay,  $\Delta_{top} = 60^\circ$ .
- 44.7- 46.8 m : Medium grey silty calcarenite.
- 46.8- 50.8 m : Pale grey birds eye micrite, with crushed zones/intraformational breccia? from 47.0-47.5 m ( $\Delta_{top} = 65^\circ$ ) and 48-50.4 m ( $\Delta_{top} = 20^\circ$ ,  $\Delta_{base} = 40^\circ$ ), calcite and pale green clay matrix.
- 50.8- 57.0 m : Medium grey calcisiltite, crushed zone/intraformational breccia? from 52.1-52.4 m ( $\Delta_{base} = 45^\circ$ ), calcite and pale green clay matrix.
- 57.0- 60.0 m : No core - cave filled with orange clay.  
End of hole - 60.0 m.

Diamond drill hole DLR-4

- 0 - 6.3 m : Medium grey calcisiltite.
- 6.3- 7.9 m : Medium grey oncolitic calcisiltite ( $\approx 20\text{vol}\%$  oncolites).
- 7.9- 8.6 m : Medium grey calcisiltite.
- 8.6- 9.3 m : No core - cave filled with orange clay.
- 9.3- 21.1 m : Medium grey calcarenite, fossiliferous with blue  $\text{SiO}_2$  (chalcedonic) having replaced stromatoporoid margins (Upper Chert Zone).
- 21.1- 22.6 m : Medium-dark grey calcisiltite, clay filled cave from 21.1-21.3 m.
- 22.6- 24.3 m : Medium grey calcarenite, fossiliferous and burrowed.
- 24.3- 24.7 m : Intraformational breccia, calcite matrix.
- 24.7- 25.0 m : Medium grey calcisiltite.
- 25.0- 25.4 m : Intraformational breccia with calcarenite fragments in a calcite matrix.
- 25.4- 37.0 m : Pale-medium grey calcarenite, carbonaceous shaley bands from 26.8-30.8 m, intraformational breccia from 30.4-30.6 m and 31.3-31.4 m, both with calcite matrices.
- 37.0- 42.6 m : Medium grey calcarenite, fossiliferous with blue  $\text{SiO}_2$  (chalcedonic) having replaced (typically) stromatoporoids and other fossil debris, (Lower Chert Zone).
- 42.6- 57.5 m : Medium-dark grey calcisiltite, carbonaceous shaley bands from 44.4-45.6 m, oxidised black shale from 48.7-48.8 m.

- 57.5- 61.0 m : Pale grey algal laminated and birds eye micrite, ('Grey Band').
  - 61.0- 61.3 m : Medium grey calcisiltite.
- End of hole - 61.3 m.

Diamond drill hole DLR-5

- 0 - 2.0 m : Pale grey calcisiltite.
- 2.0- 2.9 m : Pale grey calcirudite, numerous fossil debris.
- 2.9- 4.6 m : Medium grey calcisiltite, rich in trilobite fragments.
- 4.6- 7.3 m : Interbedded medium grey-brown calcisiltite and calcarenite (the latter trilobite rich), both types have carbonaceous shale bands, the interval consists of thirteen couplets of calcisiltite-calcarenite.
- 7.3- 12.5 m : Medium grey arenaceous calcirudite, abundant coral debris.
- 12.5- 14.7 m : Interbedded medium grey-brown calcisiltite and calcarenite (the latter either rich in trilobites or corals and bryozoans), carbonaceous shale bands as for 4.6-7.3 m, and the interval consists of seven couplets of calcisiltite-calcarenite.
- 14.7- 18.4 m : Pale-medium grey calcarenite, oncolitic to 17.0 m.
- 18.4- 20.3 m : Medium-dark brown calcisiltite, carbonaceous shale bands.
- 20.3- 23.7 m : Medium grey oncolitic rudaceous calcarenite, minor carbonaceous shaley matrix (similar to DLR3).
- 23.7- 27.2 m : Medium grey-brown calcarenite.
- 27.2- 28.0 m : Pale grey birds eye micrite.
- 28.0- 29.2 m : Pale grey-brown birds eye calcisiltite.
- 29.2- 32.3 m : Pale grey calcisiltite, 20vol% calcite veining.
- 32.3- 32.6 m : Crushed zone/intraformational breccia?  $\Delta$ top 70°,  $\Delta$ base 85°.
- 32.6- 33.2 m : Buff coloured thinly bedded calcisiltite.
- 33.2- 36.5 m : Four cycles of black shale overlying calcisiltite in turn overlying calcarenite from 33.2-34.6 m, 34.8-35.6 m, 35.6-36.1 m and 36.1-36.5 m, intraformational breccia with carbonaceous shaley matrix from 34.6-34.8 m.
- 36.5- 41.7 m : Medium grey calcisiltite, ?autobrecciated 38.7-41.7 m.
- 41.7- 44.1 m : Medium grey calcarenite.
- 44.1- 51.5 m : ?Intraformational breccias/?crushed zones from 44.1-44.7 m, 47.7-48.6 m, 49.1-49.5 m and 50.6-51.5 m, ( $\Delta$ angles range 35°-60°); dark brown calcisiltite 44.7-47.7 m, pale grey calcarenite 48.6-49.1 m and dark brown calcisiltite 49.5-50.6 m; both calcisiltite units have 'wispy' black shale interbeds.
- 51.5- 53.1 m : Medium brown calcisiltite, intraformational breccias (IFB) with black shale matrix from 51.7-51.8 m, 52.9-53.1 m.

- 53.1- 55.0 m : Medium grey calcarenite.
  - 55.0- 74.2 m : Dark brown calcisiltite with 'wispy' black shale bands, IFB's with black shale matrices 55-55.4 m, 55.8-56.1 m, 57.1-58.0 m, 60.5-60.8 m, 62.1-62.2 m, 65.7-66.1 m, 66.4-66.9 m, 67.1-67.3 m, 67.6-68.1 m, 70.2-70.6 m, 71.3-71.4 m and 71.7-72 m. Minor oncolitic silty calcarenite 63.1-63.4 m, and pyritic black shales 70.6-70.9 m with calcisiltite and calcarenite phases at the base (i.e. similar to 33.2-36.5 m).
  - 74.2- 74.4 m : Medium grey calcarenite.
  - 74.4- 74.9 m : IFB with calcarenite fragments.
  - 74.9- 75.5 m : Dark brown calcisiltite, 'wispy' black shale bands.
  - 75.5- 80.3 m : Pale-medium grey calcarenite with IFB's 75.5-75.8 m, 77.6-78.0 m, 78.3-79.1 m and 80.1-80.3 m, minor 'wispy' black shale stringers occur.
  - 80.3- 82.5 m : Medium-dark brown calcisiltite, 'wispy' black shale bands.
  - 82.5- 82.8 m : IFB with calcarenite, black shale, calcite and pyrite fragments.
  - 82.8- 85.2 m : Medium grey-brown oncolitic calcarenite.
  - 85.2- 85.8 m : IFB - similar to 82.5-82.8 m.
  - 85.8- 88.2 m : Dark grey-brown calcisiltite, 'wispy' black shale bands.
  - 88.2- 90.0 m : Oncolite horizon, minor calcarenite matrix.
  - 90.0- 90.4 m : ?sheared zone, with yellow-green clay mineral.
  - 90.4- 93.6 m : Medium grey silty calcarenite; IFB 92.1-92.9 m.
  - 93.6- 94.1 m : ?sheared zone - calcarenite porphyroclasts enclosed in yellow-green clay mineral matrix.
  - 94.1- 96.0 m : Dark brown calcisiltite, minor black shale bands.
  - 96.0-100.8 m : Dark brown silty calcarenite, 'wispy' black shale interbeds (similar to those in the calcisiltite horizons above).
  - 100.8-101.1 m : Pale grey birds eye micrite.
  - 101.1-102.0 m : Medium grey rudaceous calcarenite.
  - 102.0-110.8 m : Dark brown calcisiltite, 'wispy' black shale interbeds with IFB's 102.3-103.6 m, 104.4-104.8 m, 105.7-105.9 m, 106.2-106.5 m and 106.7-107.6 m.
  - 110.8-112.4 m : Pale grey birds eye micrite.
  - 112.4-113.8 m : Pale grey birds eye calcisiltite, calcarenite at base.
  - 113.8-117.8 m : Dark grey-brown calcisiltite, 'wispy' black shale bands, IFB's 114.5-114.7 m, 115.3-115.4 m which are pyritic.
  - 117.8-120.0 m : IFB with oxidised black shale fragments.
- End of hole - 120.0 m.

Diamond drill hole DLR-6

- 0 - 12.5 m : Medium-dark grey calcisiltite with black shaley stringers, bands.
  - 12.5- 14.5 m : Cave filled with Permian sedimentary rock and Jurassic dolerite fragments.
  - 14.5- 15.0 m : Pale grey birds eye micrite.
  - 15.0- 16.8 m : Cave filled with Permian sedimentary rock debris.
  - 16.8- 18.0 m : Dark grey calcisiltite, pseudo nodular with black shaley stringers.
  - 18.0- 26.7 m : Cave filled with Permian and Jurassic (dolerite) age rock debris.
  - 26.7- 27.1 m : Pale grey birds eye micrite.
  - 47.1- 39.0 m : Cave filled with Permian sedimentary rock fragments, large water flow recorded, hole abandoned.
- End of hole - 39.0 m.

Diamond drill hole DLR-7

- 0 - 29 m : Transported and residual clay.
- 29 - 31 m : Extremely weathered limestone.
- 31 - 39 m : Cave filled with Permian sedimentary rocks and Jurassic dolerite debris.
- 39 - 40.8 m : Medium grey calcisiltite.
- 40.8- 42.6 m : Dark grey-brown calcisiltite, minor black shaley bands.
- 42.6- 46.0 m : Medium grey calcisiltite.
- 46.0- 46.4 m : Cave filled with Permian sedimentary rock debris.
- 46.4- 51.4 m : Dark grey-brown calcisiltite, black shaley bands, ?intraformational breccia with calcite matrix 57.2-57.4 m.
- 51.4- 53.6 m : Medium grey-brown calcisiltite, carbonaceous shaley infilling in burrows.
- 53.6- 56.3 m : Pale brown birds eye calcisiltite.
- 56.3- 59.4 m : Medium grey-brown calcisiltite, black shaley burrows.
- 59.4- 65.8 m : Pale brown birds eye calcisiltite.
- 65.8- 67.6 m : Pale-medium grey calcisiltite, pale-cream coloured burrows.
- 67.6- 81.3 m : Pale grey birds eye micrite, minor ?gastropods, birds eyes range in shape from irregular to ovoid.
- 81.3- 82.2 m : Pale-medium grey birds eye micrite with dark silty bands.
- 82.2- 87.1 m : Pale grey birds eye micrite, with poorly defined algal laminated micrite.
- 87.1- 88.9 m : Pale grey birds eye and algal laminated micrite, the latter increasing toward the base.

- 88.9- 93.0 m : Medium grey birds eye micrite with dark grey silty bands and stringers (similar to 81.2-82.2 m).
- 93.0- 94.0 m : Pale-medium grey algal laminated silty micrite.
- 94.0- 94.6 m : Medium grey micrite ( $\pm$  birds eyes) with dark silty bands.
- 94.6- 95.0 m : Pale grey algal laminated micrite.
- 95.0- 96.8 m : Medium-dark brown silty micrite, with black shaley bands and stringers, ?minor burrows.
- 96.8- 97.5 m : Pale-medium grey algal laminated micrite
- 97.5- 98.4 m : Medium-dark grey calcisiltite, minor black shaley stringers.
- 98.4- 99.3 m : Pale grey birds eye micrite.
- 99.3- 99.8 m : Pale grey micrite ( $\pm$  birds eyes), with dark grey silty bands.
- 99.8-104.0 m : Pale brown birds eye micrite.
- 104.0-104.5 m : Pale grey micrite ( $\pm$  birds eyes), with dark grey silty bands.
- 104.5-109.5 m : Pale grey birds eye micrite.
- 109.5-116.4 m : Pale brown birds eye calcisiltite.
- 116.4-118.8 m : Medium grey-brown calcisiltite.
- 118.8-128.9 m : Dark grey-brown calcisiltite, minor black shale bands.
- 128.9-135.2 m : Pale-medium grey birds eye calcisiltite, including birds eye micrite 128.9-130.0 m.
- 135.2-137.2 m : Pale to medium grey calcisiltite, minor black shaley stringers and pale-cream coloured burrows.
- 137.2-138.1 m : Medium grey algal laminated micrite.
- 138.1-139.1 m : Pale grey birds eye micrite, with dark grey silty bands.
- 139.1-141.1 m : Medium grey algal laminated micrite.
- 141.1-142.2 m : Pale grey birds eye micrite with dark grey silty stringers.
- 142.2-144.0 m : Medium grey-brown micrite, with dark silty burrows.
- 144.0-145.6 m : Medium grey algal laminated micrite.
- 145.6-146.5 m : Medium brown calcisiltite, with dark sandy burrows.
- 146.5-147.6 m : Pale grey micrite ( $\pm$  birds eyes), with dark grey silty bands.
- 147.6-151.4 m : Medium grey algal laminated micrite.
- 151.4-152.0 m : Pale grey micrite ( $\pm$  birds eyes) with dark grey silty bands.
- 152.0-153.0 m : Medium grey algal laminated micrite.
- 153.0-153.7 m : Medium grey micrite ( $\pm$  birds eyes) with dark grey silty bands.
- 153.7-154.0 m : Pale grey-brown calcarenite.
- 154.0-154.7 m : Medium grey micrite ( $\pm$  birds eyes) with dark grey silty bands.

- 154.7-155.1 m : Medium grey algal laminated micrite.
- 155.1-155.5 m : Medium grey micrite ( $\pm$  birds eyes) with dark grey silty bands.
- 155.5-156.0 m : Medium grey algal laminated micrite.
- 156.0-157.4 m : Pale grey birds eye micrite.
- 157.4-159.7 m : Pale grey micrite ( $\pm$  birds eyes), with dark grey silty bands.
- 159.7-163.2 m : Pale grey birds eye silty micrite, minor algal laminated micrite.
- 163.2-169.0 m : Pale brown birds eye calcisiltite.
- 169.0-173.7 m : Pale brown-grey silty micrite ( $\pm$  birds eyes), with dark grey silty bands/stringers.
- 173.7-197.0 m : Pale-medium grey birds eye micrite, minor algal laminated micrite, cave 190.0-190.2 m, 194.2-194.6 m.
- 197.0-197.6 m : Brown (oxidised) burrowed calcisiltite.
- 197.6-200.3 m : Pale-medium grey birds eye micrite.
- 200.3-202.9 m : Pale-medium grey birds eye and algal laminated micrite.
- 202.9-204.1 m : Brown (oxidised) burrowed calcisiltite.
- 204.1-205.4 m : Pale grey birds eye micrite.
- 205.4-213.9 m : Medium grey micrite ( $\pm$  birds eyes) with distinct orange and khaki silty stringers (?burrows).
- 213.9-214.3 m : Medium grey algal laminated micrite.
- 214.3-215.8 m : Medium grey burrowed silty micrite.
- 215.8-216.1 m : Medium grey algal laminated micrite.
- 216.1-217.8 m : Medium grey calcarenite, minor burrows partly dolomitised.
- 217.8-218.3 m : Medium-dark brown algal laminated silty micrite.
- 218.3-219.7 m : Medium brown burrowed calcisiltite.
- 219.7-220.3 m : Medium grey algal laminated micrite.
- 220.3-222.7 m : Medium grey burrowed calcisiltite.
- 222.7-223.1 m : Medium grey algal laminated micrite.
- 223.1-236.0 m : Pale grey birds eye micrite, minor algal laminated micrite.
- 236.0-238.4 m : Medium grey silty micrite with burrows.
- 238.4-240.3 m : Medium grey algal laminated silty micrite ( $\pm$  birds eyes) and partly dolomitised.
- 240.3-242.3 m : Pale grey birds eye micrite.
- 242.3-243.0 m : Medium grey burrowed silty micrite.
- 243.0-245.5 m : Pale grey birds eye micrite.
- 245.5-251.5 m : Medium grey calcisiltite with sandy burrows.
- 251.5-252.6 m : Pale grey birds eye and algal laminated micrite.
- 252.6-254.0 m : Pale grey birds eye micrite.
- 254.0-257.4 m : Medium grey-brown burrowed calcisiltite.

- 257.4-259.5 m : Medium grey algal laminated silty micrite ( $\pm$  birds eyes).
- 259.5-262.6 m : Medium grey burrowed calcisiltite.
- 262.6-271.5 m : Medium grey-pink algal laminated silty micrite ( $\pm$  birds eyes).
- 271.5-274.3 m : Medium grey burrowed calcisiltite.
- 274.3-277.7 m : Pale grey birds eye micrite.
- 277.7-278.9 m : Medium grey silty micrite ( $\pm$  birds eyes), dark grey silty stringers.
- 278.9-279.3 m : Medium grey granular dolomite (ex 277.7-278.9 m type).
- 279.3-281.0 m : Medium grey birds eye silty micrite, with dark silty stringers.
- 281.0-283.1 m : Pale grey birds eye micrite.
- 283.1-286.4 m : Medium grey algal laminated silty micrite ( $\pm$  birds eyes).
- 286.4-287.8 m : Medium grey granular dolomite (ex 283.1-286.4 m type).
- 287.8-301.4 m : Medium-dark grey granular dolomite with trace of disseminated pyrite, bleached, pale grey-brown intervals 287.8-291.5 m, 293.2-294.8 m and 295.8-299.3 m, relict burrows and stylolites.
- 301.4-311.3 m : Medium grey granular dolomite ex oncolite horizon (oncolite calcarenite), oxidised/bleached interval from 303.6-311.31 m, where the oncolites (?*Girvanella*) are selectively oxidised, oncolites range 10-15 mm in diameter, and the dolomite is variably porous and vuggy.
- 311.3-313.1 m : Massive and disseminated pyrite in medium grey to pale grey-brown (oxidised) granular dolomite ex oncolite limestone, the dolomite is variably porous and vuggy, and is cut by both calcite/dolomite and pyrite veinlets.
- 313.1-317.0 m : Medium grey to grey-brown (oxidised) granular dolomite ex oncolite limestone (calcarenite), with 5-10vol% disseminated pyrite.
- 317.0-333.7 m : Medium grey to brown (oxidised) granular dolomite ex oncolite limestone, oncolites decrease in size to approximately 5 mm diameter from 330.0-333.7 m, variably porous and vuggy.
- 333.7-334.4 m : Dark grey granular dolomite ex burrowed calcisiltite.
- 334.4-374.2 m : Medium grey burrowed calcisiltite, silty to sandy material infilling the burrows, oxidised intervals from 355.5-356.2 m, and 368.4-369.5 m, the entire unit is monotonous, with minor calcite veins from 343.0-360.0 m, and 366-374.2 m. Fossil material consists of very small ?oncolites, stromatoporoid at 364.7 m, molluscs at 372.0 m, and ?*Maclurites* at 372.4 m.
- 374.2-378.2 m : Pale grey calcisiltite.
- 378.2-391.4 m : Pale grey siliceous calcisiltite with grey chert bands (30-50 mm thick) and minor chert nodules.

- 391.4-400.2 m : Medium grey-brown siliceous granular dolomite with numerous white-cream coloured chert bands (one 50 mm thick), minor black and white banded chert, and minor white-grey chert nodules.
- 400.2-416.3 m : Pale grey (partly oxidised) granular dolomite, with relict ?burrows.
- 416.3-423.8 m : Grey-brown (i.e. variable oxidation states) granular dolomite with disseminated and blebby goethite (<10vol%).
- 423.8-464.3 m : Pale-medium grey granular dolomite, with relict ?burrows, irregular vuggy dolomitised calcite veins/bands from 428.6-429.3 m, 434.1-434.5 m and 437.3-437.8 m, goethite blebs (<20 mm) at 436.5 m, 441.9 m, 447.8 m, and 459 m.
- 464.3-483.5 m : Dark grey granular dolomite, minor relict ?burrows, irregular vuggy dolomite veins/bands from 479.2-481.2 m, pyrite blebs (<20 mm) at 477.6 m and 480.9 m.
- 483.5-484.7 m : Medium grey burrowed calcisiltite.
- 484.7-494.1 m : Dark grey granular dolomite, partially vuggy, minor relict ?burrows, pyrite blebs from 488-494 m, which are <20 mm diameter.
- 494.1-506 m : Medium grey burrowed calcisiltite, <10vol% pyrite blebs (20 mm) from 494.1-495.0 m.

Rotary drill hole DLR-8

This hole was intended to be diamond drilled, but was abandoned at 30 m in orange-brown clay, interpreted as both transported and residual limestone-derived insoluble residue.

Diamond drill hole DLR-9

- 0 - 5.0 m : Orange-red coloured clay (?insoluble residue from limestone).
- 5.0- 14.2 m : Medium grey-brown calcisiltite, burrowed, black shaley bands.
- 14.2- 15.8 m : Medium grey calcisiltite, minor pale grey calcarenite bands.
- 15.8- 16.9 m : Pale grey birds eye micrite.
- 16.9- 17.4 m : Medium grey algal laminated micrite.
- 17.4- 18.7 m : Pale grey birds eye micrite.
- 18.7- 19.0 m : Medium grey ?algal laminated micrite.
- 19.0- 20.4 m : Pale grey birds eye micrite.
- 20.4- 21.2 m : Medium grey algal laminated micrite.
- 21.2- 23.0 m : Pale grey birds eye micrite.
- 23.0- 23.3 m : Medium grey algal laminated micrite.
- 23.3- 25.1 m : Pale grey birds eye micrite.
- 25.1- 26.0 m : Medium grey algal laminated micrite.
- 26.0- 27.3 m : Pale grey silty micrite, minor calcarenite bands.

- 27.3- 28.2 m : Crushed zone, angular fragments, calcite veins,  $\Delta_{top} = 65^\circ$ ,  $\Delta_{base} = 50^\circ$ .
- 28.2- 29.2 m : Medium grey calcisiltite, strongly brecciated and calcite veined.
- 29.2- 29.4 m : Calcite vein, ( $\Delta = 50^\circ$ ), with  $\approx 10\text{vol}\%$  coarse grained pyrite.
- 29.4- 30.2 m : Pale grey silty micrite, minor calcarenite bands ( $\Delta_{So} = 60^\circ$ ).
- 30.2- 36.0 m : Crushed and sheared zone localised on black shale/calcisiltite/calcarenite (similar to intervals in DLR5); rafts of limestone similar to 29.4-30.2 m from 31.8-32.1 m and 32.3-32.7 m ( $\Delta$  contacts ranges  $15^\circ$ - $60^\circ$ ); quartzite fragments at 31.4 m, disseminated pyrite in the black shales, and ?calcopyrite at 36.0 m.
- 36.0- 37.3 m : Pale grey micrite.
- 37.3- 39.9 m : Crushed and sheared zone, similar to 30.2-36.0 m.
- 39.9- 42.7 m : Medium grey calcisiltite, black shaley bands,  $<3\text{vol}\%$  pyrite 40.5-41.0 m, oxidised intervals 41.2-42.7 m (with  $<3\text{vol}\%$  goethite from 41.2-41.7 m).
- 42.7- 43.7 m : Crushed and sheared zone, developed in the DLR5 type of black shale/calcisiltite/calcarenite cycle,  $\Delta_{top} = 20^\circ$ ,  $\Delta_{base} = 60^\circ$ .
- 43.7- 45.3 m : Medium grey calcisiltite, with bands of black shale (10 mm).
- 45.3- 46.0 m : Crushed and sheared zone, similar to 42.7-43.7 m, ( $\Delta_{top} = 55^\circ$ ).

End of hole - 46.0 m.

## APPENDIX 2

## Analyses of DLR-1

Interval (m)	CaCO <sub>3</sub> (% ±0.8)	Composite sample	Interval (m)	CaCO <sub>3</sub> (% ±0.8)	Composite sample
0 - 4.2	95.0	2	38.0-39.0	86.9	1
4.4- 4.9	95.3		39.0-40.0	87.4	1
11.9-12.9	93.5		40.0-40.7	94.5	1
12.9-13.7	94.0		40.7-41.7	95.3	1
13.7-14.7	87.4		41.7-42.7	97.3	1
14.7-15.7	84.0		42.7-43.7	97.5	1
15.7-16.7	86.3		43.7-44.7	98.3	1
16.7-17.7	88.3		44.7-45.8	95.5	1
17.7-18.7	92.0		45.8-46.8	95.8	1
18.7-19.8	94.5		46.8-47.8	93.3	2
19.8-20.8	93.3	2	47.8-48.8	93.8	1
20.8-22.0	90.5		48.8-49.8	94.0	1
22.0-23.0	94.5		49.8-50.8	94.0	2
23.0-24.0	94.0		50.8-51.8	92.0	
24.0-25.0	97.0		51.8-52.8	92.3	
25.0-26.0	98.5		52.8-53.4	94.0	1
26.0-27.4	95.8		53.4-54.9	96.8	2
27.4-28.4	96.5		54.9-55.7	90.5	2
28.4-29.4	94.3		57.7-58.1	94.0	
29.4-30.4	96.0		58.1-58.5	92.2	
30.4-31.8	95.8		58.5-59.5	91.5	6
31.8-32.8	95.0	3	59.5-60.5	92.5	6
32.8-34.2	93.0		60.5-61.5	91.5	6
34.2-35.2	96.3	4	61.5-62.1	92.0	6
35.2-36.2	96.5	5	62.1-63.0	95.3	3
36.2-37.1	97.3	5	63.0-64.0	95.0	
37.1-38.0	86.0	1	64.0-65.0	94.3	2

## DLR1. Individual and composite sample analyses (weighted averages)

Sample	CaCO <sub>3</sub> %	MgCO <sub>3</sub> %	SiO <sub>2</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	Al <sub>2</sub> O <sub>3</sub> %	K <sub>2</sub> O %	SrO %	Na <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	TOTAL
Individual samples (m)										
0 ~ 4.2	95.0	3.1	2.1	0.23	0.33	0.09	0.03	<0.01	0.02	100.9
12.9-13.7	94.0	0.9	3.4	0.33	0.72	0.23	0.02	0.01	0.05	99.7
13.7-14.7	87.4	1.2	10.4	0.59	0.94	0.34	0.03	0.01	0.06	101.0
14.7-15.7	84.0	3.0	10.6	0.60	0.89	0.34	0.03	0.03	0.06	99.6
15.7-16.7	86.3	3.0	9.1	0.59	1.2	0.47	0.04	0.02	0.08	100.8
16.7-17.7	88.3	3.3	6.7	0.41	0.89	0.37	0.03	0.03	0.06	100.1
17.7-18.7	92.0	1.7	4.7	0.38	0.75	0.26	0.03	0.02	0.05	99.9
19.8-20.8	93.3	1.3	3.9	0.22	0.62	0.22	0.04	0.02	0.02	99.6
20.8-22.0	90.5	1.5	5.9	0.31	1.09	0.39	0.04	0.03	0.03	99.8
24.0-25.0	97.0	1.2	2.3	0.17	0.19	0.05	0.03	0.02	0.02	101.0
25.0-26.0	98.5	0.8	1.2	0.12	0.09	0.05	0.03	0.01	0.01	100.8
29.4-30.4	96.0	1.2	3.2	0.20	0.57	0.21	0.04	0.03	0.01	101.5
38.0-39.0	86.9	4.7	6.2	0.56	1.53	0.54	0.04	0.02	0.04	100.5
39.0-40.0	87.4	3.2	6.1	0.54	1.7	0.61	0.03	0.02	0.04	99.6
60.5-61.5	91.5	1.1	5.1	0.42	1.19	0.46	0.02	0.01	0.02	99.8
Composite samples										
1	93.7	1.1	2.6	0.26	0.51	0.24	0.03	0.04	0.02	98.5
2	94.2	1.2	2.3	0.26	0.33	0.15	0.03	0.03	0.02	98.5
3	95.1	1.8	2.4	0.22	0.35	0.17	0.01	0.03	0.01	100.1
4	96.3	0.8	3.0	0.34	0.11	0.08	0.03	0.03	0.01	100.7
5	96.9	0.8	1.2	0.12	0.14	0.07	0.03	0.03	0.01	99.3
6	91.9	1.1	4.9	0.35	0.94	0.41	0.02	0.03	0.02	99.7

The composite samples shown in the above table represent the following lithologies:

1. Birds eye micrite : composite sample 6;
2. (a) Calcisiltite with black stylolites : composite sample 1;  
(b) Calcisiltite with orange stylolites : composite sample 2;  
(c) Calcisiltite with red stylolites : composite sample 3;
3. Calcarenite with orange stylolites : composite sample 4;
4. Calcirudite (?autobrecciated calcisiltite) : composite sample 5.

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Analyses of DLR2

Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample	Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample
2 - 4	97.5	4	105.2-107.2	84.0	13
4 - 6	97.0	4	107.2-109.5	90.5	13
6 - 8	96.0	4	109.5-110.5	92.5	15
8 - 10	97.0	4	110.5-112.2	93.0	15
10 - 12	95.0	4	112.2-114.2	91.5	20
12 - 14	94.0		114.2-116.2	90.0	20
14 - 16	92.0	1	116.2-118.6	97.5	
16 - 17.6	95.5	1	118.6-120	93.0	
21.6- 23	94.0	4	120 -121.3	93.0	16
24 - 24.4	96.5	7	121.3-123.3	90.0	20
24.9- 26	95.0	7	123.3-125.3	90.5	19
26.7- 28.2	91.0	7	125.3-126.8	89.0	19
28.2- 30.7	88.0	5	126.8-128.1	87.0	22
30.7- 32.7	92.5	5	128.1-129	97.5	22
32.7- 34.7	94.0	5	129 -131	96.5	
34.7- 36.7	95.0	5	131 -133	89.5	16
36.7- 38.7	98.0	2	133 134.6	93.5	22
38.7- 40.7	96.0	2	134.6-136	90.5	22
40.7- 42.2	93.5	8	136 -137.9	90.5	18
42.2- 44.2	96.0	8	137.9-138.95	93.0	20
44.2- 46.6	92.5	8	138.95-139.65	90.0	
46.6- 48.6	90.5	6	139.65-141.9	86.5	
48.6- 50.6	86.0	6	141.9-143.8	92.0	
50.6- 52.6	85.0	6	143.8-144.75	94.5	21
52.6- 54.1	89.5	6	144.75-146.75	88.5	18
54.1- 55.55	96.0	4	146.75-148.45	89.5	
55.8- 57	90.0	2	148.45-150.15	90.0	17
57 - 59	96.5	3	150.15-152.1	82.5	21
59 - 61.3	97.5	3	152.1-153	82.0	17
61.3- 63.3	96.0	4	153 -154.2	93.5	23
63.3- 65.3	94.0	4	154.2-155.7	97.0	
65.3- 67.3	96.0	4	155.7-157.95	90.5	
67.3- 68.5	96.0	4	157.95-160	93.0	27
68.5- 70.8	93.5	9	160 -162	93.5	27
70.8- 71.6	94.0	10	162 -163.2	96.0	27
71.6- 73.5	92.5	11	163.2-164.2	93.5	26
73.5- 75.3	95.0	12	165.8-167.8	95.0	24
75.3- 77.1	93.5	11	167.8-169.8	91.5	24
77.1- 79.1	95.0	11	169.8-171.8	94.0	25
79.1- 81.9	90.0		171.8-174.4	93.0	25
81.9- 83.2	96.5	12	174.4-176.4	94.5	27/28
83.2- 85.2	91.5	11	176.4-178.4	93.0	27/28
85.2- 87.2	91.0	11	178.4-180.8	94.0	28
87.2- 89.1	89.5	11	180.8-183.3	90.0	26
89.1- 92	92.0		183.3-185.3	93.0	27
92 - 93.4	88.5	13	185.3-187.3	96.0	
93.4- 94.9	92.5	14	187.3-189.9	84.0	
94.9- 96.1	91.0	13	189.9-191.5	80.0	
96.1- 98.1	89.0	14	191.5-193.5	81.0	
98.1-100.1	92.5	13	193.5-195.5	86.5	
100.1-102.1	92.5	14	195.5-197.5	87.0	
102.1-103.8	94.5	13	197.5-199	80.0	
103.8-105.2	93.0	13	199 -200.4	79.5	

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Analyses of DLR2 (continued)

Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample	Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample
200.4-202.7	93.5		259.3-262.0	98.0	
202.7-204.7	96.5	30	262 -264	94.5	
204.7-206.95	95.5	30	264 -265.5	64.5	
206.95-208.1	92.5	33	265.5-268.12	89.8	
208.1-209.45	98.0	30	268.12-270	79.5	
209.45-211.3	97.5	29	270 -272	75.5	
211.3-212.8	98.5	31	272 -274	76.0	
212.8-214.6	95.0	31	274 -276	87.0	
214.6-216	93.0	32	276 -278	87.0	
216 -217.5	88.5	32	278 -280.13	82.5	
217.5-219.5	95.5	29	280.13-282	91.8	
219.5-221.5	95.0	29	282 -284	90.0	
221.5-223.5	94.0	29	284 -285.7	83.5	
223.5-224.4	91.5	29	285.7-286.95	82.5	
224.4-226.55	82.0	32	286.95-288	84.5	
226.55-227.9	95.0	33	288 -290.75	82.0	
227.9-229.9	92.5	29	290.75-292.8	85.0	
229.9-231.7	84.0	32	292.8-294.5	85.5	
231.7-233.2	93.0	29	294.5-296.65	88.0	
233.2-235	93.0	29	296.65-299	84.0	
235 -237	94.0	29	299 -301.95	82.5	
237 -239.5	89.0		301.95-304.1	85.5	
239.5-241.7	83.5		304.1-306	85.0	
241.7-242.35	83.5		306 -307.65	91.8	
242.35-243.5	81.0		307.65-310	97.0	
243.5-245.5	80.0		310 -312	98.0	
245.5-246.6	87.5		312 -314	96.3	
246.6-248.5	90.8		314 -316.8	96.8	
248.5-250.5	87.8		316.8-318.8	89.0	
250.5-252.5	87.0		318.8-320.8	85.0	
252.5-254.4	90.5		320.8-321.5	59.5	
254.4-257.0	95.0		321.5-323.25	89.5	
257 -259.3	96.5		323.25-324.55	89.5	

## Analyses of DLR2 (continued)

Interval (m)	CaCO <sub>3</sub> (% ±1)	MgCO <sub>3</sub> (% ±1)	Composite sample
324.55-329.0	63.0	35.0	
329.0-333.3	60.0	37.0	
333.3-335.1	59.0	38.0	
335.1-339.35	61.0	34.0	
339.35-343.95	64.0	30.0	
343.95-344.38	91.0	4.0	34
344.38-344.51	80.0	17.0	38
344.51-345.1	84.0	10.0	34
345.1-345.5	67.0	29.0	38
345.5-346.9	89.0	6.0	34
346.9-347.45	65.0	25.0	38
347.45-348.05	91.0	7.0	34
348.05-349.05	67.0	29.0	38
349.05-349.78	84.0	10.0	34
349.78-355.0	61.0	36.0	36
355.0-361.25	59.0	38.0	36
361.25-361.45	78.0	21.0	
361.45-364.05	61.0	36.0	36
364.05-365.05	83.0	14.0	35
365.05-365.6	62.0	30.0	
365.6-367	81.0	16.0	35
367 -367.55	80.0	12.0	
367.55-368.6	61.0	31.0	
368.6-371.58	63.0	22.0	35
371.58-372.92	57.0	35.0	36
372.92-375.88	72.0	19.0	35
375.88-380.8	57.0	37.0	
380.8-383.8	56.0	41.0	
383.8-385.6	59.0	38.0	
385.6-386.7	85.0	13.0	
386.7-390	57.0	41.0	37
390 -393	57.0	41.0	39
393 -393.85	57.0	43.0	
393.85-399	57.0	41.0	37
399 -402.2	55.0	39.0	37
402.2-403.8	55.0	42.0	39
403.8-407.2	54.0	39.0	37
407.2-410.1	55.0	40.0	37
410.1-413.85	54.0	36.0	37
413.85-418.0	54.0	39.0	39

DLR2. Composite sample analyses (weighted averages)

Composite sample number	CaCO <sub>3</sub> %	MgCO <sub>3</sub> %	SiO <sub>2</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	Al <sub>2</sub> O <sub>3</sub> %	K <sub>2</sub> O %	SrO %	Na <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	TOTAL
1	94.0	3.4	2.2	0.20	0.17	0.12	0.04	0.03	0.033	100.2
2	95.0	1.4	3.2	0.25	0.28	0.19	0.05	0.03	0.029	100.4
3	97.0	1.2	1.4	0.12	0.08	0.09	0.05	0.04	0.018	100.0
4	96.5	1.1	1.7	0.18	0.15	0.13	0.03	0.01	0.022	99.8
5	92.4	1.3	5.7	0.33	0.34	0.22	0.04	0.03	0.060	100.4
6	87.8	2.3	9.1	0.53	0.47	0.26	0.03	0.03	0.074	100.6
7	94.3	0.9	4.4	0.36	0.23	0.17	0.03	0.02	0.051	100.5
8	94.0	2.3	3.8	0.29	0.22	0.17	0.02	0.03	0.041	100.9
9	92.5	1.2	4.7	0.35	0.83	0.42	0.03	0.03	0.077	100.1
10	90.5	1.7	5.5	0.35	1.13	0.49	0.04	0.03	0.081	99.9
11	92.2	3.2	4.0	0.23	0.48	0.22	0.03	0.03	0.022	100.3
12	95.0	1.5	3.0	0.20	0.28	0.13	0.03	0.03	0.009	100.2
13	90.5	2.5	5.5	0.31	0.81	0.30	0.03	0.04	0.021	100.0
14	91.0	2.0	5.6	0.38	0.90	0.36	0.02	0.03	0.012	100.3
15	93.5	3.3	1.8	0.25	0.23	0.10	0.03	0.03	0.015	99.3
16	90.9	3.4	3.8	0.41	0.65	0.25	0.03	0.03	0.024	99.5
17	88	4.4	5.8	0.52	1.10	0.40	0.03	0.03	0.005	100.3
18	89.7	2.8	5.5	0.44	0.92	0.40	0.02	0.03	0.014	99.8
19	89.9	2.7	6.1	0.46	0.93	0.42	0.02	0.05	0.026	100.6
20	92.0	2.1	1.2	1.29	0.90	0.39	0.02	0.03	0.018	98.0
21	83.0	5.2	7.3	0.68	2.2	0.62	0.02	0.02	0.021	99.1
22	91.5	3.8	3.5	0.46	0.46	0.28	0.02	0.04	0.024	100.6
23	93.5	2.6	3.8	0.34	0.43	0.24	0.02	0.02	0.009	101.0
24	91.0	4.1	4.3	0.39	0.29	0.21	0.02	0.03	0.012	100.4
25	92.0	4.0	3.2	0.29	0.23	0.14	0.02	0.01	0.010	99.9
26	88.5	4.7	4.4	0.45	0.84	0.42	0.02	0.02	0.016	99.4
27	92.0	1.7	4.0	0.33	0.69	0.36	0.02	0.01	0.013	99.1
28	93.8	1.2	2.5	0.73	0.55	0.28	0.02	0.05	0.005	99.1
29	94.2	1.6	2.3	0.69	0.77	0.34	0.02	0.06	0.004	100.0
30	96.5	≈2.0	≈1.0	≈0.40	≈0.20	≈0.10	≈0.02	≈0.01	≈0.004	≈100.2
31	96.6	2.1	0.2	0.69	0.10	0.08	0.02	0.05	0.004	99.8
32	86.2	≈8.0	≈2.4	≈0.80	≈0.65	≈0.30	≈0.02	≈0.06	≈0.005	98.4
33	93.9	2.5	1.8	0.78	0.63	0.28	0.02	0.05	0.004	100.0
34	87.8	7.3	2.7	0.39	-	-	-	0.03	-	(98.2)
35	71.6	19.0	6.5	0.65	-	-	-	0.04	-	(97.8)
36	59.8	36.7	2.8	0.56	-	-	-	0.05	-	(99.9)
37	55.4	39.2	3.5	0.50	-	-	-	0.05	-	(98.6)
38	67.3	27.2	2.6	0.67	-	-	-	0.04	-	(97.81)
39	55.2	40.2	3.5	0.59	-	-	-	0.06	-	(99.5)

The composite samples shown in the above tables represent the following lithologies:

1. (a) Birds eye micrite : composite samples 9, 27, 28, 29, 34;  
 (b) Birds eye (with algal laminated) micrite : composite sample 20;
2. Algal laminated micrite : composite samples 10, 21, 26;
3. Birds eye micrite and calcisiltite (with *Tetradium*) in equal proportions : composite samples 14, 19;
4. (a) Calcisiltite with birds eyes : composite sample 30;  
 (b) Calcisiltite with black stylolites : composite samples 1, 11, 16, 23;

- (c) Calcisiltite with black and orange stylolites : composite samples 3, 31;
- (d) Calcisiltite with orange stylolites : composite samples 4, 12, 24;
- (e) Calcisiltite with black shale bands : composite sample 2;
- (f) Calcisiltite with orange stylolites and blue silica nodules : composite samples 5 (Upper Chert Zone), 6 (Lower Chert Zone);
- (g) Calcisiltite with *Tetradium* : composite samples 13, 18;
- (h) Calcisiltite with burrows : composite samples 17, 25, 32;
- 5. (a) Calcarenite with orange stylolites : composite samples 7, 22, 33;
- (b) Calcarenite with orange stylolites and blue silica nodules : composite sample 8 (Lower Chert Zone);
- (c) Oncolitic calcarenite/calcisiltite : composite sample 15;
- 6. (a) Partly dolomitised calcisiltite (including approximately 20vol% algal laminated micrite) : composite sample 35;
- (b) Partly dolomitised calcisiltite interbedded with birds eye micrite (composite sample 34) : composite sample 38;
- (c) Granular dolomite (above fault from 383.8-386.7 m) : composite samples 37, 39;
- (d) Granular dolomite (below fault) : composite samples 37, 39.

Composite samples 1 to 10 were taken from the surface to 71.6 m (base of the 'Grey Band');

Composite samples 11 to 15 were taken from 71.6 m to 112.2 m (base of the Upper Oncolite Horizon);

Composite samples 16 to 22 were taken from 112.2 m to 153.0 m (top of the medium grade limestone);

Composite samples 23 to 28 were taken from 153.0 m to 187.3 m (base of the medium grade limestone);

Composite samples 29 to 33 were taken from 200.4 m to 237.0 m (which represents high grade limestone No 1);

Composite samples 34 to 39 were taken from 324.5 m to 418.0 (which represents the gross interval of dolomite).

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Analyses of DLR3

Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample	Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample
2.4- 4.2	96.0	1	30.0-32.0	92.0	3
5.4- 8.2	95.0	1	32.0-34.0	94.0	3
8.2-11.3	97.0	4	34.0-36.0	91.0	3
11.3-12.0	93.5	1	36.0-38.3	84.5	1
12.4-14.4	98.5	4	38.9-40.7	96.5	4
14.4-16.4	98.5	4	40.7-42.7	94.0	4
16.4-17.5	96.0	1	42.8-43.4	97.0	4
17.5-19.5	97.5	4	44.7-46.8	99.5	3
19.5-21.9	97.5	4	46.8-47.0	95.5	5
21.9-23.9	93.0	1	47.5-50.8	98.0	5
23.9-26.3	90.5	2	50.8-52.1	99.0	1
26.3-28.7	89.5	2	52.4-54.4	99.0	1
28.7-30.0	88.0	3	54.4-57.0	95.5	1

DLR3. Individual and composite sample analyses (weighted averages)

Sample	CaCO <sub>3</sub> %	MgCO <sub>3</sub> %	SiO <sub>2</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	Al <sub>2</sub> O <sub>3</sub> %	K <sub>2</sub> O %	SrO %	Na <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	TOTAL
Individual samples (m)										
28.7-30.0	88.0	2.5	7.7	0.49	0.63	0.37	0.06	0.04	0.035	99.8
32.0-34.0	94.0	1.1	4.9	0.45	0.59	0.33	0.03	0.02	0.091	101.5
44.7-46.8	99.5	0.8	1.2	0.19	0.14	0.09	0.03	0.02	0.043	102.0
8.2-11.3	97.0	0.7	1.3	0.29	0.23	0.13	0.03	0.03	0.053	99.8
14.4-16.4	98.5	0.6	1.3	0.21	0.17	0.14	0.03	0.04	0.048	101.0
19.5-21.9	97.5	0.8	1.9	0.24	0.21	0.14	0.03	0.05	0.062	100.9
40.7-42.7	94.0	1.4	2.8	0.59	0.16	0.08	0.03	0.04	0.038	99.1
42.8-43.4	97.0	0.4	1.2	0.75	0.13	0.05	0.03	0.02	0.050	99.6
Composite samples										
1	94.3	1.0	2.8	0.24	0.33	0.25	0.02	0.06	0.01	99.0
2	89.9	1.4	6.5	0.41	0.85	0.41	0.04	0.04	0.03	99.6
3	93.3	1.8	4.3	0.37	0.41	0.25	0.03	0.03	0.06	100.5
4	97.0	0.9	1.8	0.27	0.22	0.12	0.03	0.02	0.06	100.4
5	97.5	0.8	2.5	0.14	0.43	0.22	0.02	0.01	0.01	101.6

The composite samples shown in the above table represent the following lithologies:

1. Birds eye micrite (≈35vol%) and ?crushed zone with calcite and minor pale green clay matrix : composite sample 5;
2. (a) Calcisiltite with black stylolites : composite sample 1;  
(b) Calcisiltite with orange stylolites : composite sample 2;
3. Calcarenite with orange stylolites : composite sample 3;
4. Calcirudite with carbonaceous shaley matrix : composite sample 4.

NOTE: The individual sample analyses shown were taken from composite sample 3 (28.7-46.8 m) and 4 (8.2-43.4 m).

Analyses of DLR4

Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample	Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample
0 - 2.0	95.5	2	31.4-33.0	98.0	4
2.0- 4.0	96.5	2	33.0-35.0	99.0	4
4.0- 6.3	98.0	2	35.0-37.0	98.5	4
6.3- 7.9	96.5	2	37.0-39.3	83.0	5
7.9- 8.6	95.5	2	39.3-41.4	90.0	4
9.3-12.4	95.5	4	41.4-42.6	90.5	5
12.4-14.0	99.0	4	42.6-44.4	94.5	3
14.0-16.0	99.0	4	44.4-45.6	86.5	1
16.0-18.0	95.0	4	45.6-47.1	95.0	1
18.0-21.1	94.0	4	47.1-48.7	97.0	3
21.3-22.6	98.0	2	48.8-51.4	96.0	2
22.6-24.3	98.5	4	57.4-53.0	95.0	1
24.7-25.0	98.0		53.0-55.0	92.5	1
25.4-26.8	98.0	4	55.0-57.5	93.0	1
26.8-30.4	88.0	5	57.5-61.0	92.0	6
30.6-31.3	87.5	4			

DLR4. Individual and composite sample analyses (weighted averages)

Sample	CaCO <sub>3</sub> %	MgCO <sub>3</sub> %	SiO <sub>2</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	Al <sub>2</sub> O <sub>3</sub> %	K <sub>2</sub> O %	SrO %	Na <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	TOTAL
Individual samples (m)										
9.3-12.4	95.5								0.044	N.A.
14.0-16.0	99.0								0.045	N.A.
18.0-21.1	94.0								0.055	N.A.
22.6-24.3	98.5								0.025	N.A.
31.4-33.0	98.0								0.044	N.A.
35.0-37.0	98.5								0.072	N.A.
Composite samples										
1	92.7	2.8	3.3	0.24	0.32	0.20	0.05	0.09	0.02	99.7
2	96.6	1.5	2.5	0.20	0.15	0.13	0.06	0.07	0.02	101.2
3	95.6	1.6	2.9	0.20	0.18	0.17	0.05	0.09	0.05	100.8
4	96.2	1.3	2.2	0.36	0.32	0.24	0.05	0.07	0.02	100.8
5	86.8	4.0	7.9	0.39	0.47	0.31	0.05	0.05	0.06	100.0
6	92.0	1.6	5.1	0.48	0.93	0.40	0.04	0.07	0.02	100.6

The composite samples shown in the above table represent the following lithologies:

1. Birds eye micrite : composite sample 6;
2. (a) Calcisiltite with black stylolites : composite sample 1;  
 (b) Calcisiltite with black and orange stylolites : composite sample 3;  
 (c) Calcisiltite with orange stylolites : composite sample 2;
3. (a) Calcarenite with black-brown stylolites : composite sample 5;  
 (b) Calcarenite with orange stylolites : composite sample 4.

NOTE: (i) Composite sample 4 consists of ~50vol% of the Upper Chert Zone;

- (ii) Composite sample 5 consists of ≈60vol% of the Lower Chert Zone, and the higher SiO<sub>2</sub> value is a reflection of the carbonaceous shaley bands from 26.8-30.4 m;
- (iii) The individual sample analyses shown were taken from composite sample 4, and indicate distortion of the P<sub>2</sub>O<sub>5</sub> value in the composite total P<sub>2</sub>O<sub>5</sub> value.

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Analyses of DLR5

Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample	Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample
0 - 2.0	93.5	1	36.6- 38.7	95.0	1
2.0- 2.9	94.0	8	38.7- 41.7	95.0	
2.9- 4.63	96.5		41.7- 44.1	97.0	6
4.63-4.66	91.5	2	44.7- 47.8	89.0	3
4.66-4.82	92.5	4	48.7- 49.1	95.0	6
4.82-4.85	93.5	2	49.5- 51.1	89.0	3
4.85-4.87	91.0	4	51.5- 52.9	92.0	
4.87-4.93	83.5	2	53.1- 55.0	95.5	6
4.93-5.00	92.5	4	55.4- 58.0	83.0	3
5.00-5.14	89.5	2	58.0- 60.5	88.5	
5.14-5.25	93.0	4	60.8- 63.1	92.0	3
5.25-5.31	94.0	2	63.1- 65.8	94.5	3
5.31-5.42	94.5	4	65.9- 69.0	86.5	3
5.42-5.58	92.5	2	69.0- 70.2	93.5	1
5.58-5.63	93.0	4	70.9- 73.0	85.5	3
5.63-5.73	89.5	2	73.0- 75.5	94.0	
5.73-5.78	91.5	4	75.8- 77.6	94.5	5
5.78-5.85	93.5	2	78.0- 80.1	95.5	5
5.85-5.87	86.5	4	80.3- 82.5	88.5	3
5.87-5.94	90.0	2	82.9- 85.2	95.0	6
5.94-5.97	87.0	4	85.8- 88.2	97.5	3
5.97-6.16	88.0	2	88.2- 90.0	97.5	6
6.16-6.33	91.0	4	90.1- 90.4	92.0	
6.33-7.3	92.5		90.4- 93.6	97.5	6
7.3- 10.3	93.0	8	93.6- 94.1	90.0	
10.3- 12.5	95.5	8	94.1- 96.0	89.0	3
12.5- 14.0	90.5		96.0- 97.5	90.5	5
14.0- 14.7	89.0		97.5-100.8	90.5	5
14.7- 17.0	96.5	5	100.8-101.1	91.0	
17.0- 18.4	96.5	7	101.1-102.3	91.0	5
18.4- 20.3	85.0	3	103.6-106.8	92.5	3
20.3- 23.7	96.5	5	107.6-110.2	94.0	
23.7- 26.3	96.5	7	110.8-112.4	95.5	9
26.3- 27.2	97.5	7	112.4-113.8	95.0	9
27.2- 29.2	97.0		114.3-117.8	87.5	3
29.2- 32.3	97.0				

DLR5. Composite sample analyses (weighted averages)

Sample	CaCO <sub>3</sub> %	MgCO <sub>3</sub> %	SiO <sub>2</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	Al <sub>2</sub> O <sub>3</sub> %	K <sub>2</sub> O %	SrO %	Na <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	TOTAL
1	94.1	1.4	4.2	0.20	0.30	0.19	0.02	0.04	0.032	100.5
2	90.2	1.6	7.4	0.33	1.80	0.45	0.02	0.03	0.044	101.9
3	89.3	2.9	6.6	0.69	≈3.1	0.44	0.03	0.05	0.045	103.2*
4	92.0	1.5	5.7	0.20	0.55	0.28	0.03	0.04	0.045	100.3
5	93.9	1.8	3.5	0.27	0.46	0.22	0.02	0.03	0.056	100.3
6	96.2	1.1	≈4.3	0.16	0.26	0.23	0.02	0.06	0.044	102.4**
7	96.7	0.8	1.1	0.34	0.08	0.07	0.02	0.03	0.064	99.2
8	94.0	1.1	4.4	0.23	0.60	0.33	0.02	0.02	0.070	100.8
9	95.3	1.0	2.9	0.04	0.11	0.12	0.02	0.04	0.014	99.5

\* This total is probably the result of analytical error for the Al<sub>2</sub>O<sub>3</sub> value;  
 \*\* This total is probably the result of analytical error for the SiO<sub>2</sub> value.

The composite samples shown in the above table represent the following lithologies:

1. Birds eye micrite and birds eye calcisiltite : composite sample 9;
2. (a) Calcisiltite with black stylolites : composite sample 1;  
(b) Calcisiltite with black shale bands : composite sample 2;  
(c) Calcisiltite with 'wispy' black shale : composite sample 3;
3. (a) Calcarenite with black stylolites : composite sample 6;  
(b) Calcarenite with black shale bands : composite sample 4;  
(c) Calcarenite with carbonaceous shaley matrix : composite sample 5;  
(d) Calcarenite with orange stylolites : composite sample 7;
4. Calcirudite with black stylolites : composite sample 8.

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Analyses of DLR7

Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample	Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample
39 - 40.8	90.0	5	145.6-146.5	90.0	11
40.8- 42.6	77.0	7	146.5-147.6	88.5	8
42.6- 46.0	88.0	5	147.6-151.4	84.0	9
46.4- 48.5	82.0	7	151.4-152.0	85.0	8
48.5- 51.2	77.0	7	152.0-153.0	78.0	9
51.4- 53.6	93.0	6	153.0-153.7	89.5	8
53.6- 56.3	97.0	4	153.7-154.0	87.5	13
56.3- 59.4	92.0	6	154.0-154.7	88.0	8
59.4- 61.5	97.5	4	154.7-155.1	76.0	9
61.5- 63.6	97.0	4	155.1-155.5	88.0	8
63.6- 65.8	96.5	4	155.5-156.0	81.0	9
65.8- 67.6	94.0		156.0-158.0	88.0	8
67.6- 69.0	95.0	1	158.0-159.7	79.0	8
69.0- 71.0	95.0	1	159.7-163.2	95.0	
71.0- 73.0	96.0	1	163.2-166.0	98.0	10
73.0- 75.0	95.0	1	166.0-169.0	95.0	10
75.0- 77.0	94.0	1	169.0-172.0	93.0	11
77.0- 79.0	95.0	1	172.0-173.7	82.0	11
79.0- 81.3	94.0	1	173.7-177.0	88.5	
81.3- 82.2	91.0	2	177.0-180.0	92.0	
82.2- 85.0	95.0	1	180.0-183.0	95.0	
85.0- 87.1	94.0	1	183.0-186.0	93.0	
87.1- 88.9	89.0		186.0-189.0	88.0	
88.9- 91.0	86.0	2	189.0-192.0	94.0	
91.0- 93.0	85.0	2	192.0-195.0	93.0	
93.0- 94.0	88.0	3	195.0-197.0	90.0	
94.0- 94.6	84.0	2	197.6-200.3	91.0	8
94.6- 95.0	81.0	3	200.3-202.9	84.0	
95.0- 96.9	80.0	7	204.1-207.0	85.5	14
96.9- 97.5	85.0	3	207.0-210.0	85.0	14
97.5- 98.4	89.0	7	210.0-212.0	89.5	14
98.4- 99.3	91.0	1	212.0-214.3	90.0	
99.3- 99.9	82.0	2	214.3-215.8	90.0	18
99.9-102.0	93.0	1	215.8-216.1	81.0	15
102.0-104.0	95.0	1	216.1-217.9	74.2	19
104.0-104.5	92.0	2	217.9-218.3	74.2	16
104.5-107.0	95.0	1	218.3-219.8	82.2	18
107.0-109.5	95.0	1	219.8-220.3	79.7	15
109.5-112.3	97.0	4	220.3-222.7	84.1	18
112.3-114.3	98.0	4	222.7-223.1	75.2	15
114.3-116.4	94.0	4	223.1-226.0	92.6	14
116.4-118.8	97.5	5	226.0-229.0	94.0	14
118.8-122.0	83.5	12	229.0-232.0	95.0	14
122.0-125.0	79.0	12	232.0-234.0	93.5	14
125.0-128.9	84.5	12	234.0-236.0	91.6	14
128.9-132.0	94.0	10	236.0-238.4	84.1	18
132.0-135.2	94.5	10	238.4-240.3	80.2	17
135.2-137.2	87.0	10	240.3-242.3	95.0	14
137.2-138.1	84.5	9	242.3-243.0	91.1	18
138.1-139.1	87.5	8	243.0-245.5	93.1	14
139.1-141.1	82.0	9	245.5-248.5	94.0	18
141.1-142.2	84.0	8	248.5-251.5	89.1	18
142.2-144	83.5	11	251.5-254.0	91.1	
144 -145.6	82.0	9	254.0-257.4	93.1	18

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## Analyses of DLR7' (continued)

Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample
257.4-259.5	83.6	17
259.5-262.6	87.1	18
262.6-264.6	86.6	17
264.6-266.8	86.6	15
266.8-271.5	87.6	17

## DLR7. Composite sample analyses (weighted averages)

Composite sample numbers	CaCO <sub>3</sub> %	MgCO <sub>3</sub> %	SiO <sub>2</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	Al <sub>2</sub> O <sub>3</sub> %	K <sub>2</sub> O %	SrO %	Na <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	TOTAL
1	94.1	1.5	3.3	0.37	0.56	0.40	0.02	0.04	0.009	100.3
2	86.2	6.6	5.1	0.59	0.97	0.55	0.02	0.05	0.011	100.1
3	87.2	6.4	3.3	0.61	1.05	0.53	0.02	0.04	0.015	99.2
4	96.6	1.4	1.0	0.19	0.22	0.11	0.02	0.01	0.006	99.6
5	92.1	3.1	3.8	0.36	0.37	0.20	0.02	0.01	0.008	100.0
6	91.6	3.7	3.8	0.34	0.45	0.24	0.02	0.01	0.009	100.2
7	79.9	9.5	6.8	0.68	1.05	0.48	0.02	0.03	0.019	98.5
8	88.0	6.6	3.5	0.49	0.73	0.41	0.03	0.08	0.008	99.8
9	82.3	7.4	7.4	0.65	1.44	0.65	0.01	0.10	0.018	100.0
10	94.0	3.5	3.2	0.24	0.27	0.18	0.02	0.02	0.004	101.4
11	89.1	7.0	2.8	0.41	0.44	0.27	0.03	0.03	0.005	100.1
12	82.5	8.2	7.4	0.65	1.17	0.56	0.03	0.03	0.019	100.6
13	87.4	6.7	3.8	0.45	0.64	0.35	0.02	0.06	0.009	99.4
14	91.3	3.8	3.1	0.34	0.54	0.34	0.01	0.06	0.010	99.5
15	83.6	5.5	7.6	0.84	2.03	0.77	0.01	0.05	0.002	100.4
16	74.2	10.2	12.0	1.60	2.13	1.50	0.01	0.01	0.041	101.8
17	84.8	8.1	5.3	0.62	1.28	0.59	0.02	0.05	0.003	100.8
18	88.7	8.4	3.1	0.43	0.62	0.30	0.02	0.05	0.003	101.6
19	74.2	17.1	6.1	1.1	2.25	0.76	0.01	0.14	0.019	101.7

The composite samples shown in the above table represent the following lithologies:

1. (a) Birds eye micrite : composite samples 1, 14;  
(b) Birds eye micrite with silty bands : composite samples 2, 8;
2. (a) Algal laminated micrite : composite samples 3, 9, 15;  
(b) Algal laminated micrite with mud cracks : composite sample 16;  
(c) ?Algal laminated calcisiltite (±birds eye) : composite sample 17;
3. (a) Calcisiltite with birds eyes : composite samples 4, 10;  
(b) Calcisiltite with black stylolites : composite samples 6, 11, 18;  
(c) Calcisiltite with orange stylolites : composite sample 5;  
(d) Calcisiltite with black shale bands : composite samples 7, 12;

4. Calcarenite with orange stylolites : composite samples 13, 19;

Composite samples 1 to 7 were taken from 39.0-118.8 m;

Composite samples 8 to 13 were taken from 118.8-200.3 m;

Composite samples 14 to 19 were taken from 200.3-271.5 m.

Analyses of DLR9

Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample	Interval (m)	CaCO <sub>3</sub> (% ±1)	Composite sample
6.2- 9.2	94.0	4	19.0-20.4	97.0	1
9.2-12.2	94.0	4	20.4-21.2	89.5	2
12.2-14.2	95.0	4	21.2-23.0	98.5	1
14.2-15.8	94.5		23.0-23.3	94.0	2
15.8-16.9	92.1	1	23.3-25.1	97.0	1
16.9-17.4	85.6	2	25.1-26.0	93.5	2
17.4-18.7	94.0	1	26.0-27.3	95.3	3
18.7-19.0	93.0	2			

DLR9. Composite sample analyses (weighted averages)

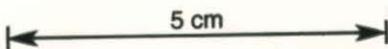
Sample	CaCO <sub>3</sub> %	MgCO <sub>3</sub> %	SiO <sub>2</sub> %	Fe <sub>2</sub> O <sub>3</sub> %	Al <sub>2</sub> O <sub>3</sub> %	K <sub>2</sub> O %	SrO %	Na <sub>2</sub> O %	P <sub>2</sub> O <sub>5</sub> %	TOTAL
1	96.1	1.7	2.5	0.22	0.43	0.24	0.02	0.11	0.005	101.3
2	89.3	4.9	5.0	0.51	1.15	0.57	0.02	0.13	0.015	101.4
3	95.3	3.1	2.8	0.17	0.36	0.21	0.02	0.16	0.005	102.1
4	94.3	2.8	3.4	0.22	0.40	0.22	0.02	0.04	0.006	101.4

The composite samples shown in the above table represent the following lithologies:

1. Birds eye micrite : composite sample 1;
2. Algal laminated micrite : composite sample 2;
3. (a) Calcisiltite with black stylolites : composite sample 3;
- (b) Calcisiltite with black shaley bands : composite sample 4.

APPENDIX 3

Graphic logs of diamond drill holes



# TASMANIA DEPARTMENT OF MINES MULTIPURPOSE DRILL HOLE LOG

55/70

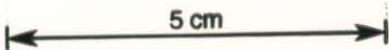
- ① Sampling
- ② Sample recovery %
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification \*
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨-⑫ Assay / Petrographic / Palaeontologic / etc.

Hole No. DLR-1 Sheet 1 of 2  
 From 0 To 57.5 m  
 Scale (s) 1:250  
 Logged by TGS 18/6/1980

\* { Dolomitic (orange) stylolites - D  
 Carbonaceous (black) " - C.  
 90 92 94 96 98 100 % CaCO<sub>3</sub>

Depth (m)	1	2	3	4	5	6	7	8	9	10	11	12	Comments
0													
2.5		95		Sw									Med. grey calcisiltite, minor fossil debris, rare coal
4.2													Cave - air for 4.9-11.9m
4.9													As for 0-4.2m
5.4													Cave - filled with orange/brown clay (? outflow)
11.9													Med. grey/brown sparry calcisiltite - SiO <sub>2</sub> repl. stromatoporoid rims
13.7													" " " " - SiO <sub>2</sub> repl. single poly corals + rare stromatoporoids
15.7													Pseudo nodular texture produced by v. distinct non-sutured stylolites (NSS) - 2-3cm thick.
19.4													Med. grey/brown calcisiltite, SiO <sub>2</sub> repl. fossil fragments as for 11.9-15.7m.
21.5													" " " " - rock in trilobite + single poly corals
22.9													" " " " - minor SiO <sub>2</sub> repl. the margins of single poly corals + stromatoporoids.
25													NSS composed of lines of dolomite " spots".
27.4													Med. grey micrite with calcisiltite bands which are fossiliferous; minor iron staining of the dolomitic NSS + ss.
31.8													As above, strongly Fe stained; 4-10% calcite veins. Calcite rich ss.
33.2													Pale grey calcarenite (? auto-brecciated calcisiltite)
34.6													Pale brown calcarenite - 2-3% calcite veining
35.5													As for 33.2-34.6m, 2-3% calcite veins.
37.08													Med/dk. grey calcisiltite, small fossil debris (finely comminuted?), v. distinct black carbonaceous shale bands; which cut the calcite veins.
40													Med. grey calcisiltite, ? minor breccias 2-5% calcite veins; pyrite nodules 2-4.4m
44.5													Med grey calcisiltite pseudonodular text. ? colonial corals
45.8													" " " " - similar black NSS to 37.08-40.0m
46.5													Med grey calcisiltite, ? breccias, ? Tetradium
47.4													Med/dk grey " , ? " , ? Tetradium
47.8													Med. grey calcisiltite - ? " , small band of ? Tetradium
49.2													Med/dk grey calcisiltite - same to 47.8-49.2
49.4													also with ? Tetradium
52.1													Pale/med. brown calcisiltite, dolomitic sutured stylolites (SS) - non-sutured (NSS).
55.7													K.L.

0 0.02 0.04 0.06 0.08 0.10 % P<sub>2</sub>O<sub>5</sub>



# TASMANIA DEPARTMENT OF MINES MULTIPURPOSE DRILL HOLE LOG

56/70

- ① Sampling
- ② Sample recovery
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨ — ⑫ Assay / Petrographic /  
Palaeontologic / etc

Hole No. D.R.-1 Sheet 2 of 2

From 57.5 m To 65.0 m

Scale (s) 1:250

Logged by TLS. 18/6/1980

Palaeontologic / etc 0.2 0.4 0.6 0.8 1.0 % P<sub>2</sub>O<sub>5</sub>  
90 92 94 96 98 100 % CaCO<sub>3</sub>

1	2	3	4	5	6	7	8	9	10	11	12	Comments
57.7-58.05 58.05-58.45												
		100	F	Algal lam. desiccation cracks	5.70							K.L. 4.5 for 53.4 - 55.7 m. Birds eye micrite - algal laminations, v. distinct desiccation structures; from bottom - unit is "blotchy". minor dolomite stylolites in upper + lower sections.
61.4 62.05			F									Med/dk. grey calcis. it. etc, ? Tetradium from 63.4 - 63.6 m.
65												EOH - 65 m.

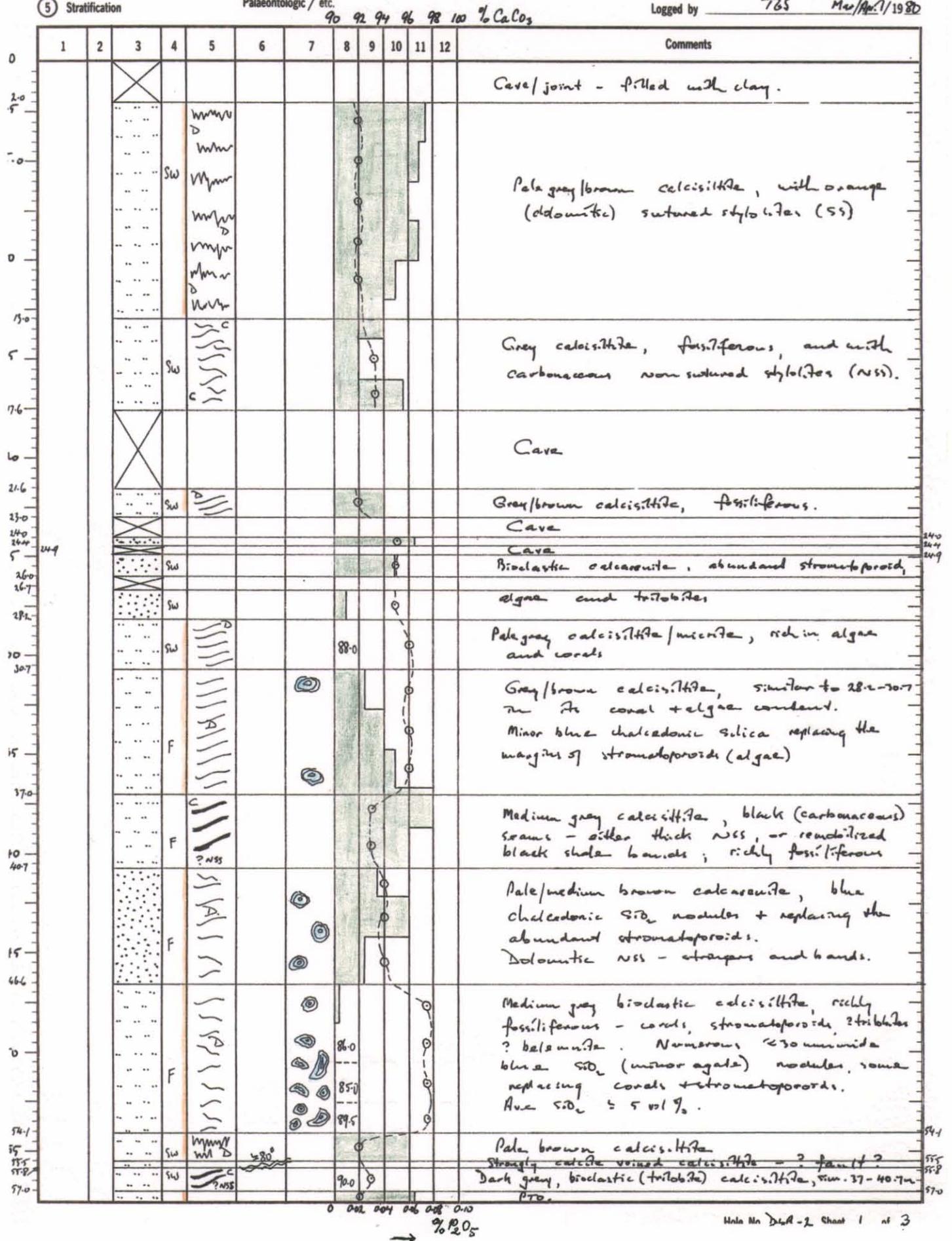
5 cm

# TASMANIA DEPARTMENT OF MINES MULTIPURPOSE DRILL HOLE LOG

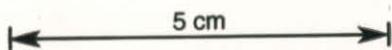
57/70

- ① Sampling
- ② Sample recovery
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨ — ⑫ Assay / Petrographic / Palaeontologic / etc.

Hole No. DLR-2 Sheet 1 of 3  
 From 0 To 57.5 m  
 Scale (s) 1 : 250  
 Logged by TGS Mar/Apr/1980



0 002 004 006 008 0.10  
 %  $SiO_2$



# TASMANIA DEPARTMENT OF MINES MULTIPURPOSE DRILL HOLE LOG

58/70

- ① Sampling
- ② Sample recovery %
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨-⑫ Assay / Petrographic / Palaeontologic / etc.

Hole No. DLR-2 Sheet 2 of 3  
 From 57.50 m To 115.0 m.  
 Scale (s) 1:250  
 Logged by RK Mar/Apr/1980

1	2	3	4	5	6	7	8	9	10	11	12	Comments
60	✓	100										Gray/brown calcisilite, carbonaceous ss > dolomite ss.
61.3												
65	✓		F									Medium gray micrite + calcisilite, orange (dolomite) nss and stringers/bands.
65.7												
68.50	✓											Medium gray calcisilite, orange (dolomite) ss.
70												Birds eye micrite, minor algal laminae, pale gray colour.
70.8												Algal laminated micrite, sparse B.E. trace pyrite
71.6												
72.5			F									Dark gray calcisilite, black carb. nss / ? shale bands. (? Tetradium, at base)
75	100											Mottled calcisilite - ? subtidal ↑ calcisilite - ? supratidal
75.2												
80												Dark gray calcisilite, black carbonaceous nss or? non-biotized black shale bands?
80.9												
82.2			F									Pale brown calcisilite, dolomite nss.
85	100											Pale-medium brown calcisilite, with coral + stromatopora fragments.
89.1												
90												Pale gray birds eye micrite; < 15% calcareous
90.1			F									Medium gray/brown calcisilite, with Tetradium at 92.8 m.
91.0												
91.2												Medium gray Tetradium rock calcisilite
95												Pale gray birds eye micrite.
96.1												Medium brown calcisilite, burrowed + Tetradium
96.7												Pale gray algal laminated micrite
97.2												" " birds eye micrite, ? Tetradium
100												Medium brown calcisilite, carbonaceous nss (+ bands?) which are pyritic. Tetradium fragments.
101.1												Pale gray birds eye micrite, with ? Tetradium
101.1												
105	100		F									Medium brown calcisilite
105.7												Tetradium - ? wave baffle ??
105.7												
109.5												As for 101.1 - 105.2 m.
110												
112.2												Oncolitic calcisilite, small oncolites (1:10 mm) to 109.9 m. followed by large (< 30 mm) to base
115	B		F									Pale gray birds eye micrite, minor algal laminae; sharp, eroded top contact.



5 cm

TASMANIA DEPARTMENT OF MINES  
**MULTIPURPOSE DRILL HOLE LOG**

60/70

KL dueto:  
 C - Cave  
 B - Broken > - Dissing.

- ① Sampling
- ② Sample recovery %
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification \*
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨-⑫ Assay / Petrographic / Palaeontologic / etc.

Hole No. DLR-3 Sheet 1 of 2  
 From 0 To 57.5 m  
 Scale (s) 1:250  
 Logged by TGS 4/7/1980

\* Dolomitic (orange) stylolites ->  
 Carbonaceous (black) " - C

90 92 94 96 98 100% CaCO<sub>3</sub>

Depth (m)	1	2	3	4	5	6	7	8	9	10	11	12	Comments
0													
2.5	C	80		MW									Pernian tuffite.
4.2													
5.4	C	37		MW	MWM WMC								Medium grey calcisiltite Cave - clay filled as for 2.5-4.2m
6.7													
7.8	C	63		MW	MWM WMC								Cave - clay filled as for 2.5-4.2m
8.2													
10	C	63		SW									Medium grey calcarenite / rudite, fossiliferous with stromatopoids, corals, minor black carbonaceous (? shaly) matrix.
11.3													
12.0													
12.4	C	87		SW	MWM C WMC								Dark grey calcisiltite - ? burrowed Cave - clay filled
15													
16.4	B	73			MWM C								Medium grey calcarenite, bioclastic, with distinct black carbonaceous (? shaly) matrix to fossil fragments
17.5													
20													
21.9	B	100		F	MW C WMC								Medium / dark grey calcarenite, bioclastic, with similar black matrix to 12.4-16.4m v. coarse fossil fragments at base (410mm)
23.9	B	77											Dark grey calcisiltite, thick black NSS.
25.9	B	66		F									Medium / dark grey calcisiltite, with minor calcarenite intervals; orange (dolomitic) and brown non-sutured stylolites (NSS).
28.7	B	70											
30	B	70											Interbedded calcisiltite + calcarenite, medium grey colour, dolomitic NSS; E sim. 463-467m, DLR-5
35	B	66		F									Medium grey calcarenite, dolomitic (orange) and brown non-sutured stylolites and ? shaly bands; minor calcite veining.
36.0													
38.2	B	80											Medium / dark grey calcisiltite, with calcarenite at base (10cm).
38.9													Crushed / sheared zone, calcite cement.
40	B	66		F									Palaeo / medium grey calcarenite / rudite, richly fossiliferous, stromatopoids; black carbonaceous matrix to fragments (sim to 12.4-21.9). dolomite spots - coarse stylolites.
41.7													
42.8	B	63											Crushed / sheared zone, calcite cement, and pale green / brown clay mineral.
43.4													
44.7	B	90											Medium grey silty calcarenite, NE micrite
45													
46.8	B	40		F									Crushed and sheared zone - frag's of NE micrite; similar clay to 42.8-44.7m. NE micrite
47.05													
47.5	B	90											Medium grey calcisiltite
48.0													
50	B	90											(Crushed / sheared zone - similar 48-50.4m.)
50.4													
50.8	B	90											Medium grey calcisiltite, dising (incorporated weffers 51.8-57m).
52.4													
55	B	90		SW									
57.0	C	0											

0 002 004 006 008 010 % P<sub>205</sub>

TASMANIA DEPARTMENT OF MINES  
**MULTIPURPOSE DRILL HOLE LOG**

61/70

- ① Sampling
- ② Sample recovery %
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨—⑫ Assay / Petrographic / Palaeontologic / etc.

Hole No. D&R-3 Sheet 2 of 2  
 From 57.50 To 60 m.  
 Scale (s) 1:250  
 Logged by TUS 4/7/1980

	1	2	3	4	5	6	7	8	9	10	11	12	Comments
57.5			X										Cave - clay filled, with boulders of limestone
60.0	C	D											
[Scale markings]													

62/70

5 cm

# TASMANIA DEPARTMENT OF MINES MULTIPURPOSE DRILL HOLE LOG

Hole No. DHR-4 Sheet 1 of 2

From 0 To 57.5 m

Scale (s) 1:250

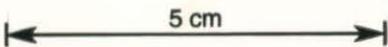
Logged by TDS. 2/7/1980

- ① Sampling
- ② Sample recovery
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨ - ⑫ Assay / Petrographic / Palaeontologic / etc.

90 92 94 96 98 100 % CaCO<sub>3</sub>

	1	2	3	4	5	6	7	8	9	10	11	12	Comments
0													
0.5		95		Sw									Med. grey calcisiltite
1.0		100											
6.3													
7.9		93											Med. grey oncolithic calcisiltite
8.6													Med. grey calcisiltite
9.3													Cave / fissure - clay filled.
10.0		90		Sw									Med. grey fossiliferous calcarenite
12.4													minor SiO <sub>2</sub> replacing fossil fragments.
17.0		93											Med. grey fossiliferous calcarenite, including
17.0		97		Sw									single poly. corals, large stromatoporoids.
17.0		73											SiO <sub>2</sub> (blue coloured) replacing margins.
17.0													Dacolite band 18.05 - 18.12 m.
21.1													Clay filled fissure
21.5													Med/dk. grey calcisiltite.
22.6		100		F									" " silty calcarenite, trilobitic, stromatopoid
23.8													" " " " " " " " " " " "
24.3													Med. grey calcisiltite
24.3													Crush zones
25.4													Med. grey fossiliferous calcarenite
26.8				F									Med. " " " " with carbonaceous
26.8													shaly bands + NSS.
26.8													large grey calcite "nodules" - ? ex colonial corals?
30.4													As for 31.4 - 37.0 m.
30.4													Crush zones
30.4													
30.4		100		F									Pale/med. grey calcarenite, with minor
30.4													large stromatopoid fragments.
30.4													(? possibly minor SiO <sub>2</sub> replacements).
37.0													
37.0													Med. grey silty calcarenite, SiO <sub>2</sub> replacing margins
37.0													of stromatoporoids; ? carbon. shaly bands, + NSS
39.3													Med. grey calcarenite, minor SiO <sub>2</sub> replacing
39.3				F									small fossil debris.
41.4													Oncolithic med. grey calcarenite, SiO <sub>2</sub> repl. fossil frag's.
42.6		100											
42.6													Med. grey calcisiltite; sharp, rounded body @ 42.6 m.
44.4													Dark grey calcisiltite, carbon. shaly bands [see DHR-1]
44.4													" " " " " " " " " " " "
45.6													" " " " " " " " " " " "
47.1				F									Med. grey calcisiltite, ~ 10% calcite veins.
47.1													
48.8													Darkened brown/black shale [same to DHR-1].
48.8													Note steep contacts - upper + lower.
51.4													Med. grey calcisiltite.
51.4		100		F									
57.5													Dark grey calcisiltite, black (carbonaceous)
57.5													non-coloured stylonites (NSS).

0 002 004 006 008 010  
→ % P<sub>2</sub>O<sub>5</sub>



TASMANIA DEPARTMENT OF MINES  
**MULTIPURPOSE DRILL HOLE LOG**

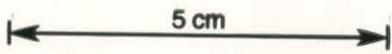
63/70

- ① Sampling
- ② Sample recovery
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨ — ⑫ Assay / Petrographic / Palaeontologic / etc.

Hole No. D.R. 4 Sheet 2 of 2  
 From 57.5 To 61.3 m  
 Scale (x) 1:250  
 Logged by TGS 2/7/1980

90 92 94 96 98 100 % CaCO<sub>3</sub>

		1	2	3	4	5	6	7	8	9	10	11	12	Comments
57.5														
60														Algal laminated + bioturbation micrite (Grey Band)
61.0	61.3													Med. grey calcification.
65														EOM - <u>61.3 m</u>



# TASMANIA DEPARTMENT OF MINES MULTIPURPOSE DRILL HOLE LOG

- ① Sampling
- ② Sample recovery %
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification \*
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨ - ⑫ Assay / Petrographic / Palaeontologic / etc.

\* Dolomitic (orange) sphyllites - D  
 Carbonaceous (black) - C  
 Sutured sphyllites - SS  
 Non - - - NSS  
 \*\*\* Intraformational breccias (I.F.B.)

Hole No. DHR-5 Sheet 1 of 3  
 From 0 To 57.5 m  
 Scale (of) 1:250  
 Logged by TGS 23 / 7 / 19 80

90 92 94 96 98 100 % CaCO<sub>3</sub>

1	2	3	4	5	6	7	8	9	10	11	12	Comments
2		Sw	Ww									Pale grey calcisiltite
2.98	100		WwC									" " bioclastic calcarenite
4.63			WwC									Med. grey/brown calcisiltite, arenitic at base + rich in trilobite fragments.
7.3		Sw	Ww									Interbedded calcisiltite + calcarenite (trilobite rid.), forming 13 siltstone units; both have black shale bands (< 5mm).
11.54		F	Ww									Med. grey bioclastic arenaceous calcarenite with abundant coral debris
14.72	100		Ww				89.0					As for 4.63 - 7.3 m.
17.0			WwC									Pale grey oncologic calcarenite; black shaly debris in matrix.
18.4			WwD									" " calcarenite.
20.35		F	Ww				85.0					Med. brown calcisiltite, black shale bands + carbonaceous NSS
27.0	100		WwC									Med. grey oncologic rudaceous calcarenite with black shaly matrix seen to DHR-3.
27.2			WwD									Med. grey calcarenite.
28		F	Ww									Binds eye micrite
29.2			Ww									Binds eye calcisiltite
32.3	100		Ww									Pale grey calcisiltite, 20% calcite veins.
32.6		F	Ww									Crush zone with reconst. calcite
33.2		Sw	Ww									Buff col. thin bedded calcisiltite
33.7		Sw	Ww									Calcarenite + black shale - folded.
34.6		F	Ww									Calcisiltite --> calcarenite (I.F.B.)
36.8		F	Ww									Graded sequence of black shale -> calcisiltite -> calcarenite. (Fossils indicated)
38.75	100		Ww									Med. grey calcisiltite, <20% calcite veins.
41.7		F	Ww									" " " - >20% " "
44.15			Ww									(- ? autoassociated)
44.7			Ww									Med. grey calcarenite, minor stromatolites
44.7			Ww									Crush zone, coarse recryst. calcite
44.7		F	Ww									Dark brown calcisiltite, "wispy" black shale interbeds + ? fragments (< 40mm)
44.7			Ww									Crush zone, as for 44.15 - 44.7 m.
49.15			WwC									Pale grey calcarenite C.Z. as for 44.15 - 44.7
49.15			WwC									Dark brown calcisiltite, "wispy" black shale etc.
50.58			WwC									Crush zone - coarse recryst. calcite
51.50	100		WwC									Med. brown calcisiltite, intraformational breccias (I.F.B.) composed of black shale, pyrite (>10%) etc.
53.4		F	Ww									Med. grey calcarenite.
55.0			WwC									Dark brown calcisiltite, "wispy" black shale interbeds + fragments (?) ; bl. shale are folded. (I.F.B. indicated ***)
55.40			WwC									
57.1		F	Ww									

← 50mm thick  
 0 0.02 0.04 0.06 0.08 0.10  
 → % P<sub>2</sub>O<sub>5</sub>

65/70

5 cm

# TASMANIA DEPARTMENT OF MINES MULTIPURPOSE DRILL HOLE LOG

- ① Sampling
- ② Sample recovery %
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨ - ⑫ Assay / Petrographic / Palaeontologic / etc.

Hole No. DLR-5 Sheet 2 of 3  
 From 57.50 m To 115 m  
 Scale (of) 1:250  
 Logged by TDS 23/7/1980

90 92 94 96 98 100 % CaO<sub>3</sub>

1	2	3	4	5	6	7	8	9	10	11	12	Comments	
58.0							82.0					58.0	Med. brown calcisiltite.
60			F		$\Delta S_0 = 80^\circ$		88.5					60.5	Dark brown calcisiltite, "wisp" black shales, + I.F.B.'s. (oncolitic silty calcarenite)
63.4					$\Delta S_0 = 60^\circ$							63.4	Dark brown calcisiltite, "wisp" black shale interbeds. (ave 5mm thick).
65			F				86.5					65.5	Med. brown calcisiltite, wisp black shales + several I.F.B.'s. (20mm)
69							86.5					69.0	Med. brown calcisiltite - laminated.
70							86.5					70.25	Med. grey calcisiltite, bedded "wisp" black shales, I.F.B.'s. (xxxx) (75mm)
73.0							86.5					73.0	As for 69.0 - 70.25m.
74.2			F				86.5					74.2	Med. grey calcarenite
75							86.5					75.5	Dark brown calcisiltite, "wisp" black shales bands etc.
76							86.5					76.8	Pale grey/brown calcarenite, "wisp" black shale stringers. I.F.B.'s have black shaly and yellow/green clay matrix. (Minor "impact discing" 75.8-76.5m)
80			F		$\Delta S_0 = 55^\circ$		88.5					80.3	Dark grey/brown calcisiltite, "wisp" black shale bands (<30mm). Minor I.F.B.'s.
82.50							88.5					82.85	Med. grey oncolitic calcarenite
85							88.5					85.25	Med/dark brown calcisiltite, "wisp" black shale bands (<10mm), -> calcarenite at base.
88.2			F				88.5					88.2	Oncolite bed, calcarenite matrix; (oncolites <= 15mm diameter.)
90							88.5					90.0	? Shear zone - yellow/green clay
92.1							88.5					92.1	Med grey silty calcarenite, with coral frags; thick I.F.B. 92.1-92.9m.
93.6							88.5					93.6	? Shear zone - yellow/orange clay matrix.
95							88.5					95.0	Dark brown shaly calcisiltite "wisp", + <100mm thick.
96							88.5					96.0	Dark brown silty calcarenite to 97.5m, gradual to calcarenite* -> base. "Wisp" blackshale interbeds, sim. to those occurring in the calcisiltites. (x thick has a black shaly matrix)
100			F				88.5					100.8	Birds eye silty matrix
101.1							88.5					101.1	Med. grey rudaceous calcarenite - [sim to 97.5-100.8]
102							88.5					102	Med. grey calcisiltite
103.65							88.5					103.65	Intraformational breccia, arenite matrix, = by, blk. etc.
105							88.5					105	Dark brown/gray calcisiltite, "wisp" black shale interbeds to 108m; minor NSSS.
106.9							88.5					106.9	Numerous Intraformational breccias, the last of which has undisturbed (not slumped) black shale.
107.6							88.5					107.6	Pale grey birds eye micrite; fine black lines defining joints??
110							88.5					110.8	Pale grey birds eye calcisiltite, -> arenite at base
112.4							88.5					112.4	Dark grey pyrite banded calcisiltite to 114.3m.
113.8							88.5					113.8	
114.5							88.5					114.5	
115.0							88.5					115.0	

87.5 0.04 0.06 0.08 0.10  
 -> 8P205

66/70

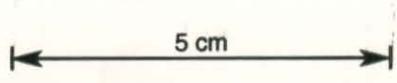
# TASMANIA DEPARTMENT OF MINES MULTIPURPOSE DRILL HOLE LOG

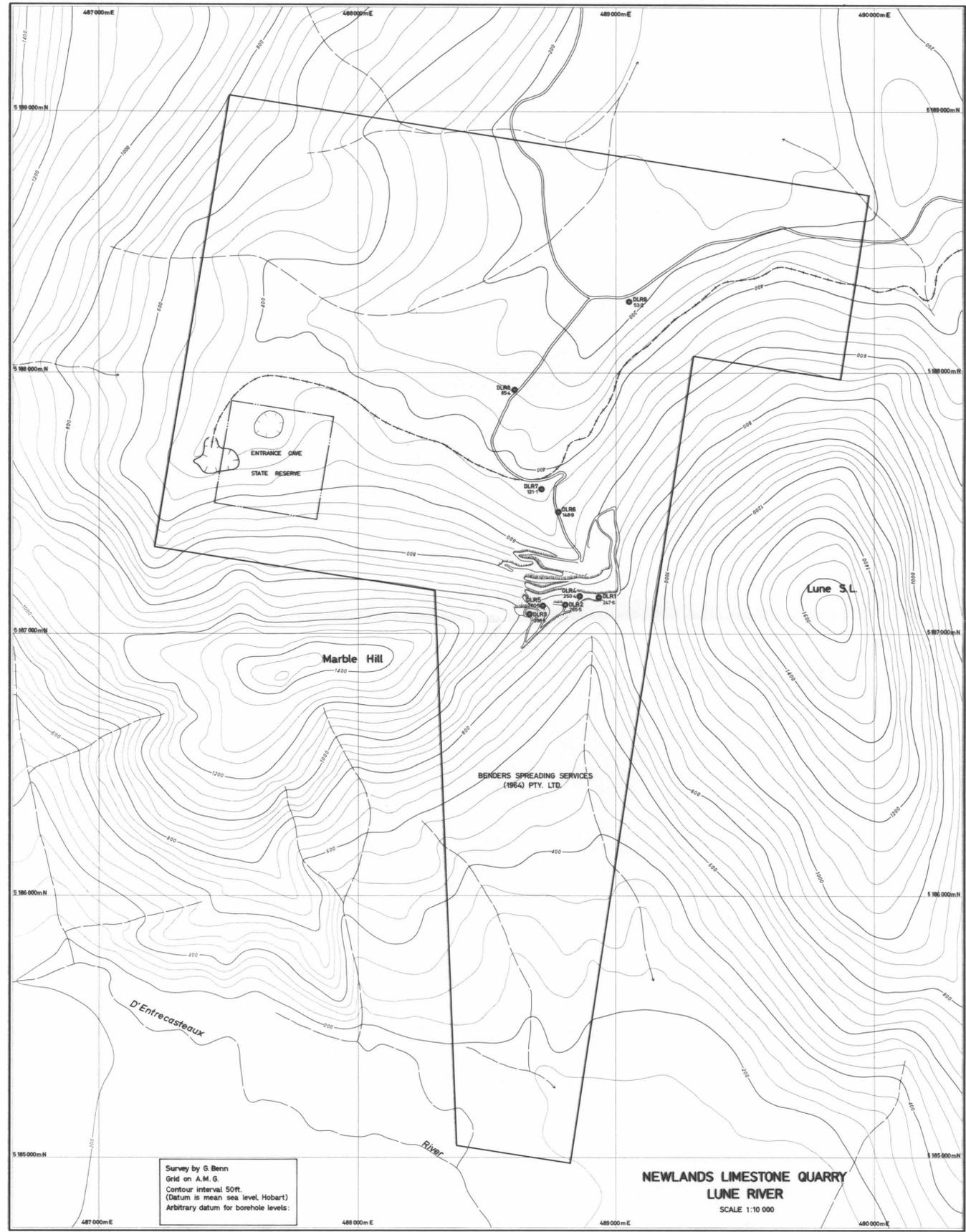
- ① Sampling
- ② Sample recovery
- ③ Rock type
- ④ Rock condition
- ⑤ Stratification
- ⑥ Structure
- ⑦ Mineralisation / Representative Fabric
- ⑧ Age code
- ⑨ — ⑫ Assay / Petrographic / Palaeontologic / etc.

Hole No. D.R. 5 Sheet 3 of 3  
 From 115.0 To 120.0 m  
 Scale (if) 1:250  
 Logged by TBS 23 / 7 / 1980

90 92 94 96 98 100 % CaO<sub>3</sub>

	1	2	3	4	5	6	7	8	9	10	11	12	Comments
115			F				87.5						gradational to dark grey / brown calc. lit. with "wispy" black holes. (<15mm). I.F.B.'s aren't visible.
117.8		100	Mw										Oxidized I.F.B.
120													EQM - 120.0 m ⚡
13													





Survey by G. Benn  
 Grid on A.M. S.  
 Contour interval 50ft.  
 (Datum is mean sea level Hobart)  
 Arbitrary datum for borehole levels:

**NEWLANDS LIMESTONE QUARRY**  
**LUNE RIVER**  
 SCALE 1:10 000

### NEWLANDS LIMESTONE QUARRY — LUNE RIVER LONGITUDINAL SECTION SHOWING DISTRIBUTION OF LIMESTONE GRADES

-  > 92% CaCO<sub>3</sub>, < 0.02% P<sub>2</sub>O<sub>5</sub>, < 4.0% SiO<sub>2</sub>
-  > 92% CaCO<sub>3</sub>, > 0.02% P<sub>2</sub>O<sub>5</sub>, < 4.0% SiO<sub>2</sub>
-  > 92% CaCO<sub>3</sub>, > 0.02% P<sub>2</sub>O<sub>5</sub>, > 4.0% SiO<sub>2</sub>
-  > 92% CaCO<sub>3</sub>, > 0.02% P<sub>2</sub>O<sub>5</sub>, > 4.0% SiO<sub>2</sub>

0 10 20 30 m

SECTION STRIKES 065° MAG. V/H=1  
GEOLOGIST: T. G. SUMMONS OCTOBER 1980  
DRAWN: H. MACKINNON NOV. 1980

