



# Maydena DDH1 : Appraisal of the limestone resource at Risbys Basin

by C.R. Calver

## Abstract

A fully cored diamond-drill hole at Risbys Basin intersected 519 m of Ordovician Gordon Group Limestone. Analytical results from selected intervals indicate that the best and most consistent grades occur in the Cashions Creek Limestone. One 50 m interval (true thickness) is 94.9% CaCO<sub>3</sub> and 0.64% Mg. Reserves extractable from this interval by quarrying are of the order of three million tonnes. A systematic outcrop sampling program is recommended to locate lenses of still higher grade within the Cashions Creek Limestone.

## INTRODUCTION

In 1989–90 a preliminary survey of Ordovician limestone in the Maydena area was carried out with the aim of locating a source of industrial limestone of size and grade suitable to supply the Pasmenco-EZ plant at Risdon (Calver, 1990). It was concluded that further work should be focused on the Cashions Creek and Benjamin Limestone formations in the Risbys Basin area two kilometres southwest of Maydena, and that diamond drilling should be initiated to fully establish the thickness and grades of prospective intervals.

A fully cored diamond-drill hole, Maydena DDH 1, was completed at Risbys Basin in late 1990. This report assesses analytical results from this drill hole in the light of the grades required by Pasmenco-EZ, now set of >94% CaCO<sub>3</sub> and <0.4% Mg.

## LOCATION AND ACCESS

The hole was collared at 468 918.5 mE, 5 264 349.5 mN, height 487 m ± 0.5 m (surveyed by G. Benn). A down-hole survey found no appreciable deviation from the vertical (B. Cox, pers. comm.) The hole bottomed at 519 m in Karmberg Limestone. A bulldozed track about 100 m long connects the drill site to Roberts Road. The limestone area at Risbys Basin is owned or controlled by Australian Newsprint Mills.

## GEOLOGICAL SETTING

Three Limestone formations, all belonging to the Ordovician Gordon Group, are present at Risbys Basin. These are (beginning with the oldest):

- the Karmberg Limestone (chert-bearing impure limestone, not considered prospective);
- the Cashions Creek Limestone (massive, oncolitic limestone identified as prospective in the reconnaissance study (Calver, 1990));
- and the Benjamin Limestone (a thick formation with variable grades possibly including some prospective intervals).

These units dip at about 35° to the northeast and are truncated to the northeast by a major fault, beyond which lies Permian mudstone and conglomerate. The drill hole intercepted 305 m (true thickness) of Benjamin Limestone, the whole of the Cashions Creek Limestone (112 m true thickness), and bottomed in the upper part of the Karmberg Limestone (fig. 1). A more detailed description of the stratigraphy is presented in Calver (1990). A log of the hole is appended (Appendix 1).

## ANALYTICAL RESULTS

Core from the entire thickness of the Cashions Creek Limestone and from two intervals within the Benjamin Limestone was split longitudinally and half (divided into samples based on lithology) was submitted for analysis by AAS (Table 1). The sampled intervals from the Benjamin Limestone were selected on the basis of a visual estimate of relatively low dolomite and other impurities.

The results, plotted as histograms (figs 2, 3, 4) show that the interval with the best and most consistent grades lies within the Cashions Creek Limestone at a depth of 408–470 m (true thickness approximately 50 m). The weighted average grade for this interval is 94.9% CaCO<sub>3</sub>, 0.64% Mg. The lithology throughout this interval is a fine to coarse-grained, sparsely oncolitic, massive calcarenite. Vertical expansion of the selected interval would not greatly compromise the average grade; the weighted average for the whole Cashions Creek Limestone being 93.3% CaCO<sub>3</sub>, 0.79% Mg.

Analytical results from the two sampled intervals in the Benjamin Limestone are considerably less favourable. The upper interval (66.5–143.0 m depth) has a weighted average 87.1% CaCO<sub>3</sub>, 0.80% Mg; the lower (167.0–221.9 m) is 88.8% CaCO<sub>3</sub> and 0.85% Mg. Grades are more variable, in accord with the more varied lithologies of the Benjamin Limestone. Only a few horizons of birdseye

limestone, none more than 8 m in thickness, approach the grade required at Pasminco-EZ with respect to both  $\text{CaCO}_3$  and Mg. Several samples, however, are low (<0.4%) in Mg. For example, the interval 111.8–143 m has a weighted average of 91.7%  $\text{CaCO}_3$  and 0.34% Mg if one sample (M32) is excluded. This low-Mg interval is unlikely to extend below 143 m depth as the core (not analysed) appears high in dolomite, particularly between 145.7 and 160.2 m (see Appendix 1).

## CONCLUSIONS

Clearly the best prospect for an industrial limestone resource at Risbys Basin is the Cashions Creek Limestone, in terms of consistently high  $\text{CaCO}_3$  content and an adequate thickness for an economical quarrying operation. However the Cashions Creek Limestone in Maydena DDH1 falls somewhat short of Pasminco-EZ's requirements with respect to Mg content. Rock lower in magnesium can be found in the Benjamin Limestone but could be extracted only at the cost of considerably poorer  $\text{CaCO}_3$  grades or much smaller total thicknesses.

Rough calculations of reserves within the 50 metre thick best interval within the Cashions Creek Limestone indicate

about three million tonnes on the basis of no overburden, no underburden, and a total strike length of about two kilometres. While it is unlikely that the whole strike length could be exploited, the toleration of slightly lower grades or some overburden/underburden would greatly increase the reserves extractable from a more limited area.

The previous report (Calver, 1990) documents two outcrop samples of Cashions Creek Limestone from Sunshine Road, with 96–97%  $\text{CaCO}_3$  and 0.17% Mg (samples V94 and V95). It is therefore possible that substantial lenses exist within the Cashions Creek Formation with considerably better grades than those found in Maydena DDH1. A systematic outcrop sampling program would be the quickest and most economical way of homing in on any such high-grade pods.

## REFERENCE

CALVER, C. R. 1990. Limestone resources of the Maydena–Florentine Valley area. *Rep. Div. Mines Miner. Res. Tasm.* 1990/06.

[13 February 1992]

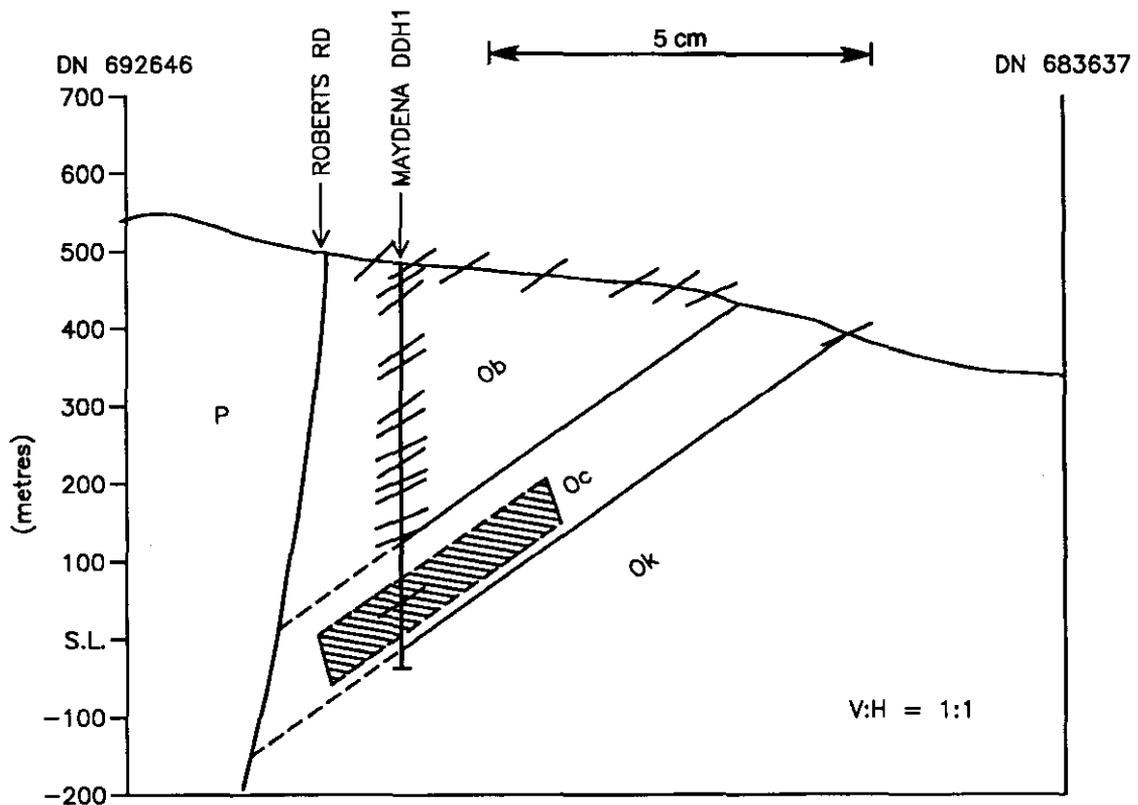


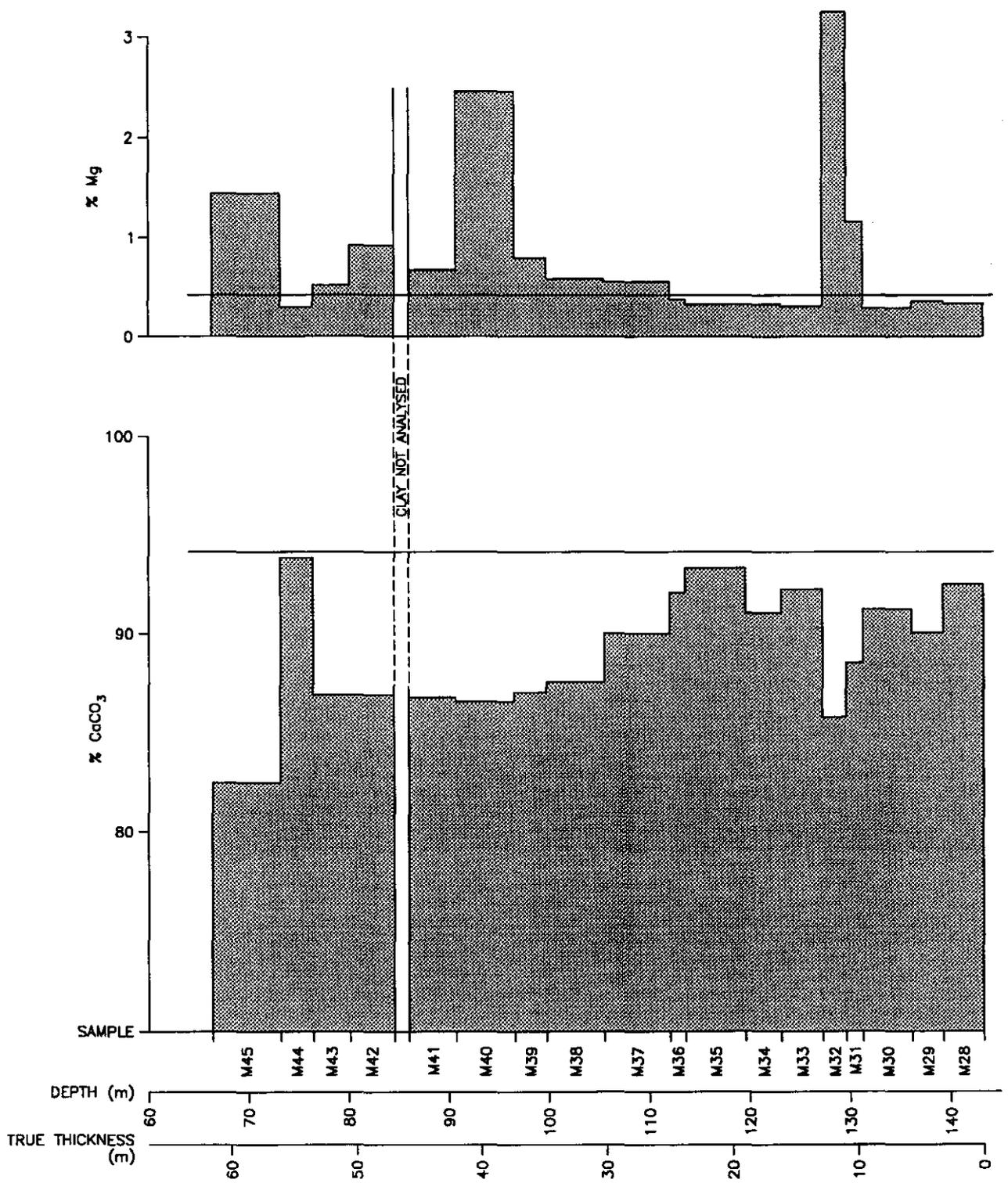
Figure 1.

NE-SW cross section through Risbys Basin showing formations intercepted by Maydena DDH1. Short lines are dips measured in core and in outcrop. Shaded area represents interval with best grades.

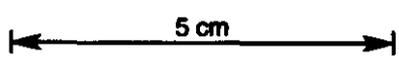
Table 1. Analyses of limestone samples, Maydena DDH 1.

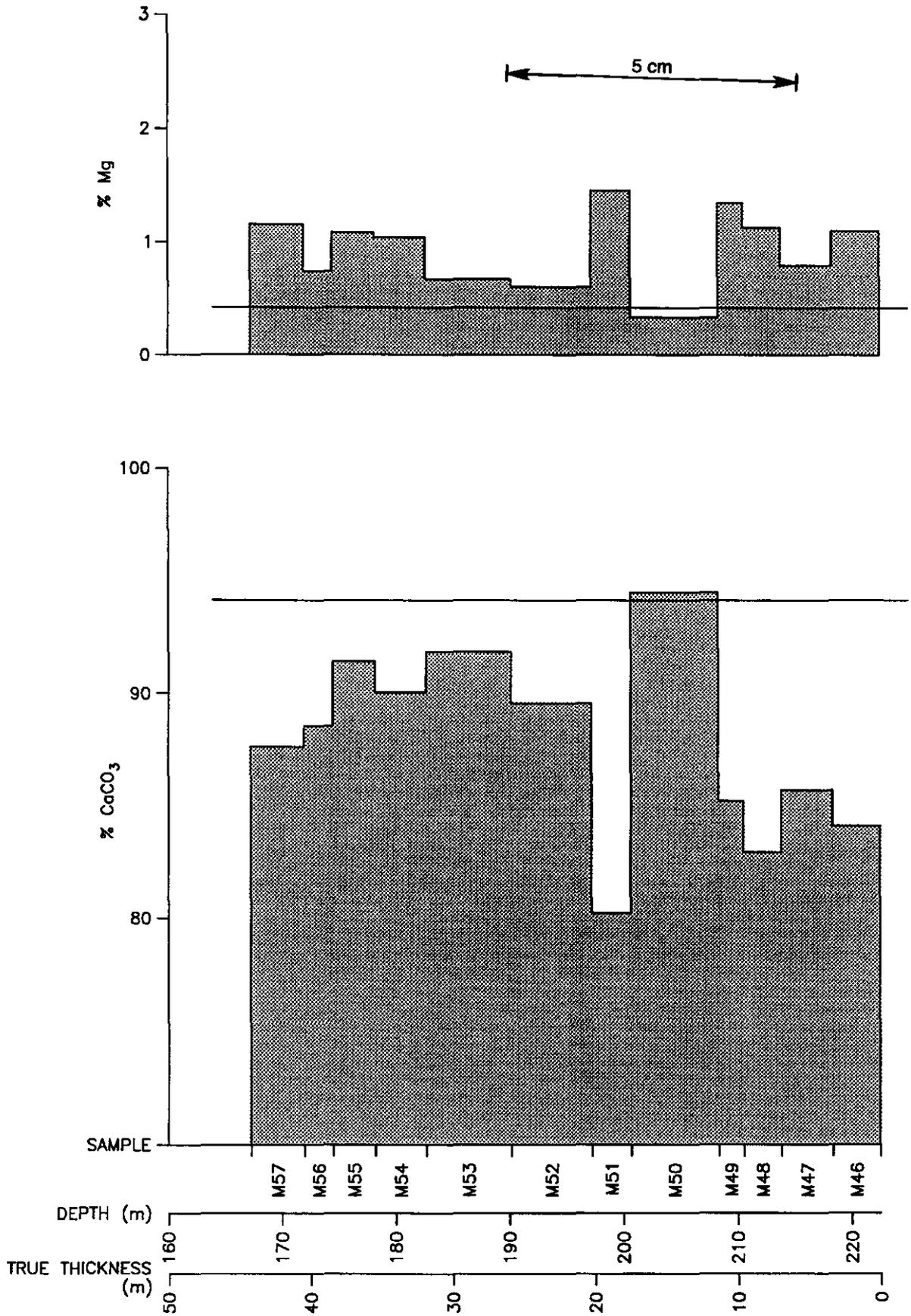
Reg. no.	Depth (m)	Sample	% CaCO <sub>3</sub>	% Mg
910252	362.0-364.1	M1	76.6	2.74
910253	364.1-366.0	M2	90.6	0.64
910254	366.0-376.1	M3	92.5	0.89
910255	376.1-384.4	M4	93.7	1.01
910256	384.4-385.0	M5	74.7	5.35
910257	385.0-395.2	M6	94.5	0.85
910258	395.2-395.9	M7	88.7	2.20
910259	395.9-400.2	M8	94.2	0.86
910260	400.2-400.6	M9	86.9	1.92
910261	400.6-406.6	M10	91.9	1.28
910262	406.6-407.5	M11	49.3	1.46
910263	408.0-415.1	M12	94.3	0.87
910264	415.1-422.1	M13	95.3	0.60
910265	422.1-429.4	M14	95.3	0.57
910266	429.4-435.2	M15	95.1	0.58
910267	435.2-443.2	M16	94.8	0.56
910268	444.2-453.3	M17	94.4	0.69
910269	453.3-462.3	M18	94.8	0.62
910270	462.3-470.2	M19	95.2	0.62
910271	470.2-473.5	M20	92.6	0.75
910272	473.5-483.5	M21	94.1	0.69
910273	483.5-492.6	M22	91.6	0.81
910274	492.6-493.6 496.6-497.2	M23	81.7	1.74
910275	493.6-496.6 497.2-498.0	M24	92.6	0.64
910276	498.0-500.9	M25	90.1	0.45
910277	500.9-504.7	M26	93.7	0.66
910278	504.7-507.3	M27	78.3	0.78
911250	139.0-143.0	M28	92.4	0.31
911251	136.0-139.0	M29	90.0	0.32
911252	131.1-136.0	M30	91.2	0.27
911253	129.6-131.1	M31	88.5	1.15
911254	127.0-129.6	M32	85.8	3.22
911255	123.0-127.0	M33	92.1	0.29
911256	119.4-123.0	M34	91.0	0.30
911257	113.3-119.4	M35	93.2	0.30
911258	111.8-113.3	M36	92.0	0.36
911259	105.4-111.8	M37	90.0	0.55
911260	99.6-105.4	M38	87.6	0.56
911261	96.4-99.6	M39	87.0	0.79
911262	90.6-96.4	M40	86.6	2.46
911263	86.0-90.6	M41	86.8	0.67
911264	80.1-84.5	M42	86.9	0.91
911265	76.3-80.1	M43	86.9	0.50
911266	73.1-76.3	M44	93.7	0.28
911267	66.5-73.1	M45	82.6	1.43
911268	218-221.9	M46	84.2	1.06
911269	213.6-218	M47	85.8	0.78
911270	210.2-213.6	M48	83.0	1.10
911271	208.1-210.2	M49	85.4	1.31
911272	200.3-208.1	M50	94.5	0.34
911273	197-200.3	M51	80.3	1.43
911274	190-197	M52	89.6	0.60
911275	182.5-190	M53	91.9	0.67
911276	178-182.5	M54	90.1	1.03
911277	174.3-178.6	M55	91.5	1.08
911278	171.9-174.3	M56	88.7	0.75
911279	167.0-171.9	M57	87.8	1.14

Analyst: Katherine Burt

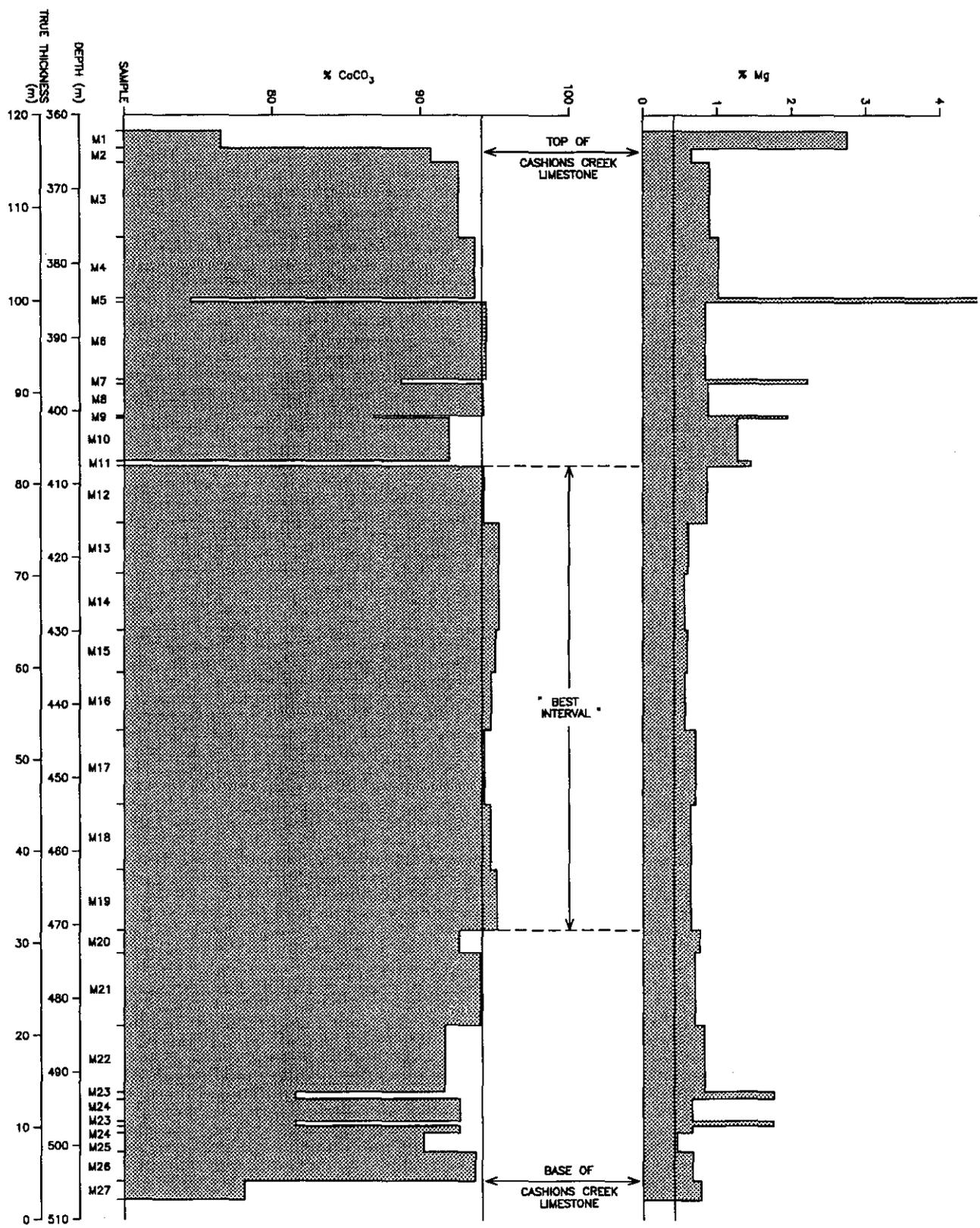


**Figure 2.**  
Histogram of % CaCO<sub>3</sub> and % Mg, 66.5–143.0 m depth (Benjamin Limestone).





**Figure 3.**  
Histogram of % CaCO<sub>3</sub> and % Mg, 167.0–221.9 m depth (Benjamin Limestone).



**Figure 4.**  
Histogram of % CaCO<sub>3</sub> and % Mg, 357.0–507.3 m depth. Top and base of Cashions Creek Limestone shown, and selected "best interval".

5 cm

# APPENDIX 1

## Log of Maydena DDH 1

Depth (m)	Description
2.0-4.0	Medium brownish-grey micrite; broadly anastomosing stylolitic seams in places. Rubbly core.
4.0-6.0	As above with ~20% pale orange-brown dolosiltite, mostly as random burrow replacements. 7 cm of brown clay at 4.0 m, 7 cm clay at 4.3 m.
6.0-8.0	Medium brownish-grey micrite; minor fossil bands (trilobite, gastropod); small vugs with iron oxide and calcite at 6.5 m; ~5% orange-brown dolosiltite burrows.
8.0-9.0	Medium grey micrite; ~5% dolosiltite; 30% fasciculate <i>Tetradium</i> fragments.
9.0-9.4	Medium grey micrite 15% brown dolosiltite stringers.
9.4-9.9	As above; 30% fasciculate <i>Tetradium</i> fragments.
9.9-11.9	Medium grey-brown micrite, ~10% brown dolomite stringers and stylolitic seams; core broken up in places.
11.9-14.1	Medium-pale grey-brown micrite, 30% pale brown dolosiltite mostly after horizontal burrows.
14.1-15.3	Limestone with ~5% dolomite as stylolitic stringers. Densely-packed <i>Tetradium</i> bands in places.
15.3	Change from oxidised (weathered) core above, with pale brown dolomite, to reduced (unweathered) core, with dark grey dolomite, below.
15.3-17.2	Medium-dark grey micrite with 10-15% dark grey dolomite as blebby stringers 0.5-1.0 cm thick, burrows, and along stylolites. Minor bioclastic horizons (mollusca.).
17.2-23.5	Subequal dark grey micrite and darker dolosiltite as blebby layers, some internally burrowed; stringers and thick burrows. Wispy, low-amplitude stylolites.
23.5-24.6	Medium-dark grey micrite, 20% dolosiltite as thin layers and burrows; black, low-amplitude stylolitic seams. Bedding dips 35° at 23.6 m.
24.6-25.4	Dark grey to black micrite and dolosiltite, interburrowed, like above 23.5 m.
25.4	Probable parasequence boundary. Planar, bored, sharp contact.
25.4-25.6	Dark purplish-grey micrite, faintly mottled, with ~10% dolomite as horizontal burrows.
25.6-26.3	Medium grey micrite; 10% highly irregular, angular patches of dolomite, random spar-filled discontinuous cracks in upper part. Bedding dips 30° at 26 m.
26.3-26.6	Medium grey micrite with 10% wispy, stylolitic stringers; bioclastic band.
26.6	Sharp, planar parasequence boundary.
26.6-27.7	Pale grey micrite. Minor sparry fenestrae mostly as narrow spar-filled tubes and thin, discontinuous cracks. Greyish 'haloes' around fenestrae. 5% thin, dark shaly layers.
27.7-29.4	Medium grey micrite; 15% dolomite stringers; thicker (2 mm) spar-filled random tubes in upper part; abundant burrows (lst. in lst.); calcite veining, oxidation and core breakup around 28.8 m. Lowest 20 cm is a black silstone with small ribbed brachiopods and disoriented stromatopoids.
29.4	Probable parasequence boundary.
29.4-29.6	Medium-dark grey micrite; 10% dolomite as burrows; some spar-filled burrows, vertical, horizontal, 3 mm diameter; some with internal sediment.
29.6-29.9	Medium-dark grey micrite with 20% dolomite as intersecting network of burrows and stylolitic stringers; minor spar-filled burrows.
29.9-31.8	Medium-dark grey micrite with 5-10% dolomite and dark insolubles along stylolitic, wavy seams; some dolomite as burrows; <i>Tetradium</i> at 30.2 m.
31.8-32.0	Dark grey micrite, faintly burrow-mottled; 20% thin beds of black shale.
32.0	Parasequence boundary; planar to slightly irregular.
32.0-32.2	Medium-pale grey micrite; spar-filled tubes and thin wavy cracks, greyish 'haloes'.
32.2-35.2	Medium-dark grey micrite, ~10% dolomite plus insolubles on wavy, broadly anastomosing seams. Minor bioclastic horizons — <i>Tetradium</i> , molluscs.

Note: Box No. 8 (35-39 m): core is reversed.

Depth (m)	Description
35.2	Parasequence boundary.
35.2–37.2	Pale grey-brown micrite, few percent pale brown stylolitic seams; common crack-like, tubular, and laminoid fenestrae.
37.2–39.0	Medium to dark grey micrite with 20% dolomite as pale brown or dark grey burrow replacements, modified by stylolites. Horizontal burrows.
39.0	Change from HQ to NQ core.
39.0–39.8	Medium grey micrite with 10–50% orange-brown dolomite stringers and burrows. Bedding dips 40°.
39.8–40.25	Medium grey micrite; ~5% dark dolomitic stringers, irregular but mostly subparallel to bedding; ~5% small sparry patches, probably mostly fossils, may be some fenestrae.
40.25–41.7	Brownish-grey micrite; wispy dolomite stringers; a few percent molluscan fragments including ' <i>Ecculiomphalus</i> '.
41.7–42.2	Bioclastic wackestone to grainstone; 5% dark dolomite stringers; caterriform <i>Tetradium</i> .
42.2–43.7	Brownish-grey micrite, 5% dark dolomite stringers; fossil fragments concentrated in several thin bands.
43.7	Parasequence boundary.
43.7–44.1	Very pale grey birdseye micrite. Sparse, small fenestrae.
44.1–46.9	Medium grey micrite with 5–10% dark dolomite stringers and burrows; more (10–20%) towards base; 'interburrowed' dolomite and micrite; a few percent fossil fragments.
46.9–49.0	Medium grey-brown micrite with ~10% orange-brown dolomite, mostly after horizontal burrows.
49.0–50.0	Micrite with 5–10% dark dolomite stringers and burrows.
50.0–51.0	Micrite with 5–10% orange-brown dolomite.
51.0–51.5	Medium grey calcisiltite; almost free of dolomite and stylolites.
51.5–51.7	Dark grey-brown, very thinly interlaminated limestone and dolomite, partly disrupted by burrows, mudcracks; bedding dips 45°.
51.7–52.5	Pale grey micrite, almost no dolomite; probable fenestrae.
52.5–56.0	Medium grey-brown micrite; 5–10% dolomite mostly as thin (2–20 mm) irregular layers. Sparse molluscan fragments, sparry blebs.
56.0–56.1	Clay and fragmented limestone core.
56.2	Probably parasequence boundary (abrupt contact).
56.2–58.0	Pale grey, laminoid-fenestral birdseye limestone. A few percent thin, dark, overburden (bedding-parallel) stylolites.
58.0–58.6	Dark grey, thinly laminated limestone with fenestrae and mud cracks.
58.6–59.2	Massive, uniform, dark grey-brown calcisiltite.
59.2	Parasequence boundary; sharp, slightly irregular.
59.2–60.4	Pale grey micrite or calcisiltite; small fenestrae in top 300 mm; few percent dark dolomitic, stylolitic material.
60.4–62.0	Fine-grained calcisiltite with ~10% diffuse dolomite patches, dark grey or pale brown. Cephalopod at 61.5 m.
62.0–68.2	Medium grey-brown micrite; ~5% brown dolomite stringers. Trilobite fragments. Clay (and core loss?) at 67, 67.5 m. Core loss at 63.0 m. No stylolites.
68.2–73.1	Dark grey micrite, with 10%+ dark, diffuse, irregular dolomite layers 5–40 mm thick; interburrowed limestone and dolomite; sparse trilobite, cyrtodontid fragments. Sample M45: 66.5–73.1 m.
73.1–73.9	Pale grey calcarenite. Little or no secondary dolomitic or stylolitic material.
73.9–74.2	Medium grey, fine-grained calcarenite similar to above unit.
74.2	Parasequence boundary.

<i>Depth (m)</i>	<i>Description</i>
74.2–76.3	Pale grey micrite, fenestral in places; no dolomite; some seismoform to wavy stylolites. Gastropod etc. fragments. <b>Sample M44:</b> 73.1–76.3 m.
76.3–80.1	Medium to dark grey-brown micrite with ~5% black, dolomitic-stylolitic material as thin seams and stringers. Sparse scattered trilobite and molluscan fragments. <b>Sample M43:</b> 76.3–80.1 m.
80.1–81.0	Purplish-grey thinly-laminated limestone, with spar-filled vertical burrows.
81.0–81.2	Pale grey micrite with random, spar-filled cracks.
81.2–81.6	Micrite with random, thicker (3 mm) spar-filled burrows.
81.6–82.3	Medium to dark grey-brown micrite with ~5% black, dolomitic-stylolitic material as thin seams and stringers.
82.3–83.1	As above but more diffuse, 'interburrowed' dolomitic layers.
83.1–83.5	Mostly dark, dolomitic, silty, bioturbated limestone.
83.5–84.5	Micrite with 5–10% dolomitised horizontal burrows. A trilobite-intrasparite band, 50 mm, at 82.5 m. <b>Sample M42:</b> 80.1–84.5 m.
84.5–86.0	Orange clay, 500 mm core loss.
86.0–87.0	Pale grey fine-grained calcarenite; a few percent stylolites; several percent sparry veins, mostly sub-perpendicular to bedding.
87.0–87.6	Thin-bedded micrite; minor spar-filled vertical burrows.
87.6–87.8	Micrite with random spar-filled cracks, with faint haloes.
87.8–88.8	Micrite with 5% dark, dolomitic-stylolitic material.
88.8–90.0	Dark grey micrite with 10% diffuse, dark, dolomitic layers. Trilobite, molluscan-rich fossil band at 89.0 m.
90.0–90.6	Micrite with 5% dark, dolomitic-stylolitic material. <b>Sample M41:</b> 86.0–90.6 m.
90.6–93.6	Micrite with 10% dolomitised horizontal burrows.
93.6–96.3	Micrite with 20% sharply-defined black stylolitic dolomite and diffuse grey dolomite.
96.3–96.4	Black shale. <b>Sample M40:</b> 90.6–96.4 m.
96.4–105.4	Medium grey micrite with 2–5% dark seams, mostly parallel to bedding, of dolomitic-stylolitic material. Minor dolomitised burrows. <b>Sample M38:</b> 99.6–105.4 m; <b>M39:</b> 96.4–99.6 m.
105.4–106.6	Laminated micrite with rare, small dolomite or spar-filled burrows and minor flat-pebble breccia.
106.6–110.0	Medium grey micrite with 2–5% dark, planar to irregularly anastomosing seams. Diagenetic layering, 5–50 mm. Sparse fossils.
110.0–111.8	Medium to dark grey micrite with 2–5% highly irregular stylolitic seams. Common shelly and <i>Tetradium</i> fragments. <b>Sample M37:</b> 105.4–111.8 m.
111.8	Parasequence boundary.
111.8–112.0	Brownish micrite, partly laminated; spar-filled burrows. Dip of bedding 38° at 112.0 m.
112.0–119.4	Pale to medium grey to pale yellow-grey, birdseye (richly fenestral) limestone. Less than 1% bedding-parallel stylolites. <b>Sample M35:</b> ~113.3–119.4 m; <b>M36:</b> 111.8–113.3 m.
119.4–121.8	Pale yellow-brown (bone-coloured) micrite, birdseyes in places; 1–2% seismoform to laminoid stylolites.
121.8–122.8	Fine-grained calcenerite; a few percent lacy fine anastomosing network of stylolites.

<i>Depth (m)</i>	<i>Description</i>
122.8–123.0	Limestone with abundant fasciculate-dendroid <i>Tetradium</i> , possibly in growth position. <b>Sample M34:</b> 119.4–123.0 m.
123.0–125.0	Medium brown-grey micrite with ~5% orange-brown dolomitised horizontal burrows and thin, irregular orange-brown layers which form shaly partings every 100–200 mm. Spar-filled burrows in places.
125.0	Core loss — cave — reported by drillers to be about 600 mm.
125.6–126.8	Fine to coarse-grained massive calcarenite. Very coarse (5 mm) at 126.1–126.6 m.
126.8–127.0	Coarse secondary vein — calcite. <b>Sample M33:</b> 123.0–127.0 m.
127.0–129.6	Micrite with 20–30% dark grey dolomite after horizontal burrows. Minor stylolites as thin black selvages on dolomite patches. Minor prone <i>Tetradium</i> , 129.4–129.6 m. <b>Sample M32:</b> 127–129.6 m.
129.6–130.0	70% pale brown dolomite; interburrowed dolomite and micrite. Sharp bottom contact.
130.0–130.3	Dark grey limestone with scattered shelly fossils: <i>Lophospira</i> , ? <i>Cystodonta</i> ; minor dolomite after burrows.
130.3–131.1	As above but no fossils. Gradational bottom contact. <b>Sample M31:</b> 129.6–131.1 m.
131.1–134.2	Bone-coloured to pale grey micrite, sparse fenestrae; a few percent yellow-brown stylolitic material; at 133.1–134.2 m some large (1.5 mm) fenestrae, some possibly gypsum pseudomorphs; some with pale green internal sediment.
134.2–136.0	Medium grey fenestral micrite. <b>Sample M30:</b> 131.1–136.0 m.
136.0–139.0	Pale grey to bone-coloured, thinly-laminated micrite (algal-laminated?); 1–2% very thin, abundant seismoform to planar orange-brown stylolites; minor spar-filled vertical burrows. <b>Sample M 29.</b>
139.0–143.0	Similar to above but grey with black stylolites. Oxidation front quite sharp at 139.0 m. <b>Sample M28.</b>
143.0–145.0	Cave. No core recovered.
145.0–145.7	Micrite with abundant fasciculate <i>Tetradium</i> , some in growth position; and fossil fragments.
145.7–154.3	Medium grey micrite with ~30% dark grey dolomite as horizontal burrows. Minor stylolites as black selvages in dolomite. Slickensided subvertical calcite vein, 154.4–153.5 m; with adjacent oxidised (orange-brown) dolomite.
154.3–156.0	Pale grey, massive secondary dolomite with random veins and solution seams.
156.0–157.0	Micrite with 50% dolomite after horizontal burrows.
157.0–159.7	Micrite with ~20% dark grey dolomite after horizontal burrows.
159.7–160.2	Micrite with 20% dolomite as layers and after burrows.
160.2–162.0	Micrite with 5% dolomite, mostly as thin layers subparallel to bedding.
162.0–164.1	Micrite with dolomite, mostly after horizontal burrows; abundant wavy stylolites in lower metre.
164.1–165.6	Micrite with calcarenaceous, bioclastic layers; a few percent black stylolitic seams.
165.6–166.1	Micrite with 10–15% dolomite after horizontal burrows.
166.1–167.0	Thinly laminated micrite; minor thin dolomite layers. Algal-laminated? Bedding dips 35° at 166.5 m.
167.0–168.0	Micrite with 10–20% dolomite after horizontal burrows and as irregular layers (stringers). Stylolites minor.
168.0–168.8	Pale to medium grey micrite, with minor spar-filled cracks and laminoid fenestrae and minor, spaced (50–100 mm) thin dolomitic and stylolitic layers.
168.8–171.9	Medium grey micrite with spaced, thin dolomitic and stylolitic layers; minor burrows. <b>Sample M57:</b> 167.0–171.9 m.
171.9–172.7	Laminated micrite with stromatolitic doming in upper half of unit.

<i>Depth (m)</i>	<i>Description</i>
172.7–173.8	Micrite with 5–10% dolomitised horizontal burrows; burrow-mottled micrite; fossil fragments.
173.8–174.3	Dark grey micrite with a black shale bed. Lithofacies 7. <b>Sample M56:</b> 171.9–174.3 m.
174.3–175.0	Micrite with large (10 mm) fenestrae with internal dolosiltite sediment, and smaller spar-filled tubes and pores.
175.0–178.0	Micrite with 10–20% dolomitised horizontal burrows and stringers; stylolites as black thin selvages; some diffuse shelly fossil-fragment bands. <b>Sample M55:</b> 174.3–178.0 m.
178.0–180.0	Pale to medium grey micrite with 5% dolomitic and stylolitic material as thin, spaced planar layers. Bedding dips 35° at 179.1 m.
180.0–181.0	Micrite with 10% dolomitised horizontal burrows.
181.0–182.0	Micrite with 5% dolomite as irregular stringers and, possibly, burrows.
182.0–182.5	Micrite with a few percent thin planar solution seams. <b>Sample M54:</b> 178.0–182.5 m.
182.5–185.1	Micrite with 2–5% irregular dolomitic seams.
185.1–185.3	Dark, oncolitic micrite.
185.3–197	Pale to medium grey-brown micrite with 2–5% dolomite as thin, darker, planar seams spaced at 5–20 mm. <b>Sample M53:</b> 182.5–190.0 m; <b>M52:</b> 190.0–197.0 m.
197–198.6	Medium grey-brown micrite with 10% dolomite stringers and minor burrows. Bedding dips 30° at 198 m.
198.6	Probable parasequence boundary.
198.6–199.4	Dark grey, thinly laminated micrite with abundant fenestrae.
199.4–200.3	Dark grey micrite with ill-defined darker muddy (?) layers, 50%. Upper part with spar-filled cracks. <b>Sample M51:</b> 197.0–200.3 m.
200.3	Parasequence boundary.
200.3–208.1	Pale grey micrite; no dolomite; <1% solution seams; scattered, large fenestrae (spar-filled burrows; calcitised enlarged fossil molds, etc.); birdseye fabric 206.4–206.8 m. <b>Sample M50:</b> 200.3–208.1 m.
208.1–208.4	Dark grey micrite with 20% black shaly bituminous layers — lithofacies 7.
208.4	Parasequence boundary.
208.4–209.7	Pale, laminated micrite; minor solution seams; top 200 mm is birdseye limestone.
209.7–210.2	Pale micrite with a few percent stylolitic seams. <b>Sample M49:</b> 208.1–210.2 m.
210.2–213.6	Dark brown to black calcisiltite or micrite, 10% black dolomitic or shaly layers; considerable bioturbation. Lithofacies 7. <b>Sample M48:</b> 210.2–213.6 m.
213.6	Parasequence boundary
213.6–213.9	Pale grey micrite with fenestrae.
213.9–214.6	Micrite with dolomitised horizontal burrows.
214.6	Parasequence boundary.
214.6–218	Pale grey micrite with spar-filled vertical burrows; some faint haloes; a few percent stylolitic seams. <b>Sample M47:</b> 213.6–218 m.
218–219.1	Dark brown to black limestone with abundant thin, intersecting calcite veins; core broken, oxidised at 218 m: a fault?
219.1–221.7	Dark brown to black limestone, 10% darker, bituminous layers; bioturbation; lithofacies 7. <b>Sample M46:</b> 218.0–221.9 m.

<i>Depth (m)</i>	<i>Description</i>
221.7–222.2	Micrite with dolomitised horizontal burrows.
222.2	Parasequence boundary.
222.2–224.2	Pale micrite; 5% wavy to planar bedding-parallel stylolitic layers; spar-filled vertical burrows.
224.2–225	Micrite with 10–15% pale brown dolomitised horizontal burrows (oxidised).
225.0–232.5	Micrite with ~15% dark dolomite, mostly as horizontal burrows. Abundant wavy stylolites. Hardgrounds. Fossils include <i>Lophospira</i> , trilobites, gastropods.
232.5–236.8	Dark grey micrite, 5% dark dolomite stringers and burrows; pervasive bioturbation; pyritised hardgrounds.
236.8	Parasequence boundary.
236.8–238.0	Pale grey micrite; upper part laminated; lower part darker, with pale masses of stromatoporoid and shelly debris. Sharp bottom contact. Bedding dips 30° at 237 m.
238.0–241.5	Medium to dark grey-brown micrite with 10% darker dolomite, mostly as horizontal burrows.
241.5	Parasequence boundary.
241.5–241.8	Pale laminated micrite with minor fine birdseye spar.
241.8–242.9	Dark grey-brown, laminated micrite with abundant sparry blebs; lamination ill-defined in lower part.
242.9–244.5	Dark limestone with 50% dark brown siltstone as irregular layers; middle 0.5 m has micrite nodules in siltstone. Fossils including ribbed brachiopod in basal 100 mm; sharp basal contact.
244.5–245.1	Fine-grained bioclastic calcarenite with bryozoan and other fossil fragments; 5% darker dolomitised burrows.
245.1–248.8	Medium grey-brown micrite with 10–15% irregular to wispy (shaly) stringers. Dolomitised burrows, mostly horizontal, present. ' <i>Ecculiomphalus</i> ' at 247 m.
248.8–261.0	Medium grey micrite with ~5% irregular stringers of stylolitic/dolomitic material. Minor thin dolomitised random and vertical burrows. Sharp bottom contact. Bedding dips 32° at 257.7 m.
261.0–261.35	Dark grey calcisiltite with 10% wispy black stringers.
261.35–265.9	Medium grey micrite with highly irregular, dark stylolitic seams; minor dolomitised horizontal burrows; minor small sparry blebs; rare tiny fossil fragments. Lithofacies 5.
265.9–266.9	Pale micrite with 15% dolomitised burrows (random and horizontal) and stringers.
266.9–268.5	Medium grey micrite with 5–10% dark stylolitic seams and minor bituminous shale horizons.
268.5–269.1	Biosparite, with gastropod, bivalve and trilobite fragments recognisable near top.
269.1–270.2	Micrite with 10% darker bands including a thin bituminous shale bed at 269.6 m. Fossil fragments. Sharp bottom contact — possible parasequence boundary.
270.2–270.7	Pale micrite with 5% irregular black stylolitic seams; minor tiny spar blebs, 'haloes'.
270.7–273.95	Medium grey micrite with 10–15% irregular to planar darker dolomite bands. Bored hardground at 271.8 m.
273.95	Parasequence boundary? — pyrite impregnated.
273.95–274.5	Pale micrite, 5% dolomitised burrows and stylolites; minor sparry tubes, cracks, and fenestrae. Bedding dips 27.5°.
274.5–275.0	Medium grey micrite with 10% dolomite as stringers and burrows.
275.0	Parasequence boundary: slightly irregular, bluish-grey stained hardground.
275.0–275.8	Laminated micrite passing up into pale birdseye micrite.
275.8–277.3	Alternating, predominantly pale, birdseye micrite and thinly-laminated, slightly impure micrite.
277.3–277.7	Pale micrite with 5–10% dolomitised burrows. Sharp bottom contact — possible parasequence boundary.
277.7–278.1	Interlaminated pale micrite and wispy, brown shaly laminae; abundant spar-filled vertical burrows and laminoid fenestrae.
278.1–279.3	Pale grey limestone, some of it calcarenite; a few percent stylolitic material.
279.3–283	Dark grey micrite with wispy black shaly layers. Abundant bioturbation. Horizons with fossil fragments (trilobites, molluscs). Sharp bottom contact (possible parasequence boundary).

<i>Depth (m)</i>	<i>Description</i>
283.0–286.7	Medium to pale grey micrite and calcarenite; 5% black stylolitic stringers; abundant fossil fragments — trilobites, molluscs.
286.7–288.4	Micrite with probable birdseyes, and 20% irregular beds of internally-laminated dark brown siltstone.
288.4–289.2	Micrite with large sparry blebs and 5% stylolitic-dolomitic material, passing up into dark, thinly-laminated micrite with sparry tubes and fenestrae.
289.2–290	Micrite with 10% dolomitic-stylolitic material; some dolomitised burrows. Bedding dips 30° at 290 m.
290–290.7	Medium to pale grey micrite, banded with 25% dark, irregular dolomitic layers.
290.7–292.9	Pale to medium grey micrite; 10% dark brown dolomite mostly as irregular stringers and layers, a few burrows.
292.0–292.9	Micrite with 10–15% dark brown dolomite, mostly as small (3 mm) random or horizontal burrow forms.
292.9–295.6	Medium grey micrite; 5% thick, irregular, darker dolomite layers; some shelly fossils; minor thin (40 mm) pyritic black shale layers. Basal 50 mm is black shale.
295.6	Possible parasequence boundary.
295.6–298.7	Dark, thinly laminated, shaly micrite with abundant (5%) white sparry pores, blebs and laminoid fenestrae. Non-laminated, blotchy pale micrite, 296.0–296.9 m.
296.0	Change from NQ to BQ core.
298.7–299.5	Pale grey micrite with tiny sparry pores near base.
299.5–300.5	Medium to pale grey micrite with 10% dolomitised horizontal burrows.
300.5–302.0	Breccia of micrite fragments in matrix of pyritic fine sandstone and claystone. Clasts ragged, semi-coherent in places.
302.0–303.0	Grey, fine-grained sandstone with irregular dyke-like zones richly impregnated (70%) with fine-grained pyrite.
303.0–308.0	Dark grey micrite, ~15% dark grey-brown dolomite mostly as burrows.
308.0–309.7	Dark grey micrite, ~5% dolomite as burrows and thin stylolitic stringers.
309.7–310.1	Interbedded micrite and black shale (30%). Oncolitic horizon.
310.1–311.4	Medium grey micrite, 5% dolomite stringers.
311.4–320.3	Medium to dark grey micrite, 10–30% (variable) dark dolomite as stringers and burrows, mostly horizontal; minor intrasparite horizons.
320.3–322.0	Medium grey micrite, ~5% dolomite mainly as small random burrows; molluscan fossil horizon.
322.0–322.4	Medium grey micrite with 30% dolomite, irregular forms. Intrasparite horizon.
322.4–327.0	Medium grey micrite with 10–20% (variable) dolomite as stringers and burrows. Several thin (1–5 cm) intrasparite-biosparite horizons developed on hardgrounds.
327.0–327.5	60% dark grey-brown dolosiltite; micrite. Burrowed.
327.5–329.0	Medium grey micrite with 10–15% dolomite burrows and stringers.
329.0–329.4	60% dolosiltite. Several intrasparite bands.
329.4	Possible parasequence boundary. Abrupt contact at 30° to bedding.
329.4–335.8	Medium grey micrite with 5–15% (variable) content of dolomite mostly as dark grey stringers; minor burrow forms. Minor fault breccia and slickensided surface at 332.6 m. 10 cm of biosparite at 334.1 m.
335.8–336.8	Dark grey micrite with 20% thin beds of fissile black shale. Lithofacies 7.
336.8	Probable parasequence boundary, overlain by black shale.
336.8–340.4	Medium grey micrite with variable (5–10%) dolomite mostly as dark, irregular stylolitic stringers.
340.4–341.4	Micrite with 50% dolomite as burrows, stylolitised.
341.4–342.4	Medium grey micrite with ~5% dolomite + insolubles on stylolitic seams.
342.4–343	Thinly interbedded micrite, burrowed dolosiltite, and intrasparite.
343.0–351.7	Medium grey micrite, 5–15% (variable) dolomite content mostly as thin stringers and stylolites. Intrasparite, 345.1–345.3 m, and several thinner horizons. 15 cm calcarenite with oncolites at base.

<i>Depth (m)</i>	<i>Description</i>
351.7	Possible parasequence boundary — abrupt contact.
351.7–353.5	Medium to pale grey micrite. Abundant small fenestrae.
353.5–357.0	Dark grey micrite with 20% thin beds of black shale, with diffuse boundaries. Lithofacies 7.
357.0–364.1	Medium grey calcisiltite or fine calcarenite with sparse shelly fossils; bioturbated (churned); ~20% thin beds of black shale; few percent calcite veins. <b>Sample M1:</b> 362.0–364.1 m.
364.3	Taken as (transitional) base of Benjamin Limestone and top of Cashions Creek Limestone.
364.1–364.3	Tabular stromatoporoid.
364.3–366.0	Medium grey fine calcarenite, bioturbated in places, sparse small (<10 mm) oncolites; ~5% black shale thin beds. <b>Sample M2:</b> 364.1–366.0 m.
366.0–384.4	Medium grey fine calcarenite; massive; variable (average ~5%) dark, wispy, irregularly anastomosing darker stylolitic areas, also dolomitic?; <i>Maclurites</i> at 370.1, 373.2 m; sparse oncolites to 20 mm. Other gastropods, trilobite fragments present. <b>Sample M3:</b> 366.0–376.1 m; <b>M4:</b> 376.1–384.4 m.
384.4–385.0	60% dark grey, possibly impure fine calcarenite; with two beds of pale grey calcarenite, the lower one (384.8–384.9 m) coarser, oncolitic, bioclastic. <b>Sample M5.</b>
385.0–395.2	Coarse, oncolitic, bioclastic grainstone or packstone. Average ~5% dolomitic and stylolitic impurities, mostly near top. Coarser near top: oncolites almost in closed framework. <b>Sample M6:</b> 385.0–395.2 m.
395.2–395.9	Calcarenite with 20% dark, wispy, anastomosing bodies of stylolitic material, probably mostly dolomite. <b>Sample M7.</b>
395.9–400.2	Medium grey, coarse (1 mm) calcarenite or grainstone; ~5% dolomitic and stylolitic material. Abundant (50%) oncolites to 10 mm in places. <b>Sample M8.</b>
400.2–400.6	Very fine-grained, medium to dark grey calcarenite or calcisiltite with ~10% dark, wispy dolomitic-stylolitic material. <b>Sample M9.</b>
400.6–406.6	Medium to coarse-grained (1 mm) medium to pale grey oncolitic grainstone-calcarenite. Oncolites, to 10 mm, abundant (30%) over much of core. <i>Maclurites</i> at 402.4 m. Average perhaps 5% darker dolomitic-stylolitic material, some possibly as burrow replacements. <b>Sample M10.</b>
406.6–407.5	Coarse to fine-grained pyritic sandstone, in graded beds (100 mm) and laminae, and black mudstone. Disrupted in places. Sharp top and bottom contacts. Anomalous. Core below has slickensided, irregular subvertical mudstone contact that extends down to 407.9 m, between limestone and dark mudstone/sandstone. <b>Sample M11:</b> 406.6–407.5 m.
407.5–429.4	Medium to coarse-grained (0.5–1 mm) medium to pale grey calcarenite, much of it probably grainstone; some fine-grained. Oncolites common in places. Average perhaps 5% non-limestone component, mostly dolomite patches; minor thin black seismoform stylolites. <b>Sample M12:</b> 408.0–415.1 m; <b>M13:</b> 415.1–422.1 m; <b>M14:</b> 422.1–429.4 m.
429.4–435.2	Medium grey fine-grained calcarenite, with slightly greater (5–10%) average dolomite content. Sparse oncolites. Stromatoporoids at 429.7 m. <b>Sample M15.</b>
435.2–470.2	Medium to pale grey, medium-grained calcarenite. Low (~3%) average dolomite and stylolite content; dolomite as dark brownish-grey irregular patches; stylolites black seismoform. Uncommon, small (8 mm) oncolites; common, larger (10 mm+) oncolites 457–470.2 m. <b>Sample M16:</b> 435.2–443.2 m; <b>M17:</b> 444.2–453.3 m. <b>M18:</b> 453.3–462.3 m. <b>M19:</b> 462.3–470.2 m.

<i>Depth (m)</i>	<i>Description</i>
470.2–473.5	Medium grey fine calcarenite; core has darker overall appearance due to relatively abundant thin black stylolites and dark dolomitic patches (5%); sparse oncolites. <b>Sample M20.</b>
473.5–492.6	Medium to pale grey, fine to medium-grained calcarenite; oncolites generally sparse; <i>Maclurites</i> at 480.2 m; averages about 5% dolomitic-stylolitic material; breaks in core with weathering and oxidation affecting 50–100 mm of core at 487.2 m, 489 m. Some dolomite probably after burrows. <b>Sample M21:</b> 473.5–483.5 m; <b>M22:</b> 483.5–492.6 m.
492.6–498.0	Pale grey, fine calcarenite, with variable dolomite content. 492.6–493.6 m; and 496.6–497.2 m, about 20% dolomite as wispy blebs and burrow replacements. Small (20 mm) irregular black chert nodule at 497.2 m. Rest of unit: ~5% dolomite. <b>Sample M23:</b> 492.6–493.6, 496.6–497.2 m; <b>M24:</b> 493.6–496.6; 497.2–498.0 m.
498.0–500.9	Pale grey, very fine-grained calcarenite or calcisiltite; intersecting, abundant irregular black stylolitic seams and white calcite veins impart breccoid appearance to rock. Pyritic around 499.0 m. Perhaps 5% non-limestone component. <b>Sample M25.</b>
500.9–504.7	Pale grey, very fine-grained calcarenite, possibly some micrite. 2–3% dolomite as burrows. Cluster of small oncolites in calcarenite at 503.6 m. <b>Sample M26.</b>
504.7	Top of Karmberg Limestone.
504.7–519.0	Medium to pale grey, very fine-grained calcarenite or micrite, with 10% of rock consisting of strongly anastomosing network of dark, dolomitic-stylolitic material. Irregular black chert nodules every 1–2 m of core. <b>Sample M27:</b> 504.7–507.3 m.
519.0	End of hole.