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REPORT ON

THE LIMESTONE QUARRIES AT IDA BAY

Introduction

The limestone used in the manufacture of calcium carbide at Electrona has been in the past obtained from two different quarries in the Lune or Ida Bay District. The first quarry was opened up near the Ida Bay caves 3½ miles to the Southwest of Lune, and the limestone was transported over a two foot wooden tramway owned by a timber milling company.

At a later date the construction of a steel tramway was begun from Ida Bay to connect with the old quarry. At a distance of 3 miles 50 chains from the jetty an outcrop of Limestone was intersected on the tramway. The construction of the line was then delayed, and a quarry was opened up on this limestone. Recently this was stated that the limestone from this new quarry was not of sufficiently good quality for the manufacture of carbide, and it was desired to extend the tramway a further distance to the old quarry.

The investigation on which this report is based was carried out to determine the relative quality of the limestone in the two quarries and so decide as to whether the extension of the tramway was justified.

Geology

The only rocks which need be discussed in this report are the limestones. These outcrop along the northern or north western flank of the Sugarloaf and the spur which connects it with the elevated country to the west thereof. The eastern boundary as so far known is in the vicinity of the New Quarry, but the beds possibly extend a short distance further to the east. From this locality they outcrop continuously to the W.S.W for a distance of 1½ miles as far as the Old Quarry.

On the northern side the limestone beds rise more or less abruptly above the button grass plain of that vicinity. The base of the beds does not appear to be exposed although a search might reveal it. The beds outcrop on the hill sides to an altitude of at least 500 feet above the plain. The summit of the beds was not sought and they may extend higher up the hills. Judging by the fallen blocks the top of the Sugerloaf must be composed of diabase. The limestone extends to the southern side of the hill where it is again found outcropping.

The limestone beds are thus of considerable thickness, amounting in places to at least 500 feet. In the new quarry the beds have a dip of 10 degrees to 20 degrees in a general easterly or south easterly direction while at the old quarry the dip is at low angles to the south west.

The limestone is generally a dense, fine grained type with an occasional vein of calcite. The dolour varies from a brownish-grey to dark blue or almost black. Some parts are coarser in grain due to recrystallisation. Another type is a spotted one due either to irregular coarse recrystallisation or the presence of fossils.

Visible impurities are almost absent although at one spot in the New Quarry a very small amount of flint or chert was observed.

Composition of the Limestone

The analysis prove the limestone to be generally of very good quality and to contain from 91.66% to 96.75% of calcium carbonate. The remaining constituents are small quantities of silica (1.08% to 5.08%), iron and alumina (0.16% to 1.16%), and magnesia (0.36% to 1.73%). A very small amount of free carbon (present as graphitic carbon in some of the beds) is not recorded in the analysis.

Effect of the Impurities

As the limestone is to be used for the manufacture of calcium carbide, the desirable qualities are that it should contain as high a percentage of calcium carbonate (in which the calcium is present) and as low a percentage of impurities as possible. This will enable the largest quantity possible of carbide to be produced from a given amount of limestone and obviate as much as possible the difficulties which arise as the result of the presence p of impurities. The most plentiful impurities are the silica and the magnesia. In the furnace some of the silica is reduced to silicon and alloys with metallic iron to form ferro-silicon. This alloy also collects any small amounts of impurities such as titanium, which may be present. The ferro-silicon settles below the carbide by virtue of its greater specific gravity and can be tapped separately. Except in so far as it may interfere with the electrical arrangements in the furnace, the ferro-silicon causes little trouble.

The remainder of the silicon enters the carbide in various forms. A portion may be present as silica, another as silicate of magnesium and, or, calcium, and and/or aluminium, while a third portion may exist as carborundum. However, it may be present. This part acts as a dilutent of the carbide and tends to reduce the latter below standard requirements.

Magnesium or magnesia, in which form it enters the furnace is a very undesirable impurity. It enters into the carbide in the form of silicate, oxide, and probably as magnesium carbide. These act as dilutents similarly to the compounds of silicon and also tend to reduce the carbide below standard requirements. Further the magnesium compounds effect the viscosity of the molten carbide and causes trouble in the tapping of the carbide as it will not run freely.

The oxide of iron is partly or wholly reduced to metal and enters along with the iron in the coke into the formation of the ferro-silicon. The alumina enters the carbide possibly as alumina and also silicate besides acting as a dilutent, it is stated that the alumina content has an undesired effect on the action of water on the carbide.

Present Quarry

This quarry is situated on the north western part of lease 8828/M charted in the name of the Minister for Lands and Works. It is situated about 2¼ miles S.W. from the settlement of Lune.

The only means of access and transportation are by a two foot gauge steel tramway connected with a jetty on Ida Bay, the tramway being 3 miles 50 chains in length.

The limestone has been more or less opened up for a length of 1,000 feet at the end of the tramway. The beds have a dip of 10 to 20 degrees. The quarry faces extend around the hill in a general direction from North east to South west, and the limestone beds in the faces slope gently to the east. The beds also dip into the hill which extends above the quarry.

The limestone beds are of considerable thickness at this locality. About 200 feet below this quarry another quarry is being worked for the Electrolytic Zinc Company. The beds are also found up the hill above the quarry for 200 feet at least.

Two main faces have been opened up in the quarry, one being at the western end between pegs 1 and 4. The beds in the western face represent the lowest beds exposed in the quarry and those in the eastern face represent the uppermost beds exposed. The entire thickness of beds between these has not been quarried the middle beds being represented between pegs 4 and 7.

Samples 1 to 7 were taken from this quarry and analysis of these are given in the attached table. In all, these samples represent 49 feet of limestone beds, but not a continuous sequence. Samples 1 to 5 represent 33 feet of limestone in the western face, but there is probably a small thickness of beds between samples 3 to 4 not included in the above. In this face it may be said therefore that there are 33 to 38 feet of beds of which samples 1 to 5 represent 33 feet.

Samples 6 and 7 represent 16 feet of beds in the eastern face. These form the higher beds in the main part of the face and come down to floor level to the east. The beds underneath them in the high part of the face could not be samples owing to an accumulation of debris.

Considering the 7 samples, it is seen that the limestone in this quarry varies in content of calcium carbonate from 93.40% to 96.74%; of silica from 1.40% to 5.04%; of iron and alumina from 0.28% to 1.16%; and of magnesia from 0.59% to 1.73%. The average calcium carbonate content of these seven samples is 94.65%.

Samples 1 to 5 representing 33 feet out of 33 to 38 feet of beds in the western face have an average assay of

$CaCO_3$	95.17%
SiO_2	2.21%
Fe_2O_3 & Al_2O_3	0.78%
MgO	0.95%

The 16 feet representing the upper part of the western face have the following average composition:-

$Ca\ CO_3$	93.60%
$Si\ O_2$	3.88%
$Fe_2\ O_3$ & $Al_2\ O_3$	0.35%
$Mg\ O$	1.21%

Old Quarry

This quarry is situated on lease 8461/M of 100 acres charted in the name of the Minister of Lands and Works. The location of this lease is on the south side of Mystery Creek about 3½ miles to the south-west of Lune. Access to the quarry was gained by a wooden tramway of two foot gauge and 4 to 4½ miles in length connected with the jetty in Lune.

The quarry now has the appearance of one main vertical face, practically all traces of benches having been destroyed during the last period of working. The face has a general bearing from North-east to South-west. The quarry is probably 50 to 60 feet high at its highest part but sampling of this part was difficult and dangerous without ropes. The beds were sampled from top to bottom about the central part of the quarry a total thickness of 40 feet being included.

Eight samples were taken in this depth, the description and analysis of which are given in the attached tables.

The analysis show that the constituents vary as follows: $CaCO_3$ - 91.93%-96.75%; SiO_2 - 1.28% to 5.48%; Fe_2O_3 & Al_2O_3 - 0.16% to 0.76%; and MgO - 0.36% to 2.53%, the average being:-

$Ca\ CO_3$	94.91%
$Si\ O_2$	2.85%
$Fe_2\ O_3$ & $Al_2\ O_3$	0.38%
$Mg\ O$	1.07%

These above 40 feet of limestone contains two beds corresponding to samples 14 and 17 with a low content of calcium carbonate. Excluding the bed corresponding to sample 14 the average calcium content of the 37 feet would be 95.15% while excluding 14 and 17 the average would be 95.60%. f

Comparisons of the two Quarries.

a) Quality:-

The following tables gives the average composition of the limestone.

	$CaCO_3$	SiO_2	Fe_2O_3&Al_2O_3	MgO
New quarry samples Nos. 1 - 7	94.65%	2.75%	0.64%	1.03%
Western Face Nos. 1 - 5	95.17	2.21	0.78	0.95
New Quarry east face 6 and 7	93.60	3.88	0.35	1.21
Old Quarry samples Nos. 10 - 17	94.91	2.85	0.38	1.07
Old Quarry excluding No. 14	95.15	2.63	0.35	1.01
Old Quarry excluding Nos. 14 and 17	95.60	2.64	0.28	0.72
Samples 10, 11 & 12	96.42	1.63	0.16	0.61

Considering the complete series of samples from each quarry, there is little difference in quality but what difference there is, is in favour of the old quarry. The calcium carbonate contents (94.65% and 94.91%) are however lower than is desirable.

The best limestone in the new quarry is that at the western face which gives a content of 95.17% calcium carbonate and in which the silica and magnesia contents are satifactory but the iron and alumina is above the average.

If the bed corresponding to sample No. 14 in the old Quarry be rejected the remainder of the face would give a product with 95.15% calcium carbonate and satisfactory in other respects. This would be generally similar to that at the western face of the New quarry but would be lower in iron and alumina. Rejecting the beds corresponding to Nos. 14 and 17 a still better product could be obtained, the calcium carbonate being 95.60%, the iron alumina 0.28% and the magnesia 0.72%. Undoubtedly the best material could be obtained from the lower beds in the Old quarry as can be seen from the above table.

b) Economic Workings:-

In the above discussion it has been seen that the best quality limestone can be obtained by selecting various beds. In attempting to work selected beds in a quarry face or working the whole of the face, and rejecting some of the beds, the cost of the product is greatly increased. The increased cost at once imposes a limite on the extent to which selection can be carried out. Thus the lowest 15 feet 9 inches of limestone in the western half of the Old Quarry is undoubtedly the best. available in the two quarries. It is however overlain by at least 30 feet of lower grade limestone and so would be costly to extract, unless the overlying limestone can be profitably disposed of.

The exact balance to be struck between the obtaining of high grade stone and the cost of the product is one to be decided by the management.

c) Small Stone:-

A minor factor to be considered in comparing the two quarries is the amount of small stone produced. Only pieces of 6 inch size and greater are forwarded to the Carbide works, smaller pieces being rejected. The amount of smaller rejected stone appears to be much greater in proportion to the work done at the New Quarry than at the Old Quarry. Whether this is due to a difference in physical properties of the limestone or to a rather excessive use of explosives cannot be stated. If the former reason is correct, it would be a factor in favour of the Old Quarry. If the latter be the reason, the production of small pieces could be lessened by better use of explosives.

Overburden and Clay Holes

Old Quarry:-

This quarry is fairly free of both overburden and clay holes. The limestone outcrops at the surface and there is very little soil, sub-soil and farming etc. forming a useless overburden.

A few clay holes (solution channels filled with the residual clay arriving from the decomposition of the limestone) exist in the NE end of the quarry but do not attain any great dimensions.

New Quarry:-

The overburden consists of the clayey soil and sub-soil typical of limestone areas with in addition boulders of diabase, which have apparently slipped from the summit of the Sugerloaf. The depth of overburden is not great and in many places the limestone outcrops at the surface. The quantity of overburden is however somewhat greater than at the Old Quarry.

Clay holes are present in the eastern face and are of larger dimensions than those of the Old Quarry.

General Remarks:

Whichever quarry should be worked in the future, it is recommended that for a period at least the quarrying should be carried out under scientific control, and be thoroughly sampled. The sampling should be carried out systematically and all fresh faces should be sampled at short intervals of 1, 2 or 3 days, or at fixed distances. The samples could be either assayed at the quarry in a field laboratory which would have to be installed, or at the existing assay office at Electrona. This procedure would ensure that the composition of the different beds would become known so that the quarry could be worked to the greatest advantage and the best quality limestone obtained.

It would be advisable to carry out this control permanently in order to guard against variations in the beds from point to point, if such should occur. This would increase the cost of quarrying by sixpence to one shilling per ton, against which would have to be offset however, the improvement in the quality of the stone, and the maintaining of a product of uniform, and known quality. Otherwise the sampling might be carried out for a limited period to ascertain the quality of the beds, and then dispensed with, the question of the variation of the beds being left to chance.

There is an absence of bins both at the quarry and at the jetty and only one make of trucks appears to be used. Some consideration might be given to these matters in order to provide quicker loading and transportation.

Conclusions and Recommendations:-

From the above discussions it is evident that slightly better class stone is to be obtained from the Old Quarry than the New One, and that the greater amount of selection the better the stone that can be produced. The point to which the selection can be economically extended is a matter for the management to decide.

If such selection can be economically justified, the tramway should be extended to the Old Quarry in order to enable the stone to be quarried and transported to Ida Bay.

The stone in the western face of the NEW Quarry is the best in that one and is almost equal to the general average of the Old Quarry exclusive of No. 14 sample.

Until such time as the tramway is constructed and the Old Quarry can be worked this stone should be quarried. The best bed is in the upper portion between pegs 9 to 10 but the whole of the face between Pegs 9 and 10 and opposite Peg 10 should give an average of 95% $Ca\ CO_3$.

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GOVERNMENT GEOLOGIST.

Hobart.
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ANALYSIS OF LIMESTONE

Sample	Silica $SI\ O_2$	Iron and alumina Fe_2O_3 & Al_2O_3	Calcium Carbonate $Ca\ CO_3$	Magnesia MgO
	CONSTITUENTS			
Present Quarry at 3 Miles 50 Chains.				
1	2.00	0.64	94.50	1.73
2	2.48	1.16	94.70	1.00
3	1.40	0.64	95.49	0.72
4	4.20	0.84	93.70	0.89
5	1.48	0.68	96.74	0.72
6	3.00	0.40	93.40	1.70
7	5.04	0.28	93.85	0.59
Proposed Quarry				
8	5.08	0.56	91.66	1.00
9	4.60	0.32	93.25	0.59
Old Quarry				
10	1.68	0.16	96.21	0.58
11	1.28	0.16	96.75	0.36
12	2.00	0.16	96.38	1.00
13	3.40	0.52	94.30	1.73
14	5.48	0.68	91.93	1.73
15	2.40	0.16	95.32	0.44
16	3.88	0.60	94.60	0.44
17	2.60	0.76	92.80	2.53

LOCATION OF SAMPLES

Sample No.	Quarry	
1	Present	Western face opposite Peg 10 Bottom 5 feet.
2	Quarry	Western face opposite next 6' overlaying (1)
3	at	Western Face opposite peg 10 Top 8' overlaying (2)
4	3 Miles	Western face between pegs 9 & 10 6' overlaying (3)
5	50	Western face between pegs top 8' overlaying (4)
6	Chains	Eastern face between Pegs 2 and 3 Bottom 9 feet.
7		Eastern Face between next 7' overlaying (7)
8	Proposed	Clear limestone from 2 Holes.
9	Quarry	Rough 'grab' sample from 60 feet of beds.
10		7' Beds above bottom bench.
11	Old	5' Beds overlaying (10)
12	Quarry	3'9" Beds overlaying (11)
13		4'9" beds overlaying (12)
14		3' beds overlaying (13)
15		5'6" beds overlaying (14)
16		5' beds overlaying (15)
17		6' beds overlaying (16)