1. Economic potential of the Gordon Limestone in the lower Gordon River area.

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Abstract

Two major N-S trending occurrences of Gordon Limestone cropping out in the lower Gordon River area, may be flooded by storage waters of proposed hydro-electric power development in south-western Tasmania.

The eastern occurrence of Gordon Limestone, situated at the confluence of the Gordon and Denison Rivers, occurs as a narrow fault-bounded, NNW-SSE trending lens, 7 km in length, and although containing a poorly defined central belt of relatively high grade limestone (250-350 m in width) averaging an estimated 83% $CaCO_3$, 4% $MgCO_3$ and 8% acid insoluble fraction, bounded to the east and west by very low grade limestone, the Gordon Limestone exposed in the Gordon-Denison area is not considered to be economically significant.

The western occurrence of Gordon Limestone is a 1-3 km wide strip extending north from the Olga-Hardwood saddle, for 50 km along the Olga-Gordon-Franklin river valley. Detailed investigations in two areas 22 km apart indicate the possible existence of a 500-600 m wide belt of significantly high quality limestone occurring towards the western margin (and base(?)) of the Gordon Limestone in this area, and estimated to contain at least 88% $CaCO_3$ with 4% $MgCO_3$ and significantly low quantities of minor constituents. In the Olga River valley an estimated 465 million tonnes of this relatively high quality limestone may be suitable for quarrying, but the grade of the limestone in this belt is not, at this stage, considered to be of sufficiently high quality to be economically significant. Further investigation of the Gordon Limestone towards the western side of the Olga River valley is recommended.

INTRODUCTION

A survey of the Gordon Limestone deposits in the lower Gordon River area has been undertaken to determine their potential as possible sources of high quality limestone. The investigation stems from recommendations in a previous report (Collins, 1975) on the mineral resources and mining potential of areas which may be affected by proposed hydro-electric power development in south-west Tasmania, carried out at the request of the Hydro-electric Commission.

Of the three occurrences of Gordon Limestone in the lower Gordon River area (fig. 2), only the two eastern deposits, located

(1) at the confluence of the Gordon and Denison Rivers (designated as the *Gordon-Denison area*), and
(2) in the 50 km long valley drained by the Olga, Gordon and Franklin

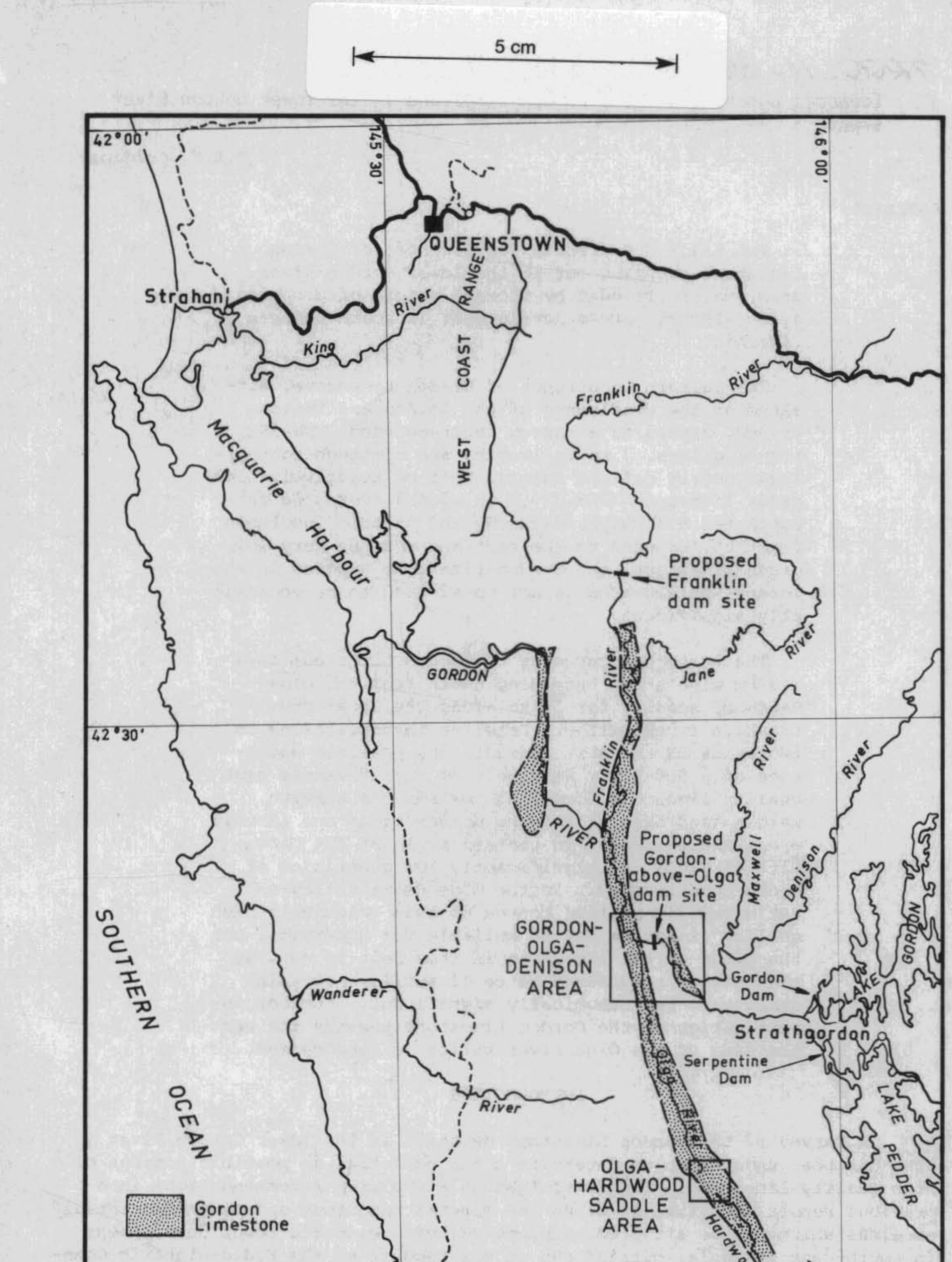

Figure 2. *Location of proposed dam sites.*

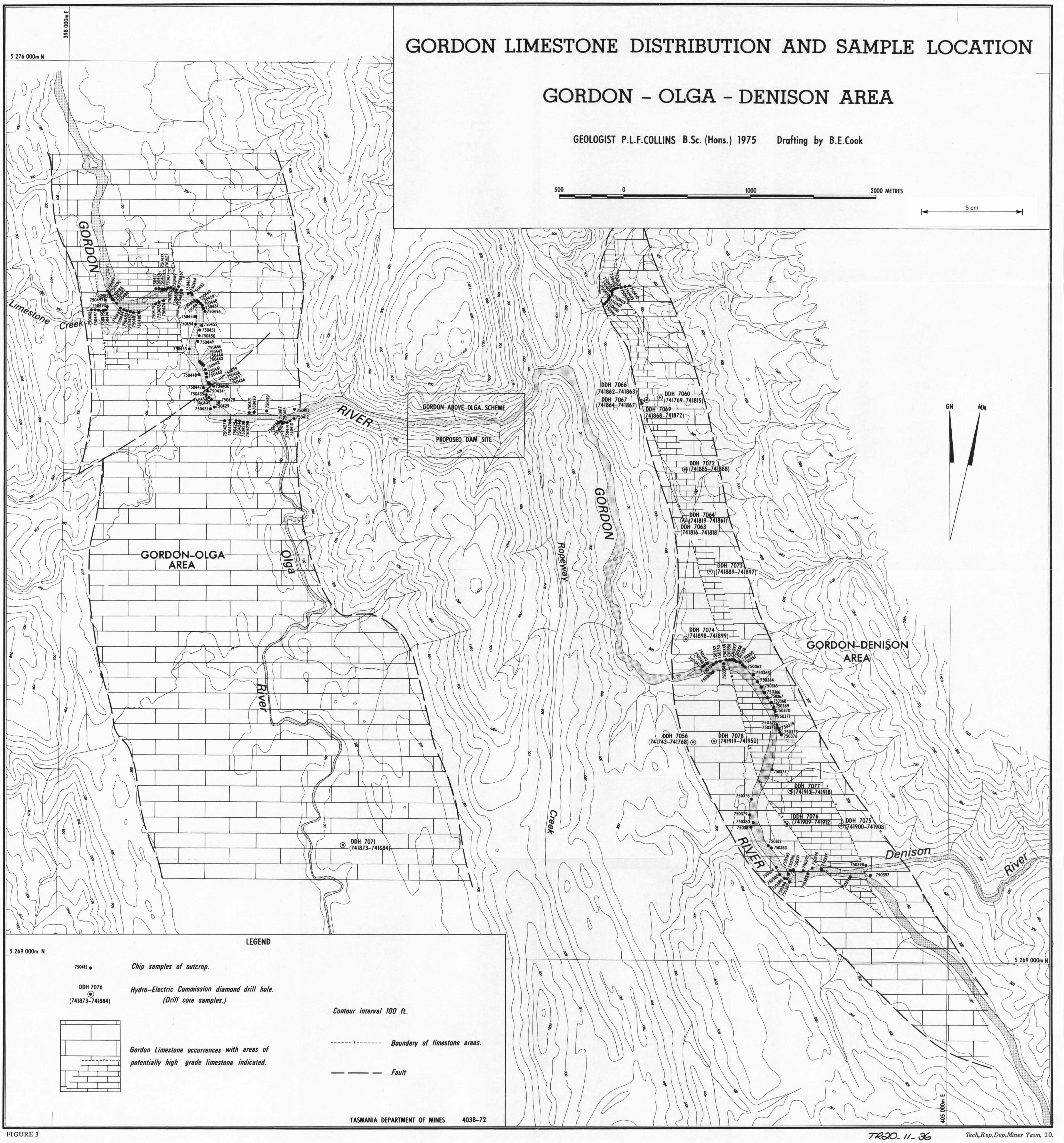

FIGURE 3

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Rivers (investigated in detail in two areas designated as the *Gordon-Olga area* and *Olga-Hardwood saddle area*),

may be flooded by the storage waters of the proposed lower Gordon power development and are dealt with in this report. An evaluation of the western deposit of Gordon Limestone along Limekiln Reach was previously undertaken by Rowe (1963).

The geology in the vicinity of the areas investigated in detail is summarised by Roberts and Andric (1974), while maps showing the regional geology of the areas affected by the proposed power schemes, and the distribution of the Gordon Limestone in relation to the proposed storage lakes are included in an earlier report by Collins (1975).

Access to the two sections of Gordon Limestone exposed in the Gordon River in the Gordon-Olga and Gordon-Denison areas was by helicopter, and within these areas by small dinghy. The assistance of the Hydro-electric Commission in providing these transport facilities is acknowledged.

REQUISITE QUALITY OF LIMESTONE

Due to the relative isolation of the lower Gordon River area, with inherent transportation problems, any economically viable limestone deposits would have to be of significantly large tonneages and of a very high quality, suitable for utilisation by the chemical and metallurgical industries.

Specifications of the chemical composition of the limestone required by these industries differ according to the use to which the limestone is to be put. However, as a guide to the quality of limestone which would be necessary for exploitation in the lower Gordon River area, the following generalised specifications will be used (compiled from Johnstone and Johnstone, 1961):

$CaCO_3$	: minimum 90%, preferably 93-96%
$MgCO_3$	: maximum 5%, usually <2%
SiO_2	: maximum 2%, usually <1%
$Fe_2O_3 + Al_2O_3$	: maximum 2%, usually <0.5%
P_2O_5	: up to 1.5%, usually <0.1%, often <0.01%
S	: maximum 0.5%
*A.I.R.**	: maximum 4-5%, preferably <3%

*Acid insoluble residue.

SAMPLING AND ANALYSIS

The following assessment of the economic potential of the Gordon Limestone is based entirely on partial analyses of 152 surface chip samples and 260 diamond drill core samples, supplemented by detailed mapping of the river sections exposed in the Gordon-Denison and Gordon-Olga areas, the results of which will be given in a later report.

All samples were analysed for CaO and MgO, and surface samples also analysed for acid insoluble residue by the Department of Mines Laboratories, Launceston, and results are listed in Appendices 1 and 2, which also include the equivalent amounts of $CaCO_3$ and $MgCO_3$ as calculated from the CaO and MgO values. The terms *equivalent* $CaCO_3$ and *equivalent* $MgCO_3$ used in the tables are abbreviated to $CaCO_3$ and $MgCO_3$ in the text.

The location of each surface sample and diamond drill hole (with appropriate samples indicated) are illustrated in Figures 3 and 4, and brief descriptions of sampling procedures are included in the appendices. Except for DDH 7066, all the drill holes samples were sunk vertically into steeply dipping strata, thereby significantly reducing the stratigraphic extent of the sampling in each drill hole. An estimate of the stratigraphic thickness of each sampled interval is therefore included in Tables 1 and 3 which summarise the relevant drilling information (compiled from Roberts and Andric 1972*a*, 1972*b*) and the analytical results for each drill hole.

X-ray diffraction analysis

Chemical analyses of the limestone indicate a number of samples contain significant amounts of MgO (*i.e.* >∿2.5% mass). Although some of this may be substituted into the calcite mineral structure, most of the MgO probably occurs in the limestone as dolomite, in the following calculated equivalent proportions.

MgO (% mass)	*equiv. $MgCO_3$ (% mass)*	*equiv. dolomite (% mass)*
1.0	2.1	4.6
2.5	5.2	11.4
5.0	10.5	23.0
10.0	20.9	45.7
20.0	41.9	91.6

To determine whether such an equivalent proportion of the MgO in each sample occurs as dolomite, qualitative and semi-quantitative mineralogical analysis of all samples was undertaken, using X-ray diffraction techniques which relate the height of the principal calcite and dolomite peaks to the proportions of these minerals in each sample (Tennant and Berger, 1957; Weber and Smith, 1961; Gavish and Friedman, 1973). All samples were scanned from 25°-33° 2θ, thereby including the principal peaks of quartz, calcite, dolomite, rhodocrosite, siderite and magnesite.

A detailed discussion of the techniques and results will be presented in a later report, but for the purposes of this investigation, the results indicate that dolomite and calcite occur in each sample approximately in similar proportions to those of equivalent dolomite and calcite as calculated from the MgO and CaO values. Quartz occurs in all samples with the peak height generally proportional to the acid insoluble residue; rhodocrosite was detected in a number of samples but its presence could not be confirmed; and siderite and magnesite were not detected.

GORDON-DENISON AREA

The Gordon Limestone crops out in the Gordon-Denison area as a narrow, fault-bounded lens, approximately 7 km long and up to one kilometre in width (fig. 3), and consists of thinly- to thickly-bedded calcareous shale, calcareous siltstone, micrite, calcisiltite and minor calcarenite and dolosiltite. The bedding strikes approximately parallel to the faulted margins and dips steeply east, but the sequence has been severely disrupted by extensive strike(?) faulting and minor folding.

Investigations in this area involved the systematic sampling of 14 diamond drill holes, drilled by the Hydro-electric Commission during investigations of the proposed Gordon-above-Olga scheme (Roberts and Andric, 1972*a*) and mapping and chip sampling of the limestone exposed in the banks of the Gordon River, and in a tributary creek towards the northern end of the area (fig. 3).

Quality of limestone

The analytical results of surface and drill core samples from this area indicate the possible occurrence of a poorly defined, 250-350 m wide, NNW-SSE trending belt of relatively high grade limestone, bounded to the east and west by very low grade limestone (fig. 3).

Analyses of the 23 surface samples from the southern part of the central belt (750356-750377, 750396) indicate considerable variation in the composition of the limestone, although the average grade is relatively high:

CaO (%)	: 25.2-52.5	(45.0-93.7% $CaCO_3$)	av. $CaCO_3$ = 82.9
MgO (%)	: 0.51-20.8	(1.1-43.5% $MgCO_3$)	av. $MgCO_3$ = 7.0
A.I.R. (%)	: 1.2-18.7		av. A.I.R.= 6.7
			96.6

Similar results were obtained for the 10 surface samples from across the northern part of this belt (750399-750408) but with a lower MgO content and higher acid insoluble residue:

CaO (%)	: 37.4-49.6	(66.8-88.5% $CaCO_3$)	av. $CaCO_3$ = 81.1
MgO (%)	: 0.57-4.2	(1.2-8.8% $MgCO_3$)	av. $MgCO_3$ = 3.7
A.I.R. (%)	: 5.5-24.4		av. A.I.R.= 10.0
			94.8

Analyses of core samples (table 1) from diamond drill holes within the central belt indicate grades of limestone similar to those of the surface samples and show a tendency to increase in quality towards the south, despite poor core recovery in the southernmost drill holes (DDH 7073, 7075-7077). The overall grade of this belt of limestone is estimated to be approximately 83% $CaCO_3$, 4% $MgCO_3$ and 8% acid insoluble residue.

The limestone to the west of the relatively high grade central belt generally contains less than 60% $CaCO_3$ and more than 20% acid insoluble residue, although occasionally interbedded with dolomitic limestone (*e.g.* 750390-750391) and high grade limestone (*e.g.* 11.5 m of 96.4% $CaCO_3$, 2.6% $MgCO_3$ in DDH 7078).

The four samples to the east of the central belt (750397-750398, 750409-750410) average only 51.4% $CaCO_3$ and 3.2% $MgCO_3$ with 34.5% acid insoluble residue.

Mining potential

Although cliffs rising to 10 m above river level occur along much of the sampled section from 750354-750376 (fig. 3), the southern part of the Gordon-Denison area generally forms a relatively flat-lying topographic low through which the Gordon River meanders. On the inside of these meanders the limestone is overlain by alluvial clay, sand and gravel, for which an indication of depth is obtained from logs of drill holes in the area as follows (compiled from Roberts and Andric, 1972*a*):

DDH	*7056*	*7078*	*7077*	*7076*	*7075*
R.L. of drill site (m)	52.4	43.6	42.7	44.5	53.3
R.L. of alluvium/limestone (m)	32.3	29.9	29.9	26.8	34.1
R.L. of Gordon River (m)	←		21-23		→

Table 1. SUMMARY OF DRILLING INFORMATION AND ANALYSES OF DRILL CORE SAMPLES FROM DIAMOND DRILL HOLES IN GORDON LIMESTONE IN THE GORDON-DENISON AREA. (Complete details of analytical results are included in Appendix 2)

DDH	Limestone intersection sampled *m*	Approximate stratigraphic thickness *m*	Samples Reg. Nos. (No. averaged)	av. CaO *% mass*	av. MgO *% mass*	Average equiv. $CaCO_3$ *% mass* (range)	Average equiv. $MgCO_3$ *% mass* (range)	Depth of overburden *m*	Core recovery *%*
7056	20.1- 64.5	15.0	741743-741755 (13)	30.0	1.8	53.4 (35.0-83.0)	3.7 (1.8- 8.8)	20.1	97
	64.5-225.5	55.0	741756-741768 (13)	36.7	2.0	65.5 (37.5-88.4)	4.2 (2.3- 9.2)		-
7060	9.6- 71.5	26.0	741769-741788 (20)	47.0	2.8	83.8 (77.5-92.3)	5.9 (2.1-11.3)	9.6	95
	71.5-225.5	65.0	741789-741808 (20)	47.4	2.5	84.6 (73.2-98.2)	5.2 (0.6-14.2)		-
	225.5-263.5	16.0	741809-741813 (5)	30.8	1.1	55.0 (41.1-62.5)	2.3 (0.6- 3.6)		-
	263.5-277.5	6.0	741814-741815 (2)	50.7	-	90.6 (83.0-98.2)	- -		-
7063	2.7- 18.2	3.5	741816-741818 (3)	51.2	1.6	91.3 (83.0-98.2)	3.5 (1.3- 5.7)	0.0	60
7064	6.0- 55.5	21.0	741819-741835 (17)	38.2	2.0	68.2 (53.5-78.5)	4.2 (1.5- 8.6)	0.0	100
	55.5- 83.8	11.8	741836-741843 (8)	48.2	1.3	86.0 (78.5-92.8)	2.7 (1.5- 6.3)		-
	83.8-114.3	13.0	741844-741851 (8)	42.8	1.6	76.3 (65.3-83.9)	3.4 (1.7- 4.8)		-
	114.3-152.4	16.0	741852-741861 (10)	49.0	1.7	87.5 (78.5-94.6)	3.6 (2.1- 6.3)		-
7066	64.8- 74.8	?	741862-741863 (2)	53.0	0.9	94.6 (94.6)	1.9 (1.1- 2.7)	?	92
7067	62.5- 76.0	5.5	741864-741867 (4)	30.5	0.9	54.5 (39.3-64.3)	1.8 (0.6- 3.1)	9.2	96

Table 1. (continued)

DDH	Limestone intersection sampled *m*	Approximate stratigraphic thickness *m*	Samples Reg. Nos. (No. averaged)	av. CaO *% mass*	av. MgO *% mass*	Average equiv. $CaCO_3$ *% mass* (range)	Average equiv. $MgCO_3$ *% mass* (range)	Depth of overburden *m*	Core recovery %
7069	35.7- 55.9	13.0	741868-741872 (5)	44.8	2.6	80.0 (66.0-87.5)	5.5 (2.1-14.6)	6.7	91
7072	38.1- 49.5	?	741885-741888 (4)	46.8	1.7	83.5 (66.0-92.8)	3.5 (2.7- 4.0)	19.5	24
7073	3.4- 30.5	?	741889-741897 (9)	53.0	1.3	94.5 (91.0-98.2)	2.7 (1.1- 4.8)	2.3	100
7074	30.2- 41.3	5.5	741898-741899 (2)	32.5	2.7	58.0 (44.6-71.4)	5.6 (2.5- 8.8)	3.0	15
7075	19.2- 33.8	7.5	741900-741904 (5)	47.0	2.3	83.9 (71.4-91.0)	4.7 (1.1-12.1)	19.2	17
	33.8- 46.2	6.0	741905-741908 (4)	53.8	1.5	96.0 (91.0-98.2)	3.2 (1.1- 7.3)		10
7076	18.7- 36.9	14.5	741909-741910 (2)	53.0	0.2	94.6 (91.0-98.2)	0.42 (0.42)	17.7	7
	36.9- 45.7	5.0	741911-741912 (2)	35.0	1.2	62.3 (60.7-64.3)	2.4 (2.1- 2.7)		12
7077	12.8- 45.7	22.0	741913-741918 (6)	50.2	2.6	89.5 (85.7-93.5)	5.4 (4.8- 7.5)	12.8	10
7078	13.7- 20.5	4.0	741919-741920 (2)	51.3	4.2	91.6 (91.0-92.1)	8.7 (7.7- 9.6)	13.7	100
	20.5- 56.8	21.0	741921-741932 (12)	42.5	7.3	75.9 (57.1-82.8)	15.3 (6.1-26.8)		100
	56.8- 91.4	20.0	741933-741942 (10)	49.6	3.7	88.5 (73.2-96.4)	7.8 (1.1-18.2)		-
	91.4-111.3	11.5	741943-741947 (5)	54.0	1.2	96.4 (94.6-99.9)	2.6 (1.5- 3.8)		-
	111.3-122.5	6.5	741948-741950 (3)	43.7	2.5	78.0 (71.4-91.0)	5.3 (2.3- 7.3)		-

A reinterpretation of parts of a resistivity survey in the vicinity of DDH 7056 and 7078 (Boniwell, 1969) indicates similar depths of overburden (*i.e.* 15-20 m) throughout the geophysical survey area. The drilling information also shows that although the country on the inside of the meanders rises to over 30 m above river level, the limestone is only 5-10 m above the river, which would prohibit quarrying of the limestone in this area.

The limestone country in the northern part of the area is more suitable for quarrying, as it rises to more than 65 m above river level, although the overburden varies considerably in thickness extending to depths of 19.5 m in DDH 7072, and the area available for quarrying is much less than the area to the south.

GORDON-OLGA AREA

Investigations in the Gordon-Olga area involved systematic sampling of one diamond drill hole (DDH 7071) and detailed mapping and chip sampling of a relatively continuous E-W section across the strike of the Gordon Limestone exposed in the Gordon River from near its confluence with the Olga River in the east to Limestone Creek in the west (fig. 3).

The Gordon Limestone cropping out in the Gordon-Olga area strikes approximately N-S, and dips (and faces) consistently east at 18°-80°, (averaging 55°-65°E). This almost complete sequence through the Gordon Limestone appears conformable with the overlying and underlying rocks, and has been subdivided into three major lithological and chemical units, tentatively described as follows:

Upper Gordon Limestone - approximately 600 m of interbedded quartzite, calcareous shale, calcareous siltstone and impure calcisiltite.

Middle Gordon Limestone - approximately 200 m of dolosiltite, dolarenite and minor calcisiltite.

Lower Gordon Limestone - approximately 650 m of micrite, calcisiltite and calcarenite with calcareous shale and impure calcisiltite towards the top and base of this unit.

A detailed description of the subdivision of the Gordon Limestone in the Gordon-Olga area will be presented in a later report, but these units are used below in evaluating the potential of the area.

Quality of limestone

Analyses of 24 samples of the upper Gordon Limestone (750411-750434), indicate considerable variation in the composition of this unit, although the MgO content tends to be consistently low:

CaO (%)	: 6.4-43.1 (11.4-76.9% $CaCO_3$)	av. $CaCO_3$ =	42.5
MgO (%)	: 0.8-7.8 (1.7-16.3% $MgCO_3$)	av. $MgCO_3$ =	5.1
A.I.R. (%)	: 16.7-80.3	av. A.I.R. =	47.0
			94.6

The position of DDH 7071 (fig. 3) probably places it towards the base of this unit, and despite higher quality limestone intersected in this drill hole (table 3), this unit is too low grade to be of economic significance.

Table 3. SUMMARY OF DRILLING INFORMATION AND CHEMICAL ANALYSES OF DRILL CORE SAMPLES FROM DIAMOND HOLES IN GORDON LIMESTONE, OLGA RIVER VALLEY. (Complete details of analytical results are included in Appendix 2).

DDH	Limestone intersection sampled *m*	Approximate stratigraphic thickness *m*	Samples Reg. Nos. (No. averaged)	av. CaO *% mass*	av. MgO *% mass*	Average equiv. $CaCO_3$ *% mass* (range)	Average equiv. $CaCO_3$ *% mass* (range)	Depth of overburden *m*	Core recovery %
6729	21.7-52.7	22.0	741691-741698 (8)	47.4	1.2	84.6 (72.3-89.6)	2.5 (1.8-5.4)	21.9	92
6730	15.4-35.9	14.5	741699-741704 (6)	50.6	2.5	90.3 (83.7-92.6)	5.1 (4.0-7.7)	15.4	100
6731	4.6-32.3	17.5	741705-741713 (9)	50.5	1.4	90.1 (84.2-93.3)	3.0 (1.3-6.5)	4.6	100
6732	5.6-33.6	18.5	741714-741722 (9)	48.7	3.2	87.0 (83.0-89.8)	6.8 (2.9-9.4)	5.6	100
6733	3.3-30.9	22.0	741723-741731 (9)	49.5	1.6	88.3 (82.1-90.8)	3.3 (1.7-5.7)	3.3	100
6735	19.7-32.0	8.5	741732-741734 (3)	47.7	1.9	85.2 (78.7-89.8)	4.0 (1.6-8.2)	approx.14.0	45
6736	6.6-31.1	16.5	741735-741742 (8)	34.6	1.6	61.8 (51.8-70.0)	3.3 (2.5-4.2)	6.6	100
7071	10.7-45.7	29.0	741873-741884 (12)	46.8	2.4	83.6 (66.0-92.8)	4.9 (1.7-8.4)	10.7	90

The dolomitic nature of the middle Gordon Limestone is reflected in the analyses of 26 samples from within this unit (750435-750453, 750456-750462), which show considerable variation in composition:

CaO (%)	: 17.5-50.9	(31.2-90.8% $CaCO_3$)	av. $CaCO_3$ = 54.9
MgO (%)	: 0.66-22.1	(1.4-46.2% $MgCO_3$)	av. $MgCO_3$ = 33.2
A.I.R. (%)	: 2.8-48.5		av. A.I.R.= 9.2
			97.3

However, if the relatively impure limestone (750438-750440) and non-dolomitic limestone (750450-750451, 750456-750458) are omitted, then the remaining 18 samples reveal a more consistent chemical unit:

CaO (%)	: 25.4-33.1	(45.3-59.1% $CaCO_3$)	av. $CaCO_3$ = 49.6
MgO (%)	: 13.8-22.1	(28.9-46.2% $MgCO_3$)	av. $MgCO_3$ = 42.2
A.I.R. (%)	: 2.8-9.3		av. A.I.R.= 5.6
			97.4

These results indicate the middle Gordon Limestone could be of suitable quality for industrial use were it not for the impure and non-dolomitic beds within this unit, which significantly downgrade the quality of the dolomite.

The lower Gordon Limestone is generally a very pure limestone although the analytical results of 38 samples from within this unit (750454-750455, 750463-750498) indicate considerable variation in the overall composition:

CaO (%)	: 13.0-53.7	(23.2-95.9% $CaCO_3$)	av. $CaCO_3$ = 82.9
MgO (%)	: 0.60-9.9	(1.2-20.7% $MgCO_3$)	av. $MgCO_3$ = 3.8
A.I.R. (%)	: 0.48-69.9		av. A.I.R.= 11.1
			97.8

If the analyses of the eight impure samples from the top and base of the unit (750454-750455, 750465-750466, 750468, 750496-750498), and the one dolomitic sample (750487) are excluded from the above values, then a more consistently pure limestone is indicated from the remaining 29 samples:

CaO (%)	: 43.8-53.7	(78.2-95.9% $CaCO_3$)	av. $CaCO_3$ = 90.5
MgO (%)	: 0.60-4.1	(1.2-8.6% $MgCO_3$)	av. $MgCO_3$ = 3.5
A.I.R. (%)	: 0.48-11.8		av. A.I.R.= 4.5
			98.5

These results indicate the possible occurrence of a 575 m wide section (450 m stratigraphic thickness) of relatively high quality limestone over the sampled interval 750469-750495 (fig. 3).

To obtain a more accurate assessment of the quality of this potentially high grade section within the lower Gordon Limestone, more complete analyses of three composite samples, made up of equal proportions of original samples, was undertaken (table 2). Each of the composite samples represent continuous chip sampling over continuously exposed cliff sections of the limestone, although there is a gap of approximately 120 m in the sampled interval, between 750479 and 750480, over which there was no outcrop (*i.e.* between composite samples 750720 and 750721).

Table 2. ANALYSES OF COMPOSITE SAMPLES FROM LOWER GORDON LIMESTONE, GORDON-OLGA AREA.

Composite sample	*750720*	*750721*	*750722*
Original samples	750469-479 (11)	750480-486 (7)	750488-495 (8)
Approx. stratigraphic thickness (m)	150	150	75
	%	%	%
CaO	49.9	47.7	49.4
MgO	2.8	2.3	1.4
SiO_2	1.5	5.0	3.0
Al_2O_3	<0.05	<0.05	<0.05
MnO	<0.05	<0.05	<0.05
Fe (Fe_2O_3)*	0.16 (0.46)	0.22 (0.63)	0.26 (0.74)
P	<0.01	<0.01	<0.01
S	0.08	0.09	0.12
L.O.I.	42.9	41.5	42.3
Total	97.4	96.9	96.5
equiv. $CaCO_3$†	89.1	85.1	88.2
equiv. $MgCO_3$†	5.9	4.8	2.9
A.I.R.	2.6	6.8	5.2
Total	97.6	96.7	96.3

*Calculated from Fe.
†Calculated from CaO and MgO respectively.

The analytical results of the composite samples indicate a significantly high grade limestone, particularly in relation to the minor constituents (Al_2O_3, Fe_2O_3, P_2O_5 and S), which conform with the general specifications for high quality limestone. The $CaCO_3$ content however is relatively low for high quality limestone (especially in 750721) and the $MgCO_3$ and SiO_2 contents are relatively high in 750720-750721, and 750721-750722 respectively.

Mining potential

The Gordon Limestone in the Gordon-Olga area forms a well defined, relatively flat-lying topographic depression with most of the area less than 20 m above river level, and bounded to the east and west by steep sided ranges rising to over 350 m above the valley floor (fig. 3). Much of the area is covered by recent alluvial deposits, 10.7 m thick in DDH 7071, which add to the unsuitability of the area for open-cut mining or quarrying.

OLGA-HARDWOOD SADDLE AREA

The Olga-Hardwood saddle area is situated on the water catchment divide between the Olga and Hardwood Rivers, towards the southern end of the 1-3 km wide N-S trending strip of Gordon Limestone extending 50 km north along the Olga-Gordon-Franklin river valley, and south towards the Davey River (fig. 2). Investigation of this area was restricted to systematic sampling of a series of short, vertical diamond drill holes, drilled across the divide by the Hydro-electric Commission during investigation of the proposed Butler Island scheme (Roberts and Andric, 1972*b*). The location of each drill hole is shown in Figure 4, and a summary of the drilling information and analytical results is given in Table 3.

The Gordon Limestone intersected in the drill holes dips 45°-55°E(?)

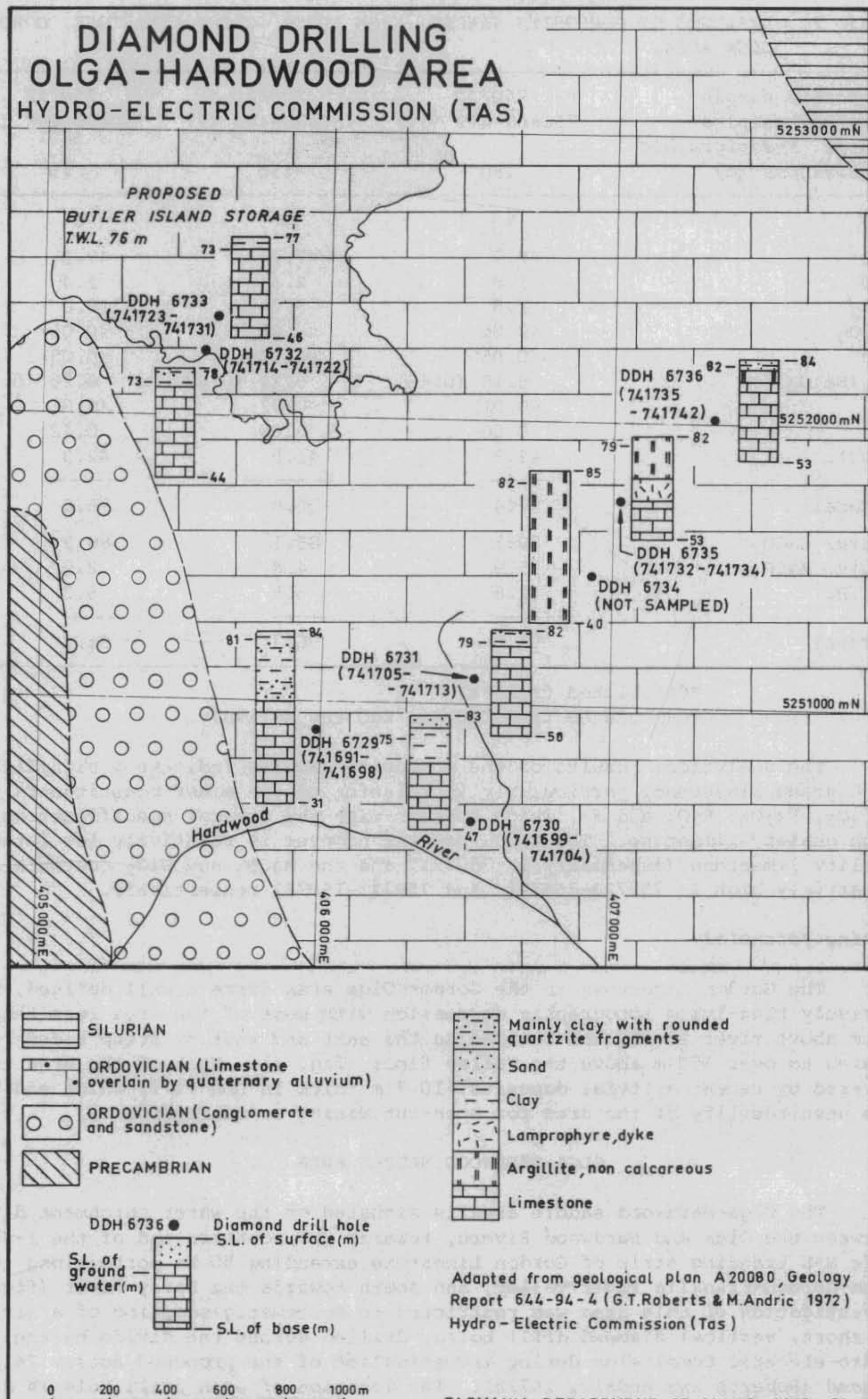

DIAMOND DRILLING
OLGA-HARDWOOD AREA
HYDRO-ELECTRIC COMMISSION (TAS)
5253000 mN
PROPOSED
BUTLER ISLAND STORAGE
T.W.L. 76 m
DDH 6733
(741723-741731)
DDH 6732
(741714-741722)
DDH 6736
(741735 - 741742)
5252000 mN
DDH 6735
(741732-741734)
DDH 6734
(NOT SAMPLED)
DDH 6731
(741705- - 741713)
5251000 mN
DDH 6729
(741691- 741698)
DDH 6730
(741699- 741704)
Hardwood
River
405 000 mE
406 000 mE
407 000 mE
SILURIAN
ORDOVICIAN (Limestone overlain by quaternary alluvium)
ORDOVICIAN (Conglomerate and sandstone)
PRECAMBRIAN
Mainly clay with rounded quartzite fragments
Sand
Clay
Lamprophyre, dyke
Argillite, non calcareous
Limestone
DDH 6736 Diamond drill hole
S.L. of surface (m)
S.L. of ground water (m)
S.L. of base (m)
Adapted from geological plan A 20080, Geology Report 644-94-4 (G.T.Roberts & M.Andric 1972) Hydro-Electric Commission (Tas)
0 200 400 600 800 1000 m
TASMANIA DEPARTMENT OF MINES 4039-79

Figure 4.

and is blanketed by up to 22 m of clay, sand and gravel. The stratigraphic thickness of the Gordon Limestone in this area is estimated at 1500-2000 m, compared with approximately 1500 m in the Gordon-Olga area.

Quality of limestone

Analyses of drill core samples from DDH 6729-6731 indicate the possible occurrence of high grade limestone, averaging 88.3% $CaCO_3$, towards the west (and base(?)) of the Gordon Limestone in this area. Analyses of samples from DDH 6732 and 6733, averaging 87.7% $CaCO_3$ indicate that this relatively high grade limestone probably occurs over a strike length of at least 2.5 km (fig. 4).

To the east, the quality of limestone intersected in DDH 6734-6736 decreases significantly, although 8.5 m of limestone containing 85% $CaCO_3$ was intersected in DDH 6735.

Mining potential

The Olga-Hardwood saddle area forms a very flat lying topographic depression, slightly steeper in the Hardwood River valley, with a blanketing cover of alluvium (up to 22 m deep) overlying the Gordon Limestone. The saddle is approximately 65 m above the level of the Gordon River at its confluence with the Olga River, 22 km to the north, so that even if 25 m of overburden had to be removed, this would still leave 40 m of limestone above river level. The area may therefore be suitable for quarrying although the removal of a considerable thickness of overburden would be necessary.

SUMMARY AND DISCUSSION

Two major N-S trending occurrences of Gordon Limestone cropping out in the lower Gordon River area, may be flooded by storage waters of the proposed lower Gordon hydro-electric power development.

The eastern deposit, situated at the confluence of the Gordon and Denison Rivers, occurs as a narrow, fault bounded, NNW-SSE trending, 7 km long lens, containing a poorly-defined, 250-350 m wide, central belt of relatively high grade limestone, with an estimated average composition of 83% $CaCO_3$, 4% $MgCO_3$ and 8% acid insoluble residue, bounded to the east and west by very low grade limestone. Although containing narrow sections in excess of 90% $CaCO_3$, the overall quality of the limestone in this central belt is insufficient for chemical or metallurgical use. In addition, most of the area is unsuitable for quarrying, as the Gordon Limestone forms a relatively flat lying topographic depression in which much of the limestone is only a few metres above river level and is blanketed by up to 20 m of alluvium.

The western occurrence of Gordon Limestone is a 1-3 km wide strip extending north from the Olga-Hardwood saddle, for 50 km along the Olga-Gordon-Franklin river valley, and was investigated in detail in two areas (the Gordon-Olga area and the Olga-Hardwood saddle area) 22 km apart.

In the Gordon-Olga area, almost continuous sampling of a relatively complete section through the Gordon Limestone, indicated the presence of approximately 200 m of relatively high grade dolomite in the centre of the section, and approximately 575 m of significantly high grade limestone towards the western margin of the section. Although much of the dolomitic unit is almost pure dolomite, it is significantly downgraded by interbedded calcisilite and impure dolosiltite, and is not of sufficient quality for industrial use.

The relatively high grade limestone towards the west and base(?) of the Gordon Limestone in the Gordon-Olga area, conforms reasonably well with the general specifications for chemical or metallurgical grade limestone, particularly with respect to the minor constituents, but is slightly below standard for $CaCO_3$ and slightly above standard for $MgCO_3$ and SiO_2. Included within this relatively high grade section in the Gordon-Olga area are several narrower sections (10-40 m in width) containing in excess of 93% $CaCO_3$ and less than 2% $MgCO_3$ which conforms well with the required general specifications.

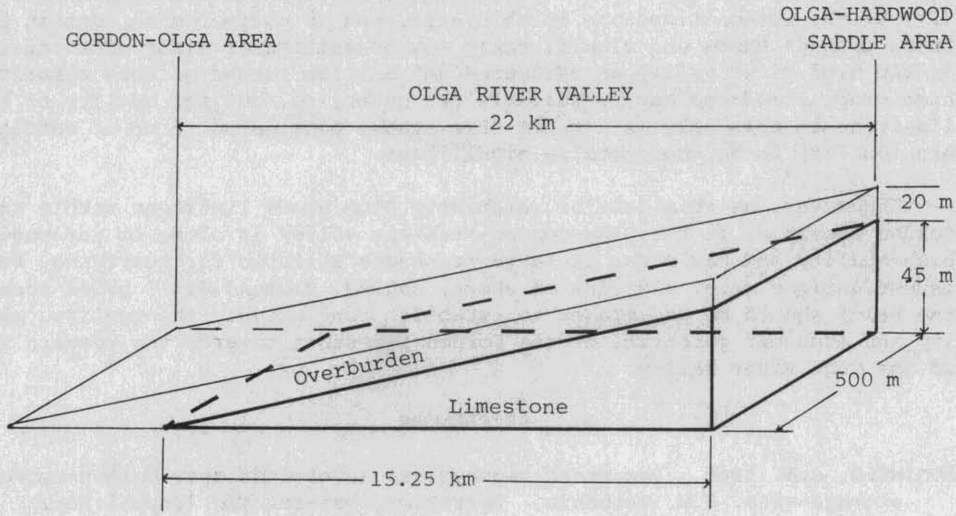
Investigations in the Olga-Hardwood saddle area indicate the possible occurrence of relatively high grade limestone towards the western margin of the Gordon Limestone in this area with similar $CaCO_3$ and $MgCO_3$ content to the relatively high grade section in the Gordon-Olga area, so that towards the west and base(?) of the Gordon Limestone in the Olga-Gordon-Franklin river valley there possibly exists a 500-600 m wide belt of relatively high grade limestone, containing an estimated 88% $CaCO_3$ and 4% $MgCO_3$.

The Gordon Limestone in the Olga-Gordon-Franklin river valley forms a flat-lying topographic depression, through which the Gordon River meanders, and is blanketed by a variably thick cover of alluvial clay, sand and gravel. In the Gordon-Olga area the limestone is generally less than 20 m above the level of the Gordon River, particularly across the relatively high grade section, and is unsuitable for quarrying. To the south, the valley floor rises gradually to a height of 65 m above the level of the Gordon River at the Olga-Hardwood saddle, with up to 22 m of alluvium blanketing the limestone, but leaving approximately 45 m of limestone above river level which could be quarried.

The Gordon Limestone north of the Gordon-Olga area was not examined during this investigation as aerial photo-interpretation indicates that similar topographic conditions to those existing in the Gordon-Olga area, would prevail over much of its length, and thus would generally not be suitable for quarrying.

Therefore there may exist within the Olga River valley, and below the overburden, a flat-lying wedge of this relatively high grade belt of limestone, approximately 45 m thick at the Olga-Hardwood saddle and tapering to the north, which would possibly be suitable for quarrying. As a guide to the size of such a deposit it is estimated that 465 million tonnes of limestone would occur in such a wedge (fig. 5) but the overall composition of this relatively high grade belt is slightly below the quality required for utilisation by the chemical and metallurgical industries. The narrower and higher grade sections occurring within this belt, as shown by the results of sampling in the Gordon-Olga area, would probably not occur in sufficient quantity.

This investigation of the economic potential of the Gordon Limestone cropping out in the Gordon-Denison area and in the Olga-Gordon-Franklin river valley is based almost entirely upon the partial analyses of 412 surface and diamond drill core samples. Due to numerous problems incurred during sampling of the limestone (particularly surface chip sampling in the Gordon-Olga area) the analytical results, although accurate for each sample, can only be taken as an accurate indication of the composition of the limestone over the sampled interval. More comprehensive sampling by improved techniques could therefore prove the relatively high grade belt within the Gordon Limestone in the Olga River valley to be of either higher or lower quality than that estimated here. Also, the possible existence of this belt is based entirely on information from two areas 22 km apart.



Volume of wedge: 171.56×10^6 m^3
Density of limestone
(see Appendix 3): 2710 kg/m^3 (= 2.71 t/m^3)
Estimated reserves: 465×10^6 t

Figure 5. *Estimated reserves of potentially high grade limestone in the Olga River valley.*

Therefore, in evaluating the economic potential of these two major occurrences of Gordon Limestone in the lower Gordon River area, it is not only sufficient to consider the analytical results of each sample, but also necessary to take into consideration the sampling method and the extent of the sampling. In view of this, the relatively high grade belt occurring towards the western margin of the Gordon Limestone in the Olga River valley, although slightly below the quality required for utilisation by the chemical and metallurgical industries, exhibits sufficient potential to warrant further investigation.

CONCLUSIONS

The lenticular occurrence of Gordon Limestone cropping out at the confluence of the Gordon and Denison Rivers contains a poorly defined central belt of relatively high grade limestone (250-350 m in width) averaging an estimated 83% $CaCO_3$, 4% $MgCO_3$ and 8% acid insoluble residue, bounded to the east and west by very low grade limestone. The limestone in this central belt is of insufficient quality to be suitable for chemical or metallurgical use, and as most of it is topographically unsuitable for quarrying, the Gordon Limestone in the Gordon-Denison area is not considered to be economically significant.

The 1-3 km wide and 50 km long strip of Gordon Limestone in the Olga-Gordon-Franklin river valley possibly contains a 500-600 m wide belt of relatively high grade limestone, occurring towards the western margin (and base (?)) of the Gordon Limestone in this area, and is estimated to contain 88% $CaCO_3$ with 4% $MgCO_3$ and significantly low quantities of minor constituents. In the Olga River valley an estimated 465 million tonnes of this relatively high grade limestone may be suitable for quarrying, but the quality of the limestone in this belt is not, at this stage, considered to be of sufficiently high quality to be economically significant.

However, as this belt of relatively high grade limestone within the Gordon Limestone in the Olga-Gordon-Franklin valley is close to the required high quality and may occur in large tonneages suitable for quarrying, further investigations (*e.g.* a series of short, angled, diamond drill holes across the belt) should be undertaken to establish conclusively the quality, quantity and economic potential of the Gordon Limestone towards the western side of the Olga River valley.

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APPENDIX 1

Surface sampling and analyses.

Surface sampling of the Gordon Limestone cropping out in the Gordon River and its tributary creeks in the Gordon-Denison and Gordon-Olga areas was undertaken by collecting a chip sample, as representative as possible, of each outcrop or of a specific interval of each outcrop. The 152 analyses listed in Tables A-C are therefore exact for that sample only, but are an accurate indication of the composition of that part of Gordon Limestone over which the sample is representative. Those samples which were collected continuously over a cliff section or ledge are indicated in the following tables by a vertical line.

Table A. ANALYSES OF GORDON LIMESTONE EXPOSED IN THE BANKS OF THE GORDON RIVER, GORDON-DENISON AREA.

Reg. No.	Width* *m*	CaO *% mass*	MgO *% mass*	Acid insol. residue *% mass*	equiv. $CaCO_3$ *% mass*	equiv. $MgCO_3$ *% mass*
750347	2	15.2	7.3	49.2	27.1	15.3
750348	2	30.9	1.4	34.7	55.2	2.9
750349	2	11.9	4.0	56.5	21.2	8.4
750350	3	17.1	4.6	51.3	30.6	9.6
750351	2	17.1	4.7	51.8	30.6	9.8
750352	15	27.1	3.8	37.2	48.4	7.9
750353	10	46.6	2.2	9.0	83.2	4.6
750354	2	5.3	1.5	79.8	9.5	3.1
750355	2	40.6	1.3	20.3	72.5	2.7
750356	8	44.2	6.0	4.8	78.9	12.6
750357	8	51.5	1.7	2.4	91.9	3.6
750358	5	49.5	2.3	1.6	88.4	4.8
750359	5	48.0	4.3	1.2	85.7	9.0
750360	7	43.8	7.3	4.2	78.2	15.3
750361	5	52.5	1.5	1.8	93.7	3.1
750362	4	47.7	2.5	6.8	85.1	5.2
750363	3	38.3	5.5	15.0	68.4	11.5
750364	4	46.9	2.5	6.6	83.7	5.2
750365	5	25.2	20.8	7.4	45.0	43.5
750366	5	48.4	1.2	4.3	86.4	2.5
750367	10	49.7	1.3	6.8	88.7	2.7
750368	5	47.4	2.4	7.6	84.6	5.0
750369	5	47.6	2.6	10.1	85.0	5.4
750370	5	43.8	2.9	8.7	78.2	6.1
750371	3	40.8	2.0	18.7	72.8	4.2
750372	5	49.4	1.3	6.8	88.2	2.7
750373	5	50.4	1.1	5.2	90.0	2.3
750374	5	48.2	1.5	8.7	86.0	3.1
750375	5	46.1	1.5	9.5	82.3	3.1
750376	5	48.4	1.5	7.3	86.4	3.1
750377	20	49.0	3.1	4.5	87.5	6.5
750378	3	20.2	3.7	49.8	36.1	7.7
750379	4	34.0	6.1	20.4	60.7	12.8
750380	4	14.0	5.8	56.7	25.0	12.1
750381	10	24.1	18.6	17.4	43.0	38.9
750382	2	25.0	12.2	25.3	44.6	25.5
750383	5	9.9	2.2	70.5	17.7	4.6

*Approximate stratigraphic thickness within which the sample was taken.

Table A. (continued)

Reg. No.	Width* m	CaO % mass	MgO % mass	Acid insol. residue % mass	equiv. $CaCO_3$ % mass	equiv. $MgCO_3$ % mass
750384	4	25.4	2.9	43.1	45.3	6.1
750385	3	27.7	1.4	40.5	49.4	2.9
750386	5	24.9	10.6	27.2	44.5	22.2
750387	4	31.8	3.2	27.0	56.8	6.7
750388	3	27.1	6.0	25.2	48.4	12.6
750389	4	13.3	2.4	55.3	23.7	5.0
750390	20	26.0	11.6	8.4	46.4	24.3
750391	10	25.6	10.6	12.4	45.7	22.2
750392	4	17.6	3.7	49.4	31.4	7.7
750393	3	18.0	4.2	46.4	32.1	8.8
750394	4	25.1	2.4	39.0	44.8	5.0
750395	2	20.5	1.1	52.2	36.6	2.3
750396	5	51.4	0.51	3.0	91.8	1.1
750397	3	12.5	0.72	68.4	22.3	1.5
750398	8	31.2	0.62	13.5	55.7	1.3

Table B. ANALYSES OF GORDON LIMESTONE EXPOSED IN A CREEK IN THE NORTHERN PART OF THE GORDON-DENISON AREA.

Reg. No.	Width* m	CaO % mass	MgO % mass	Acid insol. residue % mass	equiv. $CaCO_3$ % mass	equiv. $MgCO_3$ % mass
750399	10	44.9	0.67	13.5	80.2	1.4
750400	10	45.4	1.4	9.5	81.0	2.9
750401	10	37.4	1.1	24.4	66.8	2.3
750402	10	44.2	2.2	8.4	78.9	4.6
750403	20	49.6	0.57	5.5	88.5	1.2
750404	15	48.2	1.2	6.3	86.0	2.5
750405	10	40.2	3.5	11.7	71.8	7.3
750406	10	49.8	0.72	6.2	88.9	1.5
750407	10	45.7	4.2	7.8	81.6	8.8
750408	10	48.7	1.9	7.1	86.9	4.0
750409	10	33.0	2.7	31.6	58.9	5.6
750410	10	38.4	2.0	24.6	68.5	4.2

Table C. ANALYSES OF CHIP SAMPLES OF GORDON LIMESTONE EXPOSED IN THE BANKS OF THE GORDON RIVER BETWEEN THE OLGA RIVER AND LIMESTONE CREEK, GORDON-OLGA AREA.

Reg. No.	Width* m	CaO % mass	MgO % mass	Acid insol. residue % mass	equiv. $CaCO_3$ % mass	equiv. $MgCO_3$ % mass
750411	10	34.0	3.2	29.6	60.7	6.7
750412	10	6.4	1.4	80.3	11.4	2.9
750413	3	14.0	1.1	67.4	25.0	2.3
750414	8	32.3	0.8	41.8	57.7	1.7
750415	10	31.5	2.3	35.2	56.2	4.8
750416	20	38.6	1.7	24.8	68.9	3.6
750417	15	16.1	1.6	60.7	28.7	3.4

*Approximate stratigraphic thickness within which the sample was taken.

Tabie C. (continued)

Reg. No.	Width* m	CaO % mass	MgO % mass	Acid insol. residue % mass	equiv. $CaCO_3$ % mass	equiv. $MgCO_3$ % mass
750418	10	30.5	1.5	37.8	54.4	3.1
750419	3	27.9	3.1	39.1	49.8	6.5
750420	10	7.8	2.2	73.8	13.9	4.6
750421	10	8.7	2.1	70.7	15.5	4.4
750422	6	12.9	1.3	68.1	23.0	2.7
750423	5	16.6	2.8	58.4	29.6	5.9
750424	10	28.3	1.2	41.3	50.5	2.5
750425	10	33.5	2.3	30.6	59.8	4.8
750426	10	43.1	1.1	17.8	76.9	2.3
750427	10	40.9	2.9	16.7	73.0	6.1
750428	5	17.8	1.6	56.4	31.8	3.4
750429	15	14.7	1.5	63.3	26.2	3.1
750340	10	24.0	3.9	41.8	42.8	8.2
750431	5	18.2	3.6	52.2	32.5	7.5
750432	5	19.6	2.0	54.7	35.0	4.2
750433	3	22.5	5.4	41.6	40.2	11.3
750434	10	32.1	7.8	23.5	57.3	16.3
750435	15	25.5	20.4	8.2	45.5	42.7
750436	5	26.9	21.9	4.6	48.0	45.8
750437	5	26.5	21.9	5.7	47.3	45.8
750438	5	17.5	14.5	34.0	31.2	30.3
750439	5	19.5	5.6	48.5	34.8	11.7
750440	5	19.4	16.6	26.5	34.6	34.7
750441	5	25.4	21.9	6.5	45.5	45.8
750442	5	26.4	21.9	6.3	47.1	45.8
750443	5	26.6	22.1	4.9	47.5	46.2
750444	5	27.5	21.7	3.3	49.1	45.4
750445	5	27.9	21.5	2.8	49.8	45.0
750446	5	27.2	21.2	4.5	48.5	44.4
750447	8	27.1	22.0	3.1	48.4	46.0
750448	5	33.1	13.8	8.6	59.1	28.9
750449	3	28.2	17.5	9.3	50.3	36.3
750450	5	50.9	2.1	3.2	90.8	4.4
750451	5	50.7	1.3	5.1	90.5	2.7
750452	5	25.8	20.4	5.8	46.0	42.7
750453	8	25.4	21.2	7.1	45.3	44.4
750454	20	42.4	2.3	15.6	75.7	4.8
750455	5	26.2	1.3	45.2	46.8	2.7
750456	8	47.2	0.66	12.0	84.2	1.4
750457	10	50.6	0.66	6.4	90.3	1.4
750458	8	42.8	8.8	3.4	76.4	18.4
150459	10	33.4	14.1	7.1	59.6	29.5
750460	5	31.7	18.3	3.3	56.6	38.3
750461	5	27.8	20.3	5.6	49.6	42.5
750462	5	28.0	20.6	4.6	50.0	43.1
750463	5	49.3	1.6	7.0	88.0	3.3
750464	5	49.5	1.9	4.4	88.4	4.0
750465	5	36.9	2.3	24.7	65.9	4.8
750466	10	26.8	1.3	43.1	47.8	2.7
750467	10	51.3	1.2	3.3	91.6	2.5
750468	5	13.0	0.8	69.9	23.2	1.7
750469	10	49.5	2.7	2.8	88.4	5.6

*Approximate stratigraphic thickness within which the sample was taken.

Table C. (continued)

Reg. No.	Width* m	CaO % mass	MgO % mass	Acid insol. residue % mass	equiv. $CaCO_3$ % mass	equiv. $MgCO_3$ % mass
750470	10	53.6	1.2	0.86	95.7	2.5
750471	10	51.1	2.0	1.7	91.2	4.2
750472	10	51.3	2.9	0.9	91.6	6.1
750473	10	50.2	4.1	0.48	89.6	8.6
750474	10	52.4	1.9	1.2	93.5	4.0
750475	10	50.4	1.6	3.3	90.0	3.3
750476	10	48.4	3.3	3.4	86.4	6.9
750477	10	49.1	2.8	3.3	87.6	5.9
750478	5	50.6	1.6	3.5	90.3	3.3
750479	10	51.3	0.97	6.2	91.6	2.0
750480	5	43.8	4.0	10.3	78.2	8.4
750481	5	47.5	1.1	11.8	84.8	2.3
750482	20	52.6	0.92	3.5	93.9	1.9
750483	20	51.1	1.4	5.5	91.2	2.9
750484	20	49.5	1.1	8.2	88.4	2.3
750485	10	53.4	0.60	2.8	95.3	1.2
750486	10	53.7	0.67	3.4	95.9	1.4
750487	15	41.3	9.9	4.6	73.7	20.7
750488	10	53.1	0.90	2.6	94.8	1.9
750489	10	51.9	0.80	3.7	92.6	1.7
750490	10	53.0	0.67	3.7	94.6	1.4
750491	10	53.3	0.67	3.5	95.1	1.4
750492	10	50.8	1.6	6.2	90.7	3.3
750493	10	49.2	0.77	9.7	87.8	1.6
750494	10	50.1	1.8	6.4	89.4	3.8
750495	10	49.3	1.6	7.6	88.0	3.3
750496	10	33.0	1.8	34.5	58.9	3.8
750497	10	35.6	1.2	29.1	63.5	2.5
750498	10	38.6	0.87	24.6	68.9	1.8

*Approximate stratigraphic thickness within which the sample was taken.

APPENDIX 2

Diamond drill core sampling and analyses.

A total of 260 drill core samples were systematically collected from 22 diamond drill holes which were sunk by the Hydro-electric Commission during investigations into the water tightness of storage lakes of the proposed Lower Gordon development. Details of the drilling is contained in reports by Roberts and Andric (1972*a*, *b*), and a complete list of analytical results are presented in Table D. The CaO values are accurate to ±1% (H.K. Wellington, pers. comm.).

Systematic sampling was carried out by taking a 0.6 m (2 ft) sample of split core at approximately 3.05 m (10 ft) intervals over the limestone intersection or, in the deeper holes (*i.e.* DDH 7056, 7060, 7064, 7078), to depths of approximately 65 m. Below this depth, the deep holes were then sampled by taking 0.75 m (2.5 ft) of split core at regular intervals of approximately 7.5 m (25 ft). In the drill holes for which there was poor core recovery (*e.g.* DDH 7072, 7074-7077), either the complete section or a representative section of the core recovered in each interval was split and sampled. These samples are indicated by * in Table D.

Table D. CHEMICAL ANALYSES OF DIAMOND DRILL CORE SAMPLES FROM THE GORDON-OLGA-DENISON AND OLGA-HARDWOOD SADDLE AREAS.

DDH	Reg. No.	Depth *m*	CaO *% mass*	MgO *% mass*	equiv. $CaCO_3$ *% mass*	equiv. $MgCO_3$ *% mass*
6729	741691	25.6-26.2	50.1	1.0	89.4	2.1
	741692	28.7-29.3	49.6	1.0	88.5	2.1
	741693	31.7-32.3	50.2	0.94	89.6	2.0
	741694	34.7-35.3	45.0	1.3	80.3	2.7
	741695	37.8-38.4	40.5	2.6	72.3	5.4
	741696	40.8-44.3*	48.8	0.87	87.1	1.8
	741697	44.3-47.3*	47.1	0.87	84.1	1.8
	741698	48.8-49.4	48.0	1.1	85.7	2.3
6730	741699	17.1-17.7	51.1	1.9	91.2	4.0
	741700	20.1-20.7	50.6	2.6	90.3	5.4
	741701	23.2-23.8	51.8	2.1	92.5	4.4
	741702	26.2-26.8	51.9	2.4	92.6	5.0
	741703	29.3-29.9	51.2	2.0	91.4	4.2
	741704	32.9-33.8	46.9	3.7	83.7	7.7
6731	741705	7.0- 7.6	47.2	3.1	84.2	6.5
	741706	10.1-10.7	50.2	1.8	89.6	3.8
	741707	12.8-13.4	51.5	0.84	91.9	1.8
	741708	15.8-15.4	51.2	0.73	91.4	1.5
	741709	19.2-19.8	50.7	0.94	90.5	2.0
	741710	22.3-22.9	51.9	0.60	92.6	1.3
	741711	25.3-26.2	51.5	0.84	91.9	1.8
	741712	28.3-28.9	52.3	1.4	93.3	2.9
	741713	31.1-31.7	48.0	2.4	85.7	5.0
6732	741714	7.3- 7.9	49.6	2.6	88.5	5.4
	741715	10.4-11.0	49.0	4.1	87.5	8.6
	741716	13.1-13.7	50.3	3.0	89.8	6.3
	741717	16.2-16.8	50.2	2.9	89.6	6.1
	741718	19.2-19.8	50.1	1.4	89.4	2.9
	741719	22.6-23.2	49.0	2.5	87.5	5.2
	741720	25.6-26.2	47.1	4.0	84.1	8.4

Table D. (continued)

DDH	Reg. No.	Depth *m*	CaO *% mass*	MgO *% mass*	equiv. $CaCO_3$ *% mass*	equiv. $MgCO_3$ *% mass*
6732	741721	28.7-29.3	46.5	4.1	83.0	8.6
	741722	31.7-32.3	46.7	4.5	83.4	9.4
6733	741723	4.3- 4.9	50.3	1.7	89.8	3.6
	741724	7.3- 7.9	50.3	1.2	89.8	2.5
	74.725	10.4-11.0	49.8	1.2	88.9	2.5
	741726	13.4-14.0	48.5	1.8	86.6	3.8
	741727	16.5-17.1	50.9	0.8	90.8	1.7
	741728	19.5-20.1	50.1	1.4	89.4	2.9
	741729	22.6-23.2	49.2	1.8	87.8	3.8
	741730	25.9-26.5	50.1	1.4	89.4	2.9
	741731	29.0-29.6	46.0	2.7	82.1	5.7
6735	741732	22.9-23.5	50.3	0.74	89.8	1.6
	741733	24.8-29.5*	48.8	1.1	87.1	2.3
	741734	29.5-32.0*	44.1	3.9	78.7	8.2
6736	741735	7.3- 7.9	38.1	1.3	68.0	2.7
	741736	10.4-11.0	29.0	2.0	51.8	4.2
	741737	13.3-14.3	33.8	1.6	60.3	3.4
	741738	16.5-17.1	30.5	2.0	54.4	4.2
	741739	19.2-19.8	39.2	1.2	70.0	2.5
	741740	21.9-22.5	35.3	1.9	63.0	4.0
	741741	25.3-26.5	38.6	1.3	68.9	2.7
	741742	29.3-29.9	32.3	1.4	57.6	2.9
7056	741743	23.5-24.1	24.8	4.2	44.3	8.8
	741744	26.8-27.4	21.1	2.7	37.7	5.7
	741745	30.5-31.2	19.6	2.7	35.0	5.7
	741746	34.1-34.7	34.8	1.7	62.1	3.6
	741747	37.2-37.8	22.2	1.6	39.6	3.4
	741748	40.5-41.6	18.4	1.3	32.8	2.7
	741749	43.6-44.2	21.5	1.6	38.4	3.4
	741750	46.6-47.2	33.8	1.2	60.3	2.5
	741751	49.7-50.3	31.3	1.1	55.9	2.3
	741752	52.4-53.0	39.2	0.84	70.0	1.8
	741753	55.5-56.1	37.9	0.9	67.7	1.9
	741754	58.8-59.4	46.5	0.9	83.0	1.9
	741755	62.2-62.8	38.1	2.5	68.0	5.2
	741756	78.4-79.2	21.0	1.6	37.5	3.4
	741757	88.4-89.2	31.5	1.3	56.2	2.7
	741758	95.9-96.6	38.7	1.2	69.1	2.5
	741759	106.9-107.8	42.5	2.7	75.8	5.6
	741760	115.9-116.7	36.1	1.3	64.4	2.7
	741761	123.9-124.8	40.3	1.3	71.9	2.7
	741762	134.6-135.4	39.8	1.3	71.0	2.7
	741763	143.0-143.8	44.7	4.4	79.8	9.2
	741764	151.3-152.1	39.8	2.6	71.0	5.4
	741765	175.1-175.8	34.1	2.7	60.9	5.6
	741766	182.6-183.5	34.8	1.4	62.1	2.9
	741767	199.5-200.4	23.8	3.6	42.5	7.5
	741768	224.0-224.9	49.5	1.1	88.4	2.3
7060	741769	9.6-12.8*	50.9	1.3	90.8	2.7
	741770	13.7-14.3	51.7	1.1	92.3	2.3
	741771	15.1-19.5*	49.0	2.3	87.5	4.8
	741772	20.7-21.3	46.0	1.9	82.1	4.0

Table D. (continued)

DDH	Reg. No.	Depth m	CaO % mass	MgO % mass	equiv. $CaCO_3$ % mass	equiv. $MgCO_3$ % mass
7060	741773	23.8-24.4	44.0	5.4	78.5	11.3
	741774	26.8-27.4	46.6	2.3	83.2	4.8
	741775	29.9-30.5	44.0	2.3	78.5	4.8
	741776	32.9-33.5	46.0	1.0	82.1	2.1
	741777	36.1-36.7	47.0	3.2	84.2	6.7
	741778	39.2-39.8	43.4	4.2	77.5	8.8
	741779	42.2-42.8	47.2	1.3	84.2	2.7
	741780	45.3-45.9	48.0	4.4	85.7	9.2
	741781	48.3-48.9	45.0	2.8	80.3	5.9
	741782	51.4-52.0	46.0	3.5	82.1	7.3
	741783	54.4-55.0	47.2	4.0	84.2	8.4
	741784	57.5-58.1	50.0	1.9	89.2	4.0
	741785	60.5-61.1	50.0	2.5	89.2	5.2
	741786	63.6-64.2	47.0	3.3	83.9	7.3
	741787	66.6-67.2	43.4	3.8	77.5	8.0
	741788	69.6-70.2	47.2	4.0	84.2	8.4
	741789	74.5-75.4	50.0	2.8	89.2	5.9
	741790	82.4-83.2	47.0	4.4	83.9	9.2
	741791	90.6-91.4	41.0	3.7	73.2	7.7
	741792	98.5-99.3	51.6	1.1	92.1	2.3
	741793	106.6-107.4	47.0	3.0	83.9	6.3
	741794	114.1-115.0	44.0	2.3	78.5	4.8
	741795	121.9-122.8	45.0	2.9	80.3	6.1
	741796	129.5-130.4	51.0	2.8	91.0	5.9
	741797	137.5-138.3	42.6	0.9	76.0	1.9
	741798	145.4-146.2	52.0	3.0	92.8	6.3
	741799	152.9-153.7	43.2	6.8	77.1	14.2
	741800	160.6-161.4	48.0	2.3	85.7	4.8
	741801	168.2-170.0	44.0	2.8	78.5	5.9
	741802	175.9-176.7	51.0	0.3	91.0	0.63
	741803	183.3-184.1	44.0	1.2	78.5	2.5
	741804	190.6-191.4	55.0	-	98.2	-
	741805	198.0-198.8	49.0	3.0	87.5	6.3
	741806	205.8-206.6	53.5	0.5	95.5	1.1
	741807	213.5-214.3	44.0	1.0	78.5	2.1
	741808	221.9-222.7	45.0	3.0	80.3	6.3
	741809	229.7-230.5	30.0	1.5	53.5	3.1
	741810	237.1-237.9	35.0	1.7	62.5	3.6
	741811	244.7-245.5	35.0	0.7	62.5	1.5
	741812	252.1-252.9	23.0	1.3	41.1	2.7
	741813	260.0-260.8	31.0	0.3	55.3	0.63
	741814	267.4-268.2	46.5	-	83.0	-
	741815	274.3-275.2	55.0	-	98.2	-
7063	741816	4.0- 4.6	52.0	0.6	92.8	1.3
	741817	7.2- 7.8	55.0	-	98.2	-
	741818	16.2-16.8	46.5	2.7	83.0	5.7
7064	741819	7.3- 7.9	42.0	3.0	75.0	6.3
	741820	10.4-11.0	40.0	3.3	71.4	6.9
	741821	13.3-13.9	30.0	4.1	53.5	8.6
	741822	16.2-16.8	40.6	2.3	72.5	4.8
	741823	19.1-19.7	40.0	3.3	71.4	6.9
	741824	21.9-22.6	46.0	1.3	82.1	2.7
	741825	25.0-25.6	40.6	3.0	72.5	6.3

Table D. (continued)

DDH	Reg. No.	Depth *m*	CaO *% mass*	MgO *% mass*	equiv. $CaCO_3$ *% mass*	equiv. $MgCO_3$ *% mass*
7064	741826	27.7-28.3	36.6	1.1	65.3	2.3
	741827	30.6-31.2	43.0	1.3	76.7	2.7
	741828	33.5-34.1	30.0	1.8	53.5	3.8
	741829	36.6-37.2	36.0	2.3	64.3	4.8
	741830	39.3-39.9	37.4	1.8	66.7	3.8
	741831	42.4-43.0	41.0	-	73.2	-
	741832	45.1-45.7	44.0	0.7	78.5	1.5
	741833	48.1-48.7	36.0	0.8	64.3	1.7
	741834	50.9-51.5	32.0	1.4	57.1	2.9
	741835	53.9-54.5	34.0	0.7	60.7	1.5
	741836	56.7-57.3	47.0	1.0	83.9	2.1
	741837	59.7-60.3	44.0	1.3	78.5	2.7
	741838	62.7-63.6	51.0	0.8	91.0	1.7
	741839	66.7-67.5	47.0	0.8	83.9	1.7
	741840	70.5-71.3	51.0	0.7	91.0	1.5
	741841	73.9-74.7	42.0	2.0	75.0	4.2
	741842	77.6-78.4	52.0	3.0	92.8	6.3
	741843	81.5-82.3	52.0	0.8	92.8	1.7
	741844	85.3-86.1	44.0	2.2	78.5	4.6
	741845	89.2-90.0	40.0	2.3	71.4	4.8
	741846	92.9-93.7	42.0	1.3	75.0	2.7
	741847	96.7-97.5	46.0	0.8	82.1	1.7
	741848	100.4-101.3	41.0	1.5	73.2	3.1
	741849	104.4-105.2	47.0	1.0	83.9	2.1
	741850	108.1-108.9	45.6	1.5	81.4	3.1
	741851	111.8-112.6	36.6	2.1	65.3	4.4
	741852	115.7-116.5	51.0	1.3	91.0	2.7
	741853	119.6-120.4	48.0	1.9	85.7	4.0
	741854	123.4-124.2	47.0	1.8	83.9	3.8
	741855	127.3-128.1	53.0	1.3	94.6	2.7
	741856	130.9-131.7	51.0	1.6	91.0	3.3
	741857	134.5-135.3	51.0	1.4	91.0	2.9
	741858	138.4-139.2	50.0	1.4	89.2	2.9
	741859	142.1-142.9	47.0	2.1	83.9	4.4
	741860	146.0-146.8	48.0	3.0	85.7	6.3
	741861	149.4-150.2	44.0	1.0	78.5	2.1
7066	741862	65.8-66.4	53.0	0.5	94.6	1.05
	741863	68.6-69.2	53.0	1.3	94.6	2.72
7067	741864	65.2-65.8	30.0	0.8	53.5	1.7
	741865	68.1-68.7	22.0	1.5	39.3	3.1
	741866	71.3-71.9	34.0	0.3	60.7	0.63
	741867	74.4-75.0	36.0	0.8	64.3	1.7
7069	741868	39.5-40.1	49.0	1.0	87.5	2.1
	741869	42.7-43.3	49.0	2.3	87.5	4.8
	741870	46.0-46.6	47.0	1.2	83.9	2.5
	741871	48.8-49.4	42.0	1.7	75.0	3.6
	741872	53.1-54.2	37.0	7.0	66.0	14.6
7071	741873	12.0-12.3*	37.0	3.0	66.0	6.3
	741874	13.5-14.1	49.0	2.7	87.5	5.7
	741875	16.6-17.2	47.0	1.3	83.9	2.7
	741876	20.9-21.6	47.0	1.7	83.9	3.6
	741877	24.1-24.7	49.0	4.0	87.5	8.4

Table D. (continued)

DDH	Reg. No.	Depth *m*	CaO *% mass*	MgO *% mass*	equiv. $CaCO_3$ *% mass*	equiv. $MgCO_3$ *% mass*
7071	741878	26.8-27.4	49.0	4.0	87.5	8.4
	741879	29.6-30.2	52.0	0.8	92.8	1.7
	741880	31.9-33.4	47.0	3.5	83.9	7.3
	741881	36.0-36.6	50.0	1.0	89.2	2.1
	741882	39.0-39.6	43.0	4.0	76.7	8.4
	741883	42.1-42.7	48.0	1.0	85.7	2.1
	741884	45.0-45.6	44.0	1.3	78.5	2.7
7072	741885	38.1-41.2*	52.0	1.9	92.8	4.0
	741886	41.2-44.2*	51.0	1.3	91.0	2.7
	741887	44.2-46.8*	47.2	1.6	84.2	3.4
	741888	46.8-49.5*	37.0	1.8	66.0	3.8
7073	741889	4.6- 5.2	51.6	1.9	92.1	4.0
	741890	7.6- 8.2	52.0	1.8	92.8	3.8
	741891	10.4-11.0	54.0	0.5	96.4	1.1
	741892	13.1-13.7	54.0	1.6	96.4	3.1
	741893	16.5-17.1	51.0	2.3	91.0	4.8
	741894	19.5-20.1	54.0	0.8	96.4	1.7
	741895	22.6-23.2	55.0	0.8	98.2	1.7
	741896	25.6-26.2	54.0	0.5	96.4	1.1
	741897	28.7-29.3	51.0	1.3	96.0	2.7
7074	741898	30.2-35.3*	25.0	4.2	44.6	8.8
	741899	35.3-41.3*	40.0	1.2	71.4	2.5
7075	741900	19.4-22.3*	51.0	0.5	91.0	1.1
	741901	22.3-25.3*	46.0	2.0	82.1	4.2
	741902	25.3-28.3*	47.0	5.8	83.9	12.1
	741903	28.3-31.4*	51.0	2.5	91.0	5.2
	741904	31.4-33.8*	40.0	0.5	71.4	1.1
	741905	33.8-36.9*	54.0	0.7	96.4	1.5
	741906	36.9-40.0*	55.0	0.5	98.2	1.1
	741907	40.0-43.1*	55.0	1.3	98.2	2.7
	741908	43.1-46.2*	51.0	3.5	91.0	7.3
7076	741909	18.7-24.8*	55.0	0.2	98.2	0.4
	741910	24.8-36.9*	51.0	0.2	91.0	0.4
	741911	36.9-41.2*	34.0	1.0	60.7	2.1
	741912	41.2-45.7*	36.0	1.3	64.3	2.7
7077	741913	12.8-17.5*	52.4	1.6	93.5	3.4
	741914	17.5-23.3*	50.0	3.6	89.2	7.5
	741915	23.3-29.4*	51.0	2.3	91.0	4.8
	741916	29.4-34.9*	48.0	2.6	85.7	5.4
	741917	34.9-41.0*	48.0	2.5	85.7	5.2
	741918	41.0-45.7*	51.6	2.8	92.1	5.9
7078	741919	14.9-15.5	51.6	3.7	92.1	7.7
	741920	18.3-18.9	51.0	4.6	91.0	9.6
	741921	21.6-22.2	46.4	2.9	82.8	6.1
	741922	24.7-25.3	42.0	5.1	75.0	10.7
	741923	26.6-29.6*	45.0	4.8	80.3	10.0
	741924	30.8-31.4	32.0	12.8	57.1	26.8
	741925	34.1-34.7	46.4	5.3	82.8	11.1
	741926	37.2-37.8	46.0	4.0	82.1	8.4
	741927	40.5-41.1	48.0	5.4	85.7	11.3
	741928	43.1-43.7	37.0	10.2	66.0	21.3

Table D. (continued)

DDH	Reg. No.	Depth *m*	CaO *% mass*	MgO *% mass*	equiv. $CaCO_3$ *% mass*	equiv. $MgCO_3$ *% mass*
7078	741929	45.9-46.5	38.6	11.5	68.9	24.1
	741930	48.9-49.5	45.0	8.5	80.3	17.8
	741931	52.0-52.6	44.0	7.8	78.5	16.3
	741932	55.0-55.6	40.0	9.4	71.4	19.7
	741933	58.2-58.8	54.0	3.7	96.9	7.7
	741934	61.3-61.9	46.0	8.7	82.1	18.2
	741935	64.3-64.9	54.0	0.5	96.4	1.1
	741936	67.4-68.0	51.0	3.3	91.0	6.9
	741937	70.3-70.9	51.0	7.0	91.0	14.6
	741938	74.7-75.5	41.0	6.7	73.2	14.0
	741939	78.9-79.7	51.0	2.0	91.0	4.6
	741940	82.6-83.5	54.0	0.7	96.4	1.5
	741941	86.5-87.3	51.0	0.6	91.0	1.3
	741942	90.4-91.2	43.0	3.7	76.7	7.7
	741943	91.6-95.4	55.0	1.8	98.2	3.8
	741944	98.4-99.2	53.0	1.7	94.6	3.6
	741945	102.5-103.3	56.0	0.7	99.9	1.5
	741946	106.5-107.3	53.0	1.0	94.6	2.1
	741947	110.1-111.0	53.0	1.0	94.6	2.1
	741948	114.1-114.9	40.0	3.0	71.4	6.3
	741949	117.8-118.6	40.0	3.5	71.4	7.3
	741950	121.6-122.5	51.0	1.1	91.0	2.3

APPENDIX 3

Density determination of Gordon Limestone from the Gordon-Olga area.

G.B. Everard

Reg. No.	*Serial No.*	*Density (kg/m^3)*
750469	75-456	2710
750474	75-458	2720
750487	75-462	2700
750491	75-463	2720

Average density = 2710 kg/m^3
(2.71 t/m^3)