CANADA
DEPARTMENT OF MINES
HON. W. A. GORDON, MINISTER CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH
JOHN MCLEISH, DIRECTOR

Limestones of Canada

Their Occurrence and Characteristics

Part II
Maritime Provinces

BY

M. F. Goudge

OTTAWA
J. O. PATENAUDE
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1934

No. 742

Price, 50 cents.

CONTENTS

74471—1½

CHAPTER III

CHAPTER IV

TABLES

ILLUSTRATIONS

Photographs

Photographs—Continued

Drawings

Maps

PREFACE

This report is based on a survey of the limestone resources of Canada, made with the object of obtaining data on the physical and chemical characteristics of the deposits, methods of quarrying and preparing the stone for the market, the technology of lime manufacture, and on the uses of lime and limestone in various industries. The importance of limestone to the industrial life of the country may be gauged by the fact that in 1932 approximately 9,300,000 tons of limestone, including marble, was raised from Canadian quarries, which when fabricated into its primary products such as lime, cement, and stone for various purposes, had a selling value of $25,500,000. The peak production was reached in 1929 when nearly 13,000,000 tons was quarried.

The survey of the resources was begun in 1925 and, as the work progressed, preliminary reports[1] were issued on the resources of the various provinces and one detailed report "Canadian Limestones for Building Purposes" has also been published.

The present series deals particularly with the occurrence and chemical and physical characteristics of the limestones in the various provinces, the data obtained on the technology and uses of lime and limestone being reserved for a later report. It is being issued in five parts as follows:

Part I: Introductory.
Part II: Maritime Provinces.
Part III: Quebec.
Part IV: Ontario.
Part V: Western Canada.

It is manifestly impossible to examine all outcrops throughout a large country in which limestone is as plentiful as it is in Canada, but all active quarries, most of the inactive quarries, and many of the prominent outcrops within 3 miles of rail or water transportation were examined and sampled. Nearly all samples obtained were channel samples, or the equivalent, taken across the strata at right angles to the strike. Where a difference in character, either chemical or physical, was observed, a separate sample of each type of stone was taken. The samples, in some instances weighing as much as 25 pounds each, were crushed to a fineness of $\frac{1}{8}$ inch or less and then cut down to about 2 pounds in weight by means of a Jones sampler. The 2-pound sample was pulverized to approximately 100 mesh and from this an 8-ounce sample was obtained and sent to the chemical

[1] Mines Branch, Department of Mines, Ottawa.
Rept. No. 682: Limestones of Quebec and Ontario, Prelim. Rept.
Rept. No. 687: Invest. Min. Res. and the Min. Ind. 1926, pp. 35-52, Maritime Provinces, Gaspe, and Timiskaming.
Rept. No. 710: Invest. Min. Res. and the Min. Ind. 1928, pp. 1-18, Western Ontario and Prairie Provinces.
Rept. No. 719: Invest. Min. Res. and the Min. Ind. 1929, pp. 43-64, British Columbia.
Mem. Series, Rept. No. 50; Raw Materials for the Manufacture of Rock Wool in the Niagara Peninsula of Ontario.

laboratory for analysis. Any interbeds of shale present in the deposit were not included in the samples, for in any method of quarrying involving hand-sorting, such as is general practice in quarrying stone for lime manufacture, the shale could be largely eliminated. Thus the chemical analyses of the samples obtained from some deposits indicate a purer stone than could be obtained by non-selective methods of quarrying, as for example, where steam-shovel loading is employed. It is to be borne in mind that the analysis of a single sample from a deposit is merely indicative of the character of the deposit and much more detailed sampling and investigation than is practicable in a general survey of the resources is necessary to definitely prove the character of any deposit.

All chemical analyses of the samples, unless otherwise noted, were made by C. L. O'Brian of the Chemical Division and to him the writer's thanks are extended for co-operation in all matters pertaining to the chemical examination of limestones.

Previous reports on Canadian limestones include "The Limestones of Ontario" by the late Dr. W. G. Miller of the Ontario Department of Mines, and preliminary reports on the limestones of Ontario and Quebec by Howells Fréchette, published in the Mines Branch Summary Reports for 1915, 1916, and 1918. There are also many references to limestone deposits in the publications of the Geological Survey of Canada, and of the Departments of Mines of the various provinces. These reports and references were of great assistance, particularly in the field work in connection with the present report, and indebtedness to the various authors is acknowledged.

The writer wishes to thank the owners and operators of the various limestone properties examined for many courtesies and for willing co-operation in supplying information regarding their properties and plants.

Limestones of Canada

Their Occurrence and Characteristics

PART II

MARITIME PROVINCES

CHAPTER I

INTRODUCTORY

DEFINITION AND CLASSIFICATION OF LIMESTONES

Limestones are rocks of sedimentary origin consisting mainly of calcium carbonate (calcite) or of the double carbonate of calcium and magnesium (dolomite). Based on their content of these constituents limestones may be divided into three classes:—

1. *Calcium limestones,* or those in which calcium carbonate greatly predominates and which contain less than 10 per cent magnesium carbonate.

2. *Dolomites,* or those composed almost wholly of the mineral dolomite and which contain between 40 and 45·65 per cent magnesium carbonate.

3. *Magnesian limestones,* or those intermediate in composition between the other two classes.

The term *high-calcium limestone* as used in this report is reserved to denote a calcium limestone containing not more than 3 per cent total impurities and not more than 2 per cent magnesium carbonate.

The distinction between the classes is purely arbitrary. The classification was adopted after a study of the chemical analyses of 1,500 samples of limestone collected from all parts of Canada, which showed that the greater proportion of limestones comes within the first two classes, and that, despite the wide range in composition allotted to the magnesian limestones, i.e. those containing from 10 to 40 per cent magnesium carbonate, this class is relatively small, particularly when only the purer limestones are considered. By " pure " limestone is meant one with less than 5 per cent total impurities. Among the impure limestones the magnesian variety is somewhat more common but even here this variety is far in the minority. The presence of mechanically intermixed impurities, such as sand grains and argillaceous matter, often masks the true character of a dolomite and if the above classification were applied to all limestones a very impure dolomite would be grouped with the magnesian limestones even though the ratio between the calcium and magnesium components in the rock was that of a true dolomite. A scientific classification applicable to all varieties of limestone would be one based on the ratio between the calcium and mag-

nesium components present and this would be particularly applicable to limestones containing a high percentage of impurities. Such a classification based on the amounts of calcium oxide and magnesium oxide determined by analysis would be as follows:—

1. *Calcium limestones,* those in which the ratio of CaO to MgO is greater than 10·5 : 1.

2. *Magnesian limestones,* those in which the ratio of CaO to MgO is less than 10·5 : 1 and greater than 1·76 : 1.

3. *Dolomites,* those in which the ratio of CaO to MgO is less than 1·76 : 1 and greater than 1·39 : 1.

The ratios between calcium oxide and magnesium oxide are shown in the last column of each table of analyses in this report.

For commercial purposes, however, for which pure limestones are generally required a classification such as the first one, which is based on the actual percentages of the carbonates of calcium and magnesium present, is more convenient and useful.

A few highly metamorphosed limestones are known that contain more than 45·65 per cent of magnesium carbonate, due to replacement by magnesite (magnesium carbonate). Where the replacement is only partial such rocks are referred to as *magnesian dolomites* or *magnesitic dolomites.* Where the replacement is complete or nearly so the rock is termed *magnesite.*

All limestone deposits contain some sandy or clayey material, and the deposits may grade almost imperceptibly into a shale, sandstone, or other type of rock. The usual dividing line, arbitrarily made, between a limestone and another type of rock is that if the rock contains a total of 50 per cent or more of the combined carbonates of calcium and magnesium, it is termed a limestone, if it contains less, it is otherwise classified.

ORIGIN OF LIMESTONE

Virtually all limestones have been formed under water by the action of organic or chemical agencies, or a combination of the two, on dissolved calcareous matter, and have been deposited in layers or beds usually separated by a layer of shaly material. Each bed represents a period of uninterrupted deposition and each interbed of shale indicates a break in the process, or a change in conditions. The deposit may consist entirely of thick beds, or of thin beds; thick and thin beds may alternate; or the beds may become progressively thicker from the base to the top of the deposit or vice versa. Again, where limestones have been deposited over a large area, the same bed may be thick in one place and thin in another. Every bed is lenticular, attaining its maximum thickness where conditions were most favourable to accumulation, and thinning out toward the edges of the area. This lenticular character is typical of the great limestone formations as a whole, although in many cases the so-called lenses may be hundreds of miles across. Limestone conglomerates are formed largely by mechanical agencies whereby debris from previously formed limestones is transported to lakes or to the ocean where it again becomes consolidated.

During the process of accumulation, limestone is a loose mass of shell fragments and ooze. Consolidation into solid rock may be brought about by a number of factors acting singly or in combination. Probably the chief agency is the growth of cementing crystals of calcite, or dolomite, throughout the mass. It may also be brought about by the weight of the material itself or of beds of other material deposited on top. Pressure, due to earth movements, and the heat of igneous intrusions are also effective. The consolidation may have been only partial as in the case of chalk, or it may have been very complete as in the case of marble.

From their original position beneath the water the deposits have raised to dry land by movements of the earth's crust. In many cases they have been repeately raised and lowered. In some cases the original horizontal bedding has not been disturbed, but in others the sediments have been crumpled and broken and heaved up into mountain ranges.

CHARACTERISTICS OF LIMESTONE

Colour

Limestones range from pure white through all shades of grey to black, and from blue through green, yellow, brown, and orange to red. Cream colours are also common and occasionally purple. These various colours are due to the presence of small quantities of impurities of pigment-like nature. Limestones free of these impurities are white. Varying amounts of iron oxides are believed to cause the cream, buff, brown, yellow, orange, and red tints. The greys, blues, and blacks are due principally to very finely divided carbonaceous matter. In the weathered outcrop the colouring is never so vivid as on a polished or on a freshly broken surface, and some limestones change their surface colour completely when exposed to the weather, though this change is seldom deep except with very impure stones. Black limestones rapidly become very light grey on the weathered surface, due probably to a bleaching out of the black carbonaceous pigment that colours them. This change is never more than skin deep and is accompanied by no decay in the stone. Some limestones, particularly dolomites, turn brown on the weathered surface, the change proceeding very slowly, but it may extend to a considerable depth. It is seemingly due to the oxidation of small amounts of ferrous carbonate, as iron present in dolomites is usually in the ferrous condition. The white and light blue colour of many highly altered limestones, such as some of the marbles, is due to organic pigments having been destroyed by heat or else segregated into flakes of graphite, and to the inorganic pigments having been segregated into crystalline masses.

Texture

The texture of limestone varies considerably. Some limestones are compact, others are porous and full of cavities, still others are composed of shells and fossil remains knit together with varying degrees of firmness.

All limestones are crystalline. Even chalk which appears amorphous is actually composed of minute crystals of calcium carbonate visible only under a high-powered microscope. Thus the common usage of the term

"crystalline limestone" to designate marble and all limestones that have been recrystallized through the agencies of heat or pressure, or both, is misleading in that it implies that some limestones are noncrystalline or amorphous. The term metamorphic limestone is preferable when referring to limestones that have been altered or recrystallized through metamorphic agencies. The visible changes usually wrought by intense metamorphism are, to render the limestone lighter in colour, to obscure the original bedding planes, and to cause segregation of inorganic impurities into larger crystals and masses.

The common sizes of individual crystals of calcite and dolomite composing limestones range from microscopic dimensions up to $\frac{1}{4}$ inch in diameter. In a few deposits crystals larger than $\frac{1}{2}$ inch diameter occur. Calcite crystals are rarely present in their true symmetrical forms but usually as shapeless grains tightly interlocked. Dolomite crystals, on the other hand, are generally well shaped. It is the size of glistening facets of the freshly broken crystals that gives a limestone the appearance of being either fine or coarse in grain. On a weathered surface the grain is not readily apparent. According to grain size limestones may be classified as follows:—

Dense limestones—individual crystals not perceptible to the eye.
Fine-grained—crystals visible but under $\frac{1}{32}$ inch in diameter.
Medium-grained—average crystal diameter between $\frac{1}{32}$ and $\frac{1}{16}$ inch.
Coarse-grained—average crystal diameter between $\frac{1}{16}$ and $\frac{1}{8}$ inch.
Very coarse-grained—average crystal diameter exceeding $\frac{1}{8}$ inch.

If the crystal or grain size is uniform, a limestone is termed *uniform-grained* irrespective of the size of the crystals. As a matter of fact, wide variations in size of grain within a single stratum are uncommon (mottled limestone and partly dolomitized limestone excepted), but in a succession of beds the variation may be considerable. The presence of complete fossils or fossil fragments thickly scattered through the stone may obscure the grain. When fossils are much in evidence and plainly visible the limestone is referred to as *fossiliferous limestone,* with distinctive names for the varieties depending on the characteristic fossil, as *shell limestone, coral limestone,* and *crinoidal limestone.* Many limestones are composed in part of little spherical and oval concretions called oolites. Uusually the oolites are $\frac{1}{32}$ inch or less in diameter although much larger ones also occur. When the oolites are sufficiently numerous to impart a characteristic texture the stone is called *oolitic limestone.*

Hardness

Limestones, even the very pure varieties, have a wide range in hardness. This may seem strange when it is considered that they are composed either of calcite with a hardness of 3, or of dolomite with a hardness of 3·5 to 4, but the amount and character of the cementing material as well as the degree of cementation have a great effect on the hardness. The common cementing materials in limestones are calcium carbonate and dolomite. Some limestones, such as certain of the oolitic and shell limestones that are cemented only at the points of contact of the particles,

are very friable. Dense-textured, well-cemented limestones are usually harder than coarse-grained varieties. A limestone having a siliceous cement is invariably harder than one having a purely calcareous cement. The soft chalks and marls are examples of limestones that are only partly consolidated and cemented.

PRINCIPAL MINERALS AND IMPURITIES OF LIMESTONE

No limestone deposit is entirely free from impurities, the most common of which are silica, alumina, iron compounds, sulphur, alkalis, organic matter, and phosphorus. They may be present in such small quantities that their sum total amounts to less than 1 per cent, or at the other extreme, some of them, particularly silica and alumina, may constitute a large percentage of the deposit. A description of the principal minerals and impurities of limestone follows.

Calcite

Calcite ($CaCO_3$) is the essential constituent of all limestone. It occurs in crystals of many shapes but all will cleave to a rhombohedron of 105 degrees. The hardness is 3, that is, it can be easily scratched with a knife. The specific gravity is 2·71 to 2·72. When pure it is colourless or white and has a vitreous lustre. Calcite can be readily distinguished from other minerals, excepting aragonite, by its vigorous effervescence when dilute acid is placed on it. Aragonite has the same composition as calcite but differs in crystal form, is heavier and slightly harder, and is not of known importance as a constituent of the older limestones.

Calcite forms the bulk of all limestones but usually is present as irregular grains instead of definite crystals.

Dolomite

Dolomite ($CaMg(CO_3)_2$), the double carbonate of calcium and magnesium, is named after the French geologist Dolomieu, who announced some of its characteristics in 1791. Like calcite it possesses perfect rhombohedral fracture and commonly occurs in rhombohedral crystals, but the faces of the dolomite crystals are often curved. When pure, dolomite is white or yellowish white, has a hardness of 3·5 to 4, a specific gravity of 2·8 to 2·9, and a pearly to vitreous lustre. It may be distinguished from calcite by the very faint reaction or, in many cases, entire lack of effervescence, when cold dilute acid is applied to a fragment of the mineral, but if the cold acid is applied to the powdered mineral, or if hot acid is applied to a fragment, brisk effervescence will result. Dolomite forms large rock deposits of itself and it is present to some extent in all limestones.

Silica

Silica (SiO_2) is present in all limestones and dolomites in proportions varying from a trace to very large quantities. It may occur in visible form as sand grains, chert nodules, quartz veins, and silicified fossils, or it may be present as a constituent of microscopic silt, clay, and siliceous

ooze deposited throughout the limestone. Where the limestone has been metamorphosed, a great variety of silicate minerals may have been developed, of which the most common are serpentine, diopside, tremolite, actinolite, and hornblende. In addition aluminium silicates may have been formed, some of which are mentioned below.

Alumina

Alumina (Al_2O_3) is present in combination with silica in the form of shale or argillaceous matter. It may occur in mere traces disseminated throughout the stone, or in thin films along the bedding planes; or at the other extreme it may form a large proportion of the rock, in which case the limestone is referred to as "argillaceous". The argillaceous matter is always in an extremely fine state of division so that no characteristic crystals can be observed, but if much is present it may be detected by the characteristic earthy odour given off when the stone is breathed on. In highly metamorphosed limestone, aluminium silicates such as garnets, tourmaline, epidote, and several varieties of mica and feldspar are common.

Iron

Iron occurs in limestone principally in the form of oxides and sulphides. In chemical analyses, however, it is commonly recorded only as the ferric oxide (Fe_2O_3). Iron minerals are normally present only in small amounts but some of the oxides are pigments to which, in large measure, is due the colour of the stone.

Hematite (Fe_2O_3) and *turgite* ($2Fe_2O_3.H_2O$) even if present in very small quantities will impart a red colour, and *limonite* ($2Fe_2O_3.3H_2O$) gives yellow and brown tints. *Pyrite*, iron sulphide (FeS_2) in cubical, brassy-yellow crystals is very common in limestones. It is often visible on joint planes and in cracks but is also scattered through the stone in crystals both sufficiently large to be readily seen and of microscopic size. Less common is *marcasite*, or white iron pyrites (FeS_2), which is of the same composition as pyrite but is distinguishable from the latter by its paler colour and by its being present usually only in nodular masses instead of distinct crystals. Iron carbonate, *siderite* ($FeCO_3$), is sometimes found in limestones. When fresh it is grey or brown in colour but it oxidizes to the yellow limonite. In many metamorphosed limestones, *magnetite* (Fe_3O_4) and *specular hematite* are present. Ferrous iron is particularly characteristic of dolomites in which it is often present in very small quantities.

Sulphur

Sulphur occurs in limestones principally in combination with iron as either pyrite or marcasite. It is also present in the sulphate form combined with calcium and more rarely with magnesium. Crystals of native sulphur have occasionally been observed in limestones associated with gypsum. The fetid smell given off by some limestones when struck with a hammer is attributed to the presence of hydrogen sulphide gas (H_2S) occluded in the stone.

Organic Matter

Organic matter, resulting from vegetable matter deposited in the limestone at the time it was formed, and from the soft parts of the creatures whose shells and skeletons compose a great part of the rock, is a common constituent of limestone. Carbonaceous matter even in very small amounts distributed through the stone acts as a pigment, and to it most of the black and dark grey limestones owe their colour. In the form of petroleum, both liquid and solidified, it fills cavities in the stone. The partings, or thin films of shale between beds, often contain a high percentage of organic matter. Much of the organic matter is destroyed under the action of metamorphic agencies, but a portion of the carbon thereof may be converted into *graphite* which is commonly found in tiny flakes disseminated through metamorphosed limestones.

Other Impurities

Phosphorus in very small quantities is present in practically all Canadian limestones. The combination in which it occurs has not been determined but it is probably present as calcium phosphate, in which hypothetical combination it is shown in the analyses in this report.

Alkalis. The analyses of many limestones, particularly the impure varieties, often reveal the presence of *soda* (Na_2O) and *potash* (K_2O) compounds. The exact combination in which the alkalis occur in Canadian limestones has not been determined.

In addition to the more widely occurring impurities enumerated above, compounds of lead, zinc, arsenic, manganese, titanium, fluorine, strontium and barium are also found in limestones.

GENERAL STATEMENT ON THE LIMESTONES OF THE MARITIME PROVINCES

A great number of deposits of limestone occur in Nova Scotia and New Brunswick, but none of commercial importance is known in Prince Edward Island. In Nova Scotia the limestones occur in the central and eastern parts of the province; in New Brunswick, adjacent to the north and south coasts and in the valley of the St. John River. They are utilized for lime manufacture and for chemical, metallurgical, and agricultural purposes. In Nova Scotia the steel industry has been and is the principal consumer of limestone, whereas in New Brunswick it is the lime industry.

In contrast to the limestones of central Canada, which occur in great flat-lying formations, some of which are hundreds of feet thick and extend for hundreds of miles, the limestones of the Maritime Provinces are in lenses, which, though sometimes several miles in length, are relatively thin and dip at various angles to the horizontal, some being vertical. The largest deposits of pure limestone are of Precambrian, Silurian, or Carboniferous age.

Precambrian limestones are found in a series of metamorphosed sediments that have been engulfed by the igneous rocks comprising the greater part of the Precambrian system. In both Nova Scotia and New Brunswick

the Precambrian limestones are similar in their characteristics and associations. They differ in a number of respects from the Precambrian limestones of Quebec and Ontario. They occur together with quartzite, schist, and gneiss in steeply dipping bands that may extend for many miles and may be thousands of yards wide at right angles to the stratification. Dykes of trap rock traverse these metamorphosed sediments in all directions and are especially numerous in the New Brunswick deposits. Generally speaking the Precambrian limestone deposits of New Brunswick are larger and purer than those of similar age in Nova Scotia. In both provinces limestones of all types from high-calcium to dolomite are present and in many instances all are present in one major belt, but usually they form separate zones or bands within that belt. The width of the zones or bands of each type of limestone varies widely as does also the degree of purity, and the purest stone is usually found in lenses from a few feet to 200 feet in thickness. All varieties of Precambrian limestone yield white lime. The largest quarries in New Brunswick are in Precambrian limestone and it is also being quarried in Nova Scotia.

Carboniferous limestones occur in both Nova Scotia and New Brunswick, and the only deposit of limestone known in Prince Edward Island is of this age. The deposits are lenticular—from 20 to 50 feet thick and from several hundred feet to several miles in length. They are associated with shale and sandstone and commonly dip at various angles to the horizontal, but are rarely vertical. The limestones are all fine-grained and dark in colour, the usual colours being various shades of grey, blue, brown, and red. On calcination they yield grey, brown, and reddish limes. Deposits of all types from high-calcium limestone to dolomite are found in Nova Scotia, and very pure stone of each type is available. In New Brunswick, so far as known, only calcium and high-calcium limestones are found in the Carboniferous system. Carboniferous deposits provide the greater part of the limestone produced in Nova Scotia but in New Brunswick they are quarried only to a very small extent.

Silurian limestones, in deposits of economic importance, are found only in New Brunswick where they occur as large lenses, parts of which are of a high degree of purity. They consist almost wholly of calcium and high-calcium limestone. The normal colours are light grey and various shades of blue, some being very dark. Where, however, metamorphism has taken place, as in the deposit near St. George, the limestone is nearly white. Aside from small quantities quarried occasionally for local use there is no production from the Silurian limestone of New Brunswick at the present time.

Though there are a great number of limestone deposits in Nova Scotia and New Brunswick of the grades of purity desired for a wide variety of industrial uses, that are sufficiently large individually to form adequate sources of supply for small lime plants and for plants having a relatively small output of stone for agricultural, chemical, and other purposes, yet deposits of large tonnage and of uniform composition, so situated that they can be cheaply quarried, are not numerous.

PLATE I

A. Rough, scarred, weathered surface, typical of many Precambrian dolomites.

B. Near view of rough, weathered surface of Precambrian dolomite.

74471—2½

CHAPTER II

THE LIMESTONES OF NOVA SCOTIA

DISTRIBUTION AND CHARACTERISTICS

Limestone deposits of all varieties and degrees of purity are plentiful in the central and eastern parts of the mainland and throughout Cape Breton Island, but none of known commercial value is found west of a line between Windsor and Lunenburg. The principal deposits are of Precambrian and of Carboniferous age. Though, as is indicated in Table I, there are also limestones believed to be of Silurian and Devonian ages, they do not compose any deposits of sufficient purity or extent to be of value for industrial purposes. Among them may be cited the siliceous limestone bands (Devonian?) in Annapolis County near Nictaux and Bear River, which are more of the nature of calcareous quartzites than true limestones.

Precambrian Limestones

Limestone comprises a major part of a series of metamorphosed sedimentary rocks, termed the George River series, enfolded in the Precambrian granitic rocks that form the highlands of Cape Breton Island. Closely associated with the limestones are bands of quartzite, slaty rock, schist, etc., all of which are intersected by relatively few thin dykes of trap rock. This series of metamorphosed sediments is found principally in North Mountain, Creignish Hills, Coxheath Hills, Boisdale Hills, to a lesser extent on St. Anne Mountain north of New Campbellton, and also in isolated patches in the northern parts of Inverness and Victoria Counties. Excepting a commercially unimportant band found in some localities between the slate and quartzite divisions of the Gold-bearing series, Precambrian limestone is not known to occur on the mainland.

The George River limestones and associated rocks usually occur in long, steeply dipping bands along the granite hillsides. Some bands are hundreds of feet wide across the apparent stratification; others are only a few feet wide. As they have been subjected to all geological disturbances that have taken place in their neighbourhood since early Precambrian times, including being engulfed in the great welling up of granite that forms the above-mentioned mountains, the George River limestones are invariably much metamorphosed and usually are crumpled, faulted, and fractured. The granitic rocks may abruptly terminate the limestone both laterally and vertically, and this possibility must always be considered in estimating tonnages.

TABLE I

Rock Formations of Nova Scotia Showing Stratigraphic Position of Limestones

System	Series	Types of Rock
Triassic		Volcanic rocks and sandstone.
Carboniferous	Pennsylvanian formations	Shale, sandstone, conglomerate and coal.
	Windsor	Limestone, anhydrite, gypsum, shale, sandstone and conglomerate.
	Horton	Shale, sandstone, conglomerate, volcanic rocks.
Devonian		Granite, shale, slate, sandstone, thin siliceous limestone bands, etc.
Silurian		Slate, shale, sandstone, siliceous limestone.
Ordovician		Slate, shale, sandstone, volcanic rocks.
Cambrian		Slate, shale, sandstone, etc.
Precambrian	Gold-bearing	Quartzite, slate.
	Unclassified	Granite and other igneous intrusive rocks.
	George River	Metamorphosed limestone, slate, quartzite, schist, volcanic rocks, etc.

The George River limestones include dolomite, calcium limestone and magnesian limestone of all degrees of purity. The pure dolomites usually contain between 40 and 42·5 per cent magnesium carbonate. The magnesian limestones, on examination, are seen to consist of intermingled crystals of dolomite and calcite and most of the field evidence indicates that the magnesium content was present in the deposits prior to their solidification for there is no noticeable concentration of magnesium carbonate along joints and bedding planes where it would be most likely to occur if the dolomite crystals were due to the infiltration of magnesium-bearing solutions, the passage of which through the rock would be facilitated by these natural channels. On the other hand, at Whycocomagh (page 88), there is a dolomite deposit that has in part been altered to calcite, the replacement occurring along fracture planes. In many other dolomite deposits, thin films of calcite fill what were apparently at one time fracture planes.

Where dykes of trap rock have intruded a deposit of George River limestone the only apparent effect they have had is to render the limestone lighter in colour and in some cases slightly finer in grain for an inch or so on either side of the dyke.

As a rule two or more varieties of limestone occur in the same deposit in approximately parallel bands or lenses. When a deposit of this nature has been badly folded or faulted it presents a hopeless mixture of the

different varieties and is useless as a source of stone of uniform composition. Frequently the bands or lenses of one type are sufficiently large to be separately quarried on a considerable scale, but in general the quarries must of necessity be long and narrow in order to follow the band of the desired stone, and thus the interbanding of stone of varied composition is one of the great drawbacks to the working of the George River limestones.

All the George River limestones are highly metamorphosed. Most of them are fine- to medium-grained but some are coarse, and some, particularly the dolomites, are very fine-grained to dense in texture. There may be little or no relation between texture and chemical composition, and wide variations in texture may and do occur in a deposit of uniform composition, but on the other hand there is sometimes a noticeable difference in texture between adjoining strata of dolomite and calcium limestone. Generally dolomite and calcium limestone can readily be distinguished by the appearance of their weathered surfaces, as the dolomite almost invariably weathers to a rough, scarred surface, usually drab or brown in colour (Plate I, page 9), whereas the calcium limestone weathers to a smooth surface that is usually lighter in colour than is the unweathered stone (Plate XXIX A, page 171).

The freshly broken George River limestone is nearly always light-coloured—various shades of blue being most prevalent—but much is also white and some is tinted with red, violet, green, and other colours. Colour is not a reliable guide to the composition of the stone.

The chief impurities are silica and serpentine, the latter being particularly characteristic of dolomite. Minor amounts of mica, tremolite, graphite, specular hematite, pyrite, and magnetite occur, but they are rarely present in such quantity as to lower the quality of the limestone; also the content of alumina, sulphur, and phosphorus is usually very low. Silica, in addition to being a common impurity, is the one that varies most widely in amount. Great thicknesses of George River limestone are relatively free from it, but, on the other hand, it may compose a very substantial percentage either disseminated through the limestone in tiny grains or as stringers of white quartz, in which latter form it is quite common near igneous contacts. The limestone adjoining a bed of quartzite or of slate commonly contains thin interbeds and films of siliceous and argillaceous material that probably represent sandy and shaly partings that were present in the unmetamorphosed deposit. Serpentine in the form of veins, blebs, and masses is particularly characteristic of igneous contacts in dolomite deposits, and less commonly of the same contact zones in deposits of calcium limestone. Some dolomite deposits, as for instance the one at George River, Cape Breton County, are veined and blotched throughout with serpentine, Plate IV A, page 24. But others, as those near Whycocomagh and New Campbellton, are nearly free from this impurity.

Carboniferous Limestones

Limestones of all varieties, from high-calcium limestone to dolomite, occur extensively in the lower portion of that division of the Carboniferous system known as the Windsor series. This series of rocks is the lowest but

PLATE II

A. Cracked, weathered surface, typical of many Carboniferous calcium and high-calcium limestones.

B. Smooth, weathered surface of Carboniferous calcium limestone with peculiar concentric markings.

one of the groups of strata into which the Carboniferous system in Nova Scotia is divided; the Horton series is stratigraphically lower but in many districts it is absent, and the limestones and other rocks of the Windsor series rest directly on the Precambrian floor. Only rarely are limestones found in the other divisions of the Carboniferous and such as do occur are impure and generally in thin bands of no commercial importance. A possible exception to this is the band of limestone, 50 feet thick, near Parrsboro (page 56) that occurs in what is apparently one of the Pennsylvanian formations.

The Carboniferous limestones are widely distributed throughout the lowlands of Cape Breton Island and of the eastern and central portions of the mainland. These lowlands are fertile areas and well populated and consequently a great many deposits are adjacent to railways, and constitute by far the greater proportion of the readily available limestone resources of the province.

The deposits are lenticular and rarely exceed 50 feet in thickness without thick beds of shale or sandstone intervening. The limestone lenses may be many miles in length, as in Antigonish County, and in the Musquodoboit district in Halifax County, but usually they are very much smaller. The limestones are particularly characteristic of the lower half of the Windsor series where they occur at several horizons, the basal formation of the series being usually, but not always, a limestone. This basal limestone band is, in most localities where it occurs, a calcium limestone, but in some districts, as in the Musquodoboit Valley, Halifax County, it is highly magnesian in composition. Dolomite deposits are fairly common throughout the Windsor series and, to a lesser extent, magnesian limestones occur, but calcium limestones greatly predominate. There is no definite horizon throughout the series at which dolomite and magnesian limestone may be expected to occur but rather they seem to be characteristic of certain localities.

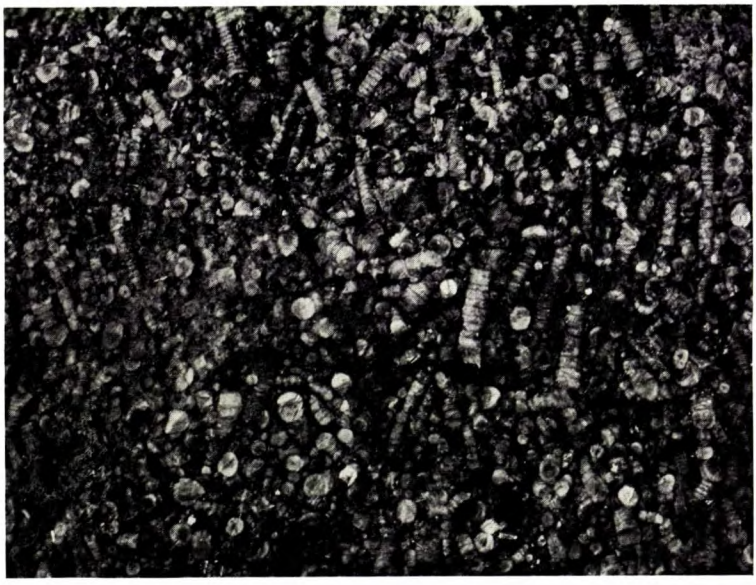
Geological disturbances subsequent to the consolidation of the limestones have tilted, folded, and faulted the deposits, and the great majority are inclined at various angles to the horizontal. Though these earth movements, together with glacial erosion, have made available many deposits that otherwise would have remained deeply buried, the tilting has also rendered difficult the quarrying of the stone. Vertical bands can be worked by long, narrow, and deep quarries, but where the deposits are tilted at angles of from 10 to 80 degrees, unless the angle of dip conforms to the slope of the land surface, only a limited amount of quarrying can be done without having to remove a great depth of overburden. The tilted deposits can be mined, but as yet mining methods have not been applied to the winning of limestone in Nova Scotia. In addition, folding and faulting render the extent of the deposit uncertain and, in faulted areas particularly, a limestone deposit must be given a very careful examination to prove the quantity available before large-scale operations are commenced.

Carboniferous limestones are of two general types—

1. Shell limestones, very pure.
2. Bedded limestones of all degrees of purity.

PLATE III

A. Carboniferous shell limestone, Windsor, N.S.



B. Carboniferous crinoidal limestone.

The shell limestones consist of marine shells and fragments of corals bound together by a fine-grained limestone cement. (Plate III A, page 15). For a description of the fossils see Memoir 155 of the Geological Survey of Canada, by W. A. Bell. In some deposits there is insufficient cementing material to bind the shells together and the rock is very fragile. At the other extreme are deposits in which the cementing material predominates to the extent that even the cavities within the shells are filled, thus giving a dense, compact stone; intermediate varieties are, however, more common than either extreme. The shell limestones are, as a class, the purest of the Carboniferous limestones and they rarely contain over 3 per cent total impurities, and in many deposits less than 1 per cent. The great majority are high-calcium in composition—the magnesium carbonate content being less than 2 per cent—but in rare instances these shell limestones have the composition of dolomite, as for example at Maxner Point, Windsor (page 68) and at Hilden, Colchester County (page 44). The Maxner Point dolomitic shell limestone affords a good example of dolomite formed by replacement of calcium carbonate by dolomite, but in the other deposits the process of dolomitization is not so evident.

The deposits are always in mounds and ridges of irregular size and shape, suggestive of reef structures, in which bedding is poorly defined or entirely absent, and they are often associated with gypsum and anhydrite. Another common mode of occurrence is as a capping, or blanket, on hills of igneous rock. These hills probably formed reefs that extended above the general level of sedimentation in the Carboniferous seas and on these reefs shell-fish and corals flourished, and the accumulation of their calcareous remains gave rise to the shell limestone deposits.

Light browns and greys are the predominant colours of the shell limestones, though some are blue. The calcium phosphate content is low; in only one instance does it run as high as 0·3 per cent and the average is 0·09 per cent, though in such a fossiliferous stone it might be expected to be high. Sulphur is a very minor impurity and is often only present in traces, excepting where the limestone is in direct contact with gypsum, as is sometimes the case, and then the high sulphur content is limited to a relatively narrow contact zone. Alumina and oxide of iron together average about 0·7 per cent, except in the dolomitic varieties in which the average content of ferric oxide alone is nearly 1·5 per cent. On calcination these limestones yield a buff or brown lime and the hydrate prepared from the quicklime also has a buff tint.

The bedded limestones, as the term "bedded" implies, are all well stratified. They commonly contain fossils but are rarely as highly fossiliferous as are the shell limestones. They include practically all varieties of limestone from high-calcium to dolomite, and are of all degrees of purity. Calcium limestones greatly predominate, and the magnesian limestones are least numerous. All are fine-grained to dense in texture. Most of them are brittle and comparatively hard, but soft, earthy deposits occur as well. The prevailing colours are various shades of blue and brown, red is fairly common, some are almost black, and some are tinted with green and purple. The dolomites and magnesian limestones are generally brownish in colour and nearly all of them turn to a rusty brown on

exposure, and the weathered surface is rough and often scarred as it is with Precambrian dolomite, illustrated in Plate I, page 9. Many of the dolomites have a cavernous structure. (Plate IV B, page 24.)

As previously mentioned all the bedded deposits are lenticular and whether their diameters are measured in miles or in hundreds of yards they thin out toward their edges or grade off into shale or sandstone, usually the former. The only deposits that exceed 50 feet in thickness are: those that have been mechanically formed, such as the limestone conglomerates; those that contain much interbedded shale (Plate V A, page 26); and those that fill indentations in the rock on which they rest. In some localities the limestones rest on Precambrian rock but generally they are underlain and overlain by shale or sandstone, though the basal limestone of the series commonly rests on the Horton quartzose conglomerate. The line of demarcation between the deposits of pure limestone and any other sedimentary rocks that may be associated with them is nearly always very sharp and distinct. Many of the deposits have ripple-marked and sun-cracked surfaces, indicating that they were formed in shallow water. Some are composed almost entirely of oolites, and a few are composed largely of crinoid stems as shown in Plate III B, page 15.

Deposits of bedded limestone of all degrees of purity occur, but taken individually the chemical composition of any one deposit is generally uniform. Silica and alumina are the chief impurities, but many deposits with less than 3 per cent total impurities are available. The majority of the deposits are composed largely of calcite, some are composed of dolomite, and but relatively few are composed of a mixture of calcite and dolomite in such proportion that they are intermediate in composition between calcium limestone and dolomite. Occasional deposits are composed of interbedded strata of calcium limestone and dolomite, and in one or two localities calcium limestone containing nodules or mottlings of dolomite occurs. Many of the deposits of limestone conglomerate contain sufficient hematite to colour them red and, particularly in Hants County near Walton and Tennecape, several deposits of this type contain, in addition, veins and pockets of manganese oxide. Pyrites is a minor impurity. Sulphur, except in the very impure deposits, rarely exceeds 0·5 per cent and is often present only as a trace. Calcium phosphate averages less than 0·1 per cent.

PRODUCTION AND UTILIZATION OF LIMESTONE IN NOVA SCOTIA

Statistics on the production of limestone and lime are given in Tables II and III and are shown graphically in Figures 1 and 2. Data prior to 1921 were obtained from the records of the Mines Branch, and for 1921 and subsequent years, from the records of the Dominion Bureau of Statistics.

A noticeable feature of the data is the low price per unit for both limestone and lime. This is due to the fact that the statistics include the production of lime and limestone by the steel industry of Nova Scotia, which industry is by far the largest producer of both in the province. Fuel is cheaply available to the steel industry and as the production of lime and limestone is valued at cost this lowers the unit price so far as statistics for the province are concerned.

The large drop in production of limestone in 1921 and subsequent years, as compared with the average production for many years prior to that date, was due to the closing down of the large flux-stone quarry at Marble Mountain, Inverness County, and the transfer of quarry operations for blast-furnace flux to Newfoundland.

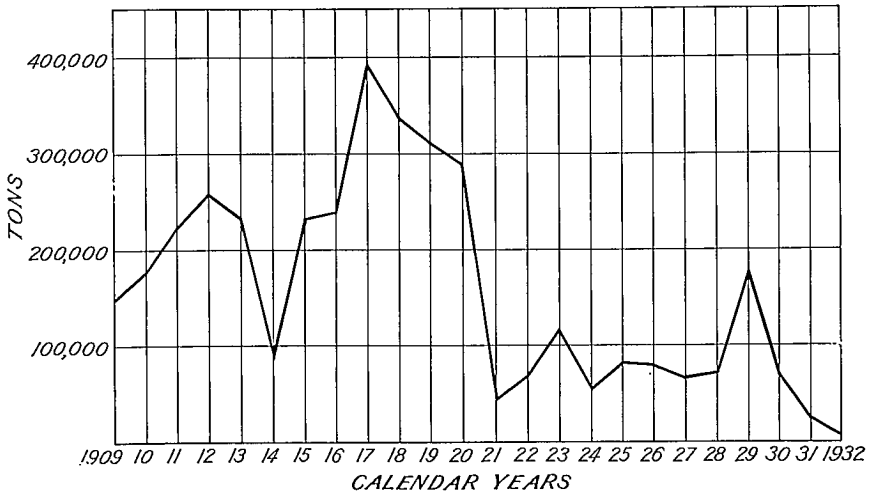


Figure 1. Production of limestone in Nova Scotia.

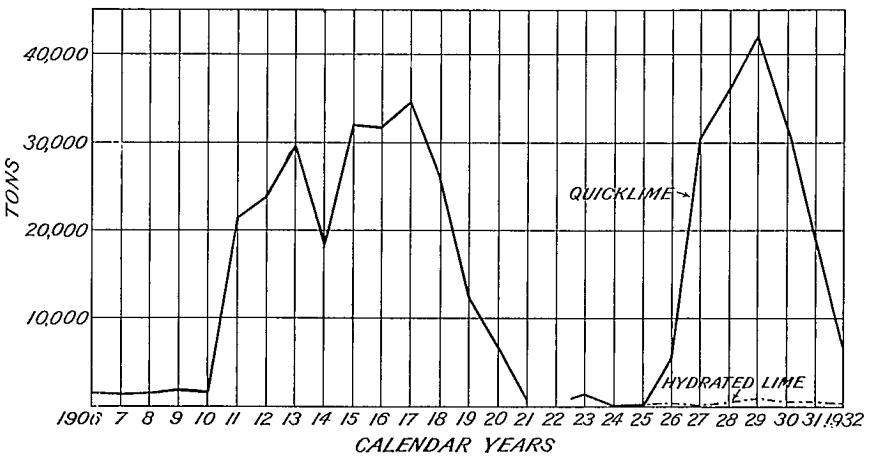


Figure 2. Production of quicklime and hydrated lime in Nova Scotia.

The principal products from Nova Scotia limestone deposits in order of tonnage are—flux for open-hearth furnaces, lime, agricultural limestone, stone for use in the manufacture of sulphite pulp, road metal, asphalt filler, and whiting substitute. The greater part of the production is from the Carboniferous deposits, Precambrian limestone (dolomite) being quarried

only for making lime for fettling the bottoms of open-hearth furnaces and to a small extent for the manufacture of whiting substitute.

Lime for purposes other than for use in the steel industry is made at only one plant—that of the Eastern Lime Company at Windsor—where a deposit of shell limestone is being utilized. Formerly lime plants were in

TABLE II

Production of Limestone in Nova Scotia

Year	Tons	Value	Year	Tons	Value
		$			$
1909	147,000*	161,922	1921	44,269	55,436
1910	176,000*	192,919	1922	68,122	56,936
1911	223,000*	245,216	1923	118,222	102,750
1912	251,000*	275,944	1924	57,069	56,323
1913	236,000*	258,719	1925	84,939	73,717
1914	86,000*	94,239	1926	82,753	97,255
1915	232,000*	255,024	1927	68,294	75,292
1916	240,000*	263,803	1928	72,350	79,320
1917	395,000*	433,987	1929	176,113	201,899
1918	337,688	370,509	1930	79,941	88,545
1919	311,620	335,192	1931	21,684	69,415
1920	292,467	327,034			

*Estimated.

TABLE III

Production of Lime in Nova Scotia

Year	Quicklime			Hydrated Lime		Total Lime	
	Bush.	Tons	Value	Tons	Value	Tons	Value
			$		$		$
1906	50,000	1,750	13,600	.....	.....	1,750	13,600
1907	45,000	1,575	16,000	.....	.....	1,575	16,000
1908	51,068	1,787	16,102	.....	.....	1,787	16,102
1909	57,730	2,121	16,729	.....	.....	2,121	16,729
1910	55,750	1,951	13,490	.....	.....	1,951	13,490
1911	618,950	21,763	123,790	.....	.....	21,763	123,790
1912	684,625	23,962	136,930	.....	.....	23,962	136,930
1913	851,050	29,787	170,210	.....	.....	29,787	170,210
1914	516,029	18,060	103,206	.....	.....	18,060	103,206
1915	915,086	32,028	183,017	.....	.....	32,028	183,017
1916	909,800	31,843	181,960	.....	.....	31,843	181,960
1917	985,286	34,485	197,057	.....	.....	34,485	197,057
1918	748,314	26,191	149,663	.....	.....	26,191	149,663
1919	366,543	12,829	73,309	.....	.....	12,829	73,309
1920	201,500	7,053	40,300	.....	.....	7,053	40,300
1921	25,914	907	6,085	.....	.....	907	6,085
1922	.....	.....	.....	.....	.....	.....	.....
1923	42,370	1,483	7,199	.....	.....	1,483	7,199
1924	.....	.....	.....	78	936	78	936
1925	57	2	20	287	3,444	289	3,464
1926	446,626	5,632	56,777	251	3,000	5,883	59,777
1927	872,914	30,542	100,134	10	120	30,552	100,254
1928	1,015,257	35,534	167,386	620	8,490	36,154	175,876
1929	.....	41,001	143,787	1,000	10,400	42,001	154,187
1930	.....	30,462	106,730	652	6,520	31,114	113,250
1931	.....	17,790	73,018	640	6,400	18,430	79,418

operation at several places from where shipment could be made by water, among which may be mentioned East River, Lunenburg County; George River, Cape Breton County; and Marble Mountain, Inverness County. In addition, lime for agricultural purposes was made in field kilns on many farms. The decline in the practice of liming farm land, the increase in rail transportation facilities permitting competition from larger lime plants outside the province, and the increasing competition of other building materials were among the factors that caused the closing down of these plants.

Attempts have been made to quarry marble from the metamorphosed Precambrian limestones and to a lesser extent from the Carboniferous limestones, but so far without success. Much of the Precambrian limestone is white or is beautifully tinted and is of a texture desirable in a marble, but the deposits so far investigated are too badly fractured to yield, without a great proportion of waste, the large, sound, rectangular blocks required by the marble industry. There are, however, large areas underlain by metamorphosed limestones that have never been fully investigated. But, owing to the fracturing that characterizes deposits of Precambrian limestone in Nova Scotia, prospects of discovering deposits capable of yielding marble in slab form are not promising, though there would be no trouble in obtaining material suitable for terrazzo. Some Carboniferous deposits are not badly fractured but these limestones do not commonly possess the beautiful colouring that would commend them as marble. A heavily bedded deposit, consisting in part of a nearly black limestone that takes a good polish, outcrops between Churchville and Eureka, Pictou County, and this deposit has attracted some attention as being a possible source of black marble.

Small quantities of building stone for local use, chiefly for foundations and the like, have been obtained in a number of localities, as noted later, but the fractured nature of the Precambrian limestones precludes them from being generally used for this purpose; and the Carboniferous limestones are either too sombre in colour or are too brittle and hard to work to be of value for cut stone.

Up to 1932 very little road metal has been produced from Nova Scotia limestones, though a number of the Carboniferous deposits would yield material quite suitable for the purpose. This is due in large measure to the abundance of gravel in the province.

NOVA SCOTIA MINING LAWS RELATING TO LIMESTONE

Limestone and building materials are not Crown property but belong to the owner of the soil[1] (Lands and Forests Act, Chapter 4, 1926, Sections 20 and 21). All quarries, however, are subject to the regulations of the Metalliferous Mines and Quarries Act, as regards their method of operation. Detailed information on mining laws relating to limestone may be had on application to the Deputy Minister of Public Works and Mines, Halifax, N.S.

[1] Since 1928, however, Crown Land grants have been issued reserving limestone to the Crown.

TABLE IV

Nova Scotia Limestone Quarries

Operator	Location of quarry	Product
	Cape Breton County	
Dominion Steel and Coal Corporation, Sydney.	Edwardsville	Flux for open-hearth furnaces, stone for dusting coal mines, lime.
Dominion Steel and Coal Corporation, Sydney.	George River	Dolomite for making lime for refractory purposes.
	Colchester County	
James Thompson, R.R. No. 2, Truro.	East Mountain	Agricultural limestone.
	Cumberland County	
Nova Scotia Departments of Highways and Agriculture, Halifax.	Pugwash	Agricultural limestone, crushed stone for roads.
MacLean and Co., Oxford	Upper Nappan	Agricultural limestone, crushed stone for roads.
	Hants County	
Eastern Lime Co., Ltd., Windsor.	Windsor	Hydrated lime, agricultural limestone, asphalt filler.
	Inverness County	
Brandram Henderson, Ltd., Halifax.	Whycocomagh	Stone for whiting substitute.
Alex. Hawley, Port Hood	Glendyer	Agricultural limestone.
	Lunenburg County	
Mersey Paper Co., Ltd., Liverpool.	East River Station	Stone for use in manufacture of sulphite pulp.
	Richmond County	
Jas. M. Cameron, Barra Head....	Robinson Cove (Barra Head).	Crude limestone shipped for making lime.

DISTRIBUTION OF LIMESTONE BY COUNTIES

Antigonish County

Carboniferous limestones occur in many places within the large area of Windsor strata occupying the centre of the county, and also in a few scattered outliers of these strata in other parts. Shell limestones of the pure, high-calcium type, and bedded limestones, comprising both dolomites and calcium limestones of many degrees of purity, are available. The shell limestone in the neighbourhood of Antigonish Harbour is particularly well situated for quarrying and for water shipment. A relatively pure dolomite, that could be quarried in quantity, occurs near Pomquet. Most of the bedded limestones are rather impure and occur in deposits inclined at various angles to the horizontal and usually less than 30 feet thick.

Certain of them, however, have considerable lateral extent, as for example the basal limestone band of the Windsor series that outcrops at intervals along the northern boundary of the main area of Windsor strata from James River Station to beyond Rights River, a distance of over 7 miles. Outcrops of what is apparently the same basal deposit are also to be seen along the southern margin of this same area of Windsor strata from near Monastery for several miles to the westward, and in all likelihood the limestone underlies, in one continuous deposit, a large proportion of the intervening area.

Among the deposits of limestone occurring in outliers of the Windsor series in parts of the county remote from a railway line are: those 2 miles west of Lochaber in the southwest corner of the county; those at Big Marsh and near Doctor Brook in the northern part; and at Cape Blue and east of Harbour au Bouche in the eastern part of the county. A partial analysis made by Professor Harlow, Provincial Chemist, shows the Doctor Brook limestone to contain 8 per cent total impurities.

No quarries are now being worked but, many years ago, stone for lime and for rough construction was obtained in small quantities at many localities.

James River Station to Antigonish

From James River Station to Rights River, a distance of 7 miles, a band of laminated, hard, blue limestone at the base of the Windsor series is visible wherever brooks have cut through the overlying soil. The deposit is 20 feet thick, invariably dips southerly at angles varying from 10 to 15 degrees and directly overlies the quartzose conglomerate of the Horton series. It is composed of impure, very fine-grained, dark blue limestone in beds up to 16 inches thick, all of which contain closely spaced films of siliceous, shaly material that project on the weathered surfaces. Towards the top of the band the strata become thin-bedded and also magnesian in composition. Cross fractures filled with white calcite are characteristic, and in some parts of the deposit these calcite veins carry crystals of purple fluorspar. Between James River Station and Antigonish, 10 small quarries have been opened up at one time or another in this band to obtain building stone and stone for making into lime; but none of them has been worked in recent years. The stone is not suitable for any but rock-face construction on account of its laminated nature and also because it is too hard to be cut and carved economically. Transportation is provided by the Canadian National railway which parallels the line of outcrops a few hundred feet to the south.

Sample 75 (see table of analyses on page 28) represents the bottom 8 feet of this limestone band where it is exposed in the bed of a tiny brook 1 mile east of James River Station.

Sample 76 was taken in a small quarry in this same band in the valley of a brook 1½ miles due north of the town of Antigonish. It includes 10 feet of strata, most of which are the thin-bedded magnesian layers composing the top of the band.

Antigonish

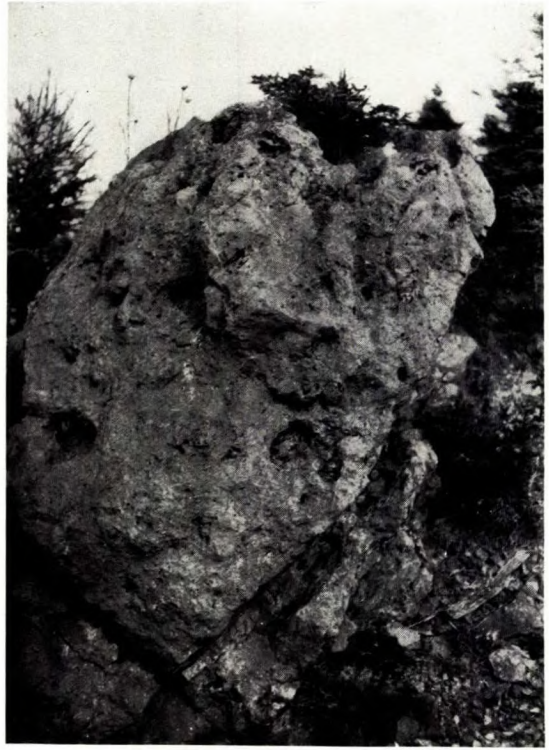
On the east shore of Antigonish Harbour opposite the mouth of North River is a ridge of igneous rock capped by pure, light brown-grey, soft, shell limestone very much like that at Windsor except that the fossils are not so numerous. The groundmass of the stone is dense-textured, but there are a great many small cavities all through it, some of which are partly filled with secondary calcite and others are coated with an earthy deposit of calcium carbonate. Outcrops are dark grey in colour and very rough and cavernous. The deposit probably averages over 20 feet in thickness with a length of ½ mile and an average width of 300 feet. Over a large part the overburden is almost negligible. It is in an excellent position for quarrying, but is 3½ miles by road from South River station—the nearest shipping point—on the Canadian National railway. Shipment by water could be made from the deposit, as deep water is available opposite the outcrops along the shore. Three samples were taken at different places on the deposit—No. 77 from the face fronting on the harbour, No. 77A from the landward face and No. 77B from many outcrops along the centre of the ridge. Ground limestone for agricultural use has been produced in small quantities from this deposit.

Limestone of the same general type blankets the lower slopes of three hills of igneous rock that occupy the central portion of the peninsula jutting out into the head of Antigonish Harbour. The highest hill attains an elevation of 300 feet, and in places the limestone extends continuously up the slope to a height of about 100 feet, after which it is present in patches up to the summit, but in all these patches many fragments of igneous rock are present. The basal limestone is much more compact than the remainder and is also less fossiliferous. Without digging pits it is impossible to estimate, other than roughly, the thickness of the limestone, but, especially on the northwest slope of the high hill, the deposit appears to have a thickness of over 20 feet and could be easily quarried. Sample 78 was obtained in a small abandoned quarry, of which there are several around the bases of the hills, the stone having been quarried many years ago for making lime in nearby kilns. The Canadian National railway passes within 1,000 yards of these deposits.

McIsaac Point

North of Antigonish Harbour a band of limestone 20 feet thick and dipping steeply seaward outcrops along the sea coast from McIsaac Point southerly for a mile. The stone is reddish brown, dense-textured, impure calcium limestone having almost the appearance of a conglomerate but this appearance is given by the presence of a network of red shale that occurs through all but the basal layers; these latter have a laminated structure and weather differentially. Sample 79 is from the top 15 feet and 79A represents the bottom 5 feet of this band, where it is exposed in the cove 200 yards south of the school house. The limestone is overlain and underlain by shale.

A. Precambrian dolomite containing many small, spherical masses of serpentine, George River, Cape Breton County, N.S.



B. Cavernous Carboniferous dolomite, Pomquet, Antigonish County, N.S.

Pomquet

One and a half miles northwest of Pomquet Lake, on the north side of the road between Pomquet village and Antigonish Harbour, is a large deposit of fairly pure dolomite and also a smaller one of magnesian limestone. The distance by road to South River station and to Pomquet station on the Canadian National railway is about the same, namely 3½ miles.

The dolomite is light brown in colour, and although dense-textured it is full of small cavities and weathers to a drab-grey, cavernous surface as shown in Plate IV B, page 24. It is exposed for a distance of 1,000 feet in an east and west direction in a ridge 100 feet wide which, in places, attains a height of 30 feet. Bedding is indistinct but, in places, the stone appears to be dipping steeply to the south. Sample 80 is a composite sample from the high face on the south flank of the west end of the ridge and from many of the boulder-like masses across the top of the ridge. The ground on either side of the ridge is rather swampy but a large quantity of dolomite is obtainable without difficulty.

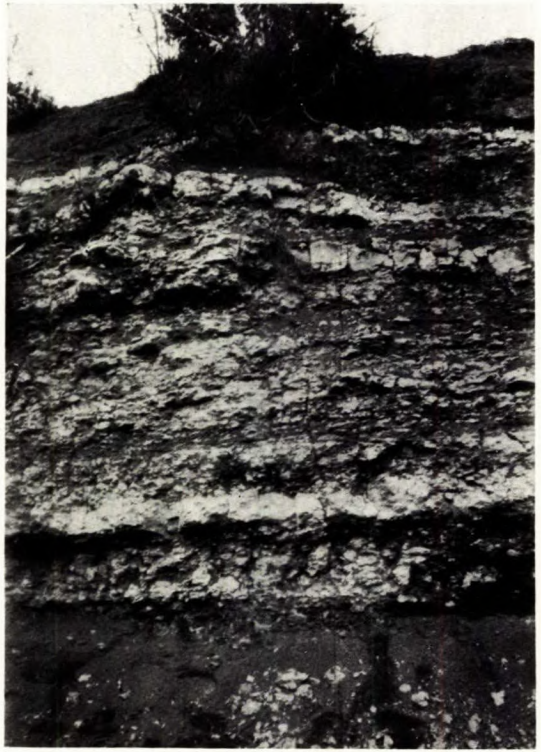
The magnesian limestone occurs in a low ridge which, beginning 800 feet west of the west end of the dolomite ridge, trends in a slightly different direction, and is entirely separate from the latter. Very little of the magnesian limestone is exposed. Some of it consists of a mass of dolomitic oolites held together by a calcite cement but most of it is a soft, dense-textured, light brown limestone containing a number of shells and not differing greatly in appearance from that in deposits 77 and 78. Sample 80A includes both the oolitic and dense varieties.

Fraser Mills

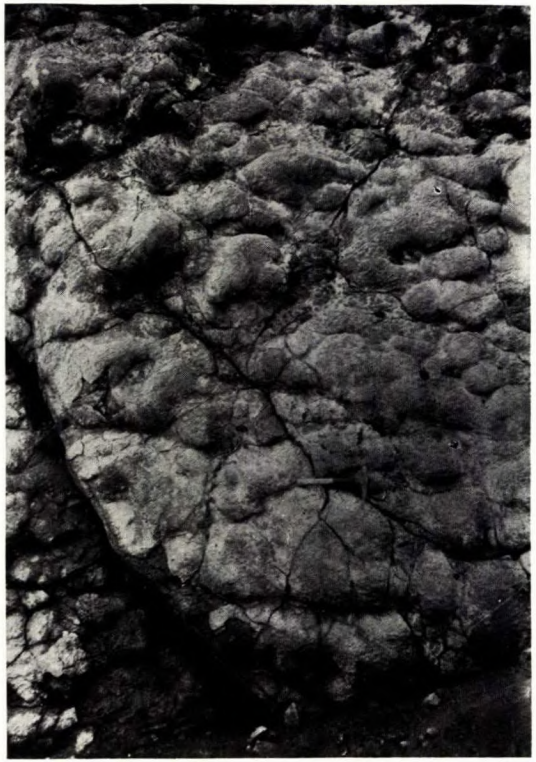
Half a mile or so northeast of the village an outcrop of light blue, laminated, very fine-grained limestone occurs in the valley of a small brook. The deposit is about 25 feet thick. It contains approximately 10 per cent total impurities, but has been quarried to a small extent for making lime and also for pulverizing for agricultural purposes. Several other outcrops of limestone are said to occur in this neighbourhood.

Monastery

Immediately west of the road and 1 mile south of Monastery station, on what is known as the Monastery farm, is an abandoned quarry that has yielded stone for lime-burning and for rough construction. It is opened in a limestone band 34 feet thick that dips at 80 degrees to the northeast, and forms the northeastern flank of a ridge 50 feet high. Shale underlies the limestone and forms the major part of the ridge. The limestone varies in type and quality. The outer edge of the deposit consists of a hard, very fine-grained calcium limestone that is to be seen only at the base of the ridge where it has an exposed width of 3 feet. The main part of the band is composed of hard, very fine-grained, dark greyish brown dolomite that weathers to a drab brown. It is heavily bedded but somewhat nodular due to a network of films of black shale. Adjacent to the shale is 3 feet of very finely granular, dark brown dolomite that is fairly pure. The analyses of three samples, Nos. 81, 81A, and 81B, representative of the 3 feet of calcium



A. Thinly bedded, shaly Carboniferous limestone.



B. Pillow structure in Carboniferous limestone near Green Oaks, Colchester County, N.S.

limestone, the 30 feet of impure dolomite, and the 3 feet of fairly pure dolomite respectively, show the different chemical characteristics of the stone. Although this limestone contains a higher percentage of impurities than is desired for most industrial uses, it is sufficiently tough and hard to be of value for road metal, and is so situated that it can be easily quarried.

Three-quarters of a mile farther south a 30-foot band of very fine-grained, dark blue limestone, dipping east at an angle of 25 degrees, crosses the road. It forms the basal layer of the Windsor series which at this point is in contact with the quartzose Horton conglomerate. Thin streaks of shaly material are included in the limestone and they project slightly on the weathered surface. At the base, beds up to 16 inches in thickness occur interstratified with thin beds, but towards the top of the deposit the beds are all thin and shaly. Veins of white calcite containing small, cubical crystals of purple fluorspar are present. The analysis of Sample 82 shows the chemical composition. This band outcrops at many places west of here along the course of Meadow Brook, which follows the contact between the Windsor series and the underlying rocks, the last outcrop examined being $3\frac{1}{2}$ miles to the west, just beyond the Afton road.

A peculiar deposit of limestone, apparently at a horizon in the Windsor series, some distance above the blue limestone just described, is exposed on Meadow Brook, 1 mile upstream from the quarry at Monastery farm. This limestone is composed of oolites, or spherical masses of black calcite $\frac{1}{32}$ inch in diameter, held together by a dolomitic cement. On exposure to the weather the calcite spherules dissolve more rapidly than the dolomitic matrix, and thus all weathered surfaces have a cellular appearance. The outcrop is 15 feet wide and is composed of beds 4 to 16 inches thick that strike S. 65°W.[1] and dip vertically. On the north side a narrow band of gypsum is in direct contact with the limestone but the southern edge of the deposit is not visible. Sample 83 was obtained from the outcrop.

[1] In this report wherever the strike of a stratum of limestone is given, the bearing refers to magnetic north and not to true north. The average magnetic declination in the Maritime Provinces is about 23 degrees west of true north.

Analyses of Antigonish County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
75.....	11·18	0·87	3·33	0·13	80·91	4·87	101·29	0·09	45·38	2·33	19 : 1
76.....	10·32	1·03	2·71	0·11	69·57	15·85	99·59	0·05	39·02	7·58	4 : 1
77.....	1·54	0·31	0·43	0·07	96·73	0·46	99·54	tr.	54·21	0·22	246 : 1
77A.....	0·86	0·26	0·42	0·04	96·33	1·39	99·30	tr.	53·96	0·66	82 : 1
77B.....	0·54	0·22	0·22	0·04	97·98	0·74	99·74	0·02	54·89	0·35	157 : 1
78.....	0·68	0·26	0·16	0·07	97·88	0·86	99·91	tr.	54·85	0·41	134 : 1
79.....	5·57	0·56	1·46	0·09	91·92	0·36	99·98	tr.	51·51	0·17	303 : 1
79A.....	4·96	0·43	1·33	0·09	92·75	0·32	99·88	tr.	52·00	0·15	347 : 1
80.....	1·08	1·04	0·62	0·02	57·23	40·55	100·54	tr.	32·06	19·39	1·65 : 1
80A.....	0·90	0·59	0·95	0·04	80·83	16·42	99·73	0·03	45·28	7·86	6 : 1
81.....	2·52	1·29	1·05	0·09	91·95	3·44	100·34	0·52	51·54	1·64	31 : 1
81A.....	5·98	1·24	1·82	0·09	51·42	40·03	100·58	0·12	28·85	19·13	1·51 : 1
81B.....	1·92	1·47	0·89	0·02	54·04	40·98	99·32	0·07	30·28	19·60	1·54 : 1
82.....	10·01	0·92	3·02	0·12	82·06	3·81	99·94	0·09	45·95	1·84	25 : 1
83.....	0·72	1·43	0·41	0·02	81·45	16·16	100·19	0·06	45·62	7·73	6 : 1

75. James River Station. Bottom 8 feet of deposit, 1 mile east of railway station.
76. Antigonish. Top 10 feet of deposit, 1½ miles north of town.
77. Antigonish Harbour. Shell limestone. Face of deposit fronting on the harbour.
77A. " " " Landward face of deposit.
77B. " " " Central part of deposit.
78. " " " At base of hill at head of harbour.
79. McIsaac Point. Top 15 feet of nodular limestone band along sea coast.
79A. " " Bottom 5 feet of same band.
80. Pomquet. Dolomite deposit 1½ miles northwest of the village.
80A. " Oolitic and dense-textured limestone 1½ miles northwest of the village.
81. Monastery. Three feet of calcium limestone on east side of deposit at Monastery farm.
81A. " Central 28 feet of dolomite in the deposit at Monastery farm.
81B. " Three feet of dolomite on west side of deposit at Monastery farm.
82. " Thirty feet of blue limestone in deposit ¾ mile south of 81.
83. " Oolitic limestone on Meadow Brook 1 mile above 81.

Cape Breton County

Both Precambrian and Carboniferous limestones are found in this county. A quarry is worked in each type by the Dominion Steel and Coal Corporation to supply the steel plant at Sydney with flux and with stone for making lime. The quarries of this corporation are the two largest at present worked in the province.

The Precambrian limestones (George River series) extend in long, narrow belts along the steep southeast slope of the Boisdale Hills from near the village of George River (the type locality of this series) to near Eskasoni on East Bay, Bras d'Or Lake. The belts in the central and southern parts of this area are composed principally of calcium limestone, much of which is very impure, but those in the northern part are composed largely of dolomite and are of a higher degree of purity. The dolomite quarry of the Dominion Steel and Coal Corporation is situated at the north end of the area, near George River village. In 1867 a lime industry flourished at this place, but the kilns are now in ruins.

The Carboniferous limestones (Windsor series) are found principally along the shores of the Bras d'Or Lakes and north thereof, but outliers of

Windsor strata containing limestone also occur near Mira Bay, Mira Lake, Gabarus Bay, and north of Loch Lomond. The limestone of Mira Bay is said to have been quarried by the French to obtain lime for the building of Louisburg. The main area of the Windsor series lies south of Sydney in the form of a huge letter S, beginning at the head of East Bay and extending northeasterly down the valley of the Sydney River to near Sydney, thence northerly across Point Edward peninsula and southwesterly up the valley of Ball Creek, and thence northeasterly again down the valley of the George River to its northern end. Many limestone deposits are found in this area and the quarry from which the Steel Company derives high-calcium limestone for flux for the open-hearth furnaces is on Point Edward peninsula. Southeast of the head of East Bay is a very large deposit of high-calcium limestone that, doubtless, would have been quarried before this had it been nearer either rail or water transportation. Dolomite deposits are few and of small extent in the Windsor strata of Cape Breton County, the principal one being on the shore of Mira Bay at Dixon Station. No deposits of shell limestone were observed. The Carboniferous limestones have been quarried on a small scale in many localities for the making of lime and for foundation stone, but the principal use made of them has been, and is, for flux.

Head of East Bay of Bras d'Or Lake

Windsor strata underlie a large area at the head of East Bay between the Coxheath Hills and the East Bay Hills, and in this area are a number of limestone deposits. Those along the base of the Coxheath Hills seem of little value, but 2½ miles southeast of the head of East Bay a very large deposit of high-grade limestone underlies the wooded area between the Morley road and the Glen Morrison road for a distance of about 1 mile. The deposit is flat-lying, or nearly so, has an apparent thickness in excess of 25 feet, and is composed for the most part of heavily bedded, dense-textured, bluish grey, high-calcium limestone. It overlies a siliceous conglomerate, and where it is in contact with the latter, the limestone is thin-bedded and shaly for a thickness of 5 feet or more and also appears magnesian. Above this is a few feet of heavily bedded limestone containing very thin, irregular films of greenish shale, but the shale is not in sufficient quantity to lower the quality appreciably. The remainder of the stone is comparatively free from visible impurities. On the west side of the deposit exposures are visible along the east and west road, known as the Meadow road, 400 yards west of its junction with the Glen Morrison road. The land is low and wet at this place but the limestone can be traced for ½ mile southeasterly along a broad ridge to the valley of a small brook crossing the Glen Morrison road a little over a mile north of the school house. The ridge rises 60 to 80 feet above the brook and thus could easily be quarried. The quartzose Horton conglomerate is seen in the bed of the brook. Sample 98 is a composite sample taken from outcrops on the Meadow road and from the many boulders on top of the ridge. Northward from here limestone is to be seen on the hillsides both east and west of the brook to where it crosses the Morley road—a distance of a mile. Sample 98A, taken near where the brook crosses the Glen Morrison road, represents 15 feet of strata above the 5-foot band of

apparently impure magnesian stone at the base. Sample 98B was obtained near the Morley road where this same brook crosses it. Actual outcrops are relatively few over this large area, but the presence of many huge limestone boulders indicates the large area underlain by limestone. It is, however, 5 miles distant from navigable water and 15 miles by road from Sydney.

Mira Bay

Dolomite and calcium limestone are both present in a small area of the Windsor series just north of Catalone Point, on the southwest shore of Mira Bay. The dolomite is exposed along the beach and dips out to sea at an angle of 30 degrees. The stone is brown, finely granular and occurs in rough beds up to 18 inches thick, which are crossed by a few veins of white calcite. About 15 feet of strata outcrop on the beach opposite Dixon Station (Sydney and Louisburg railway) and the deposit extends inland under the station. Beneath the dolomite is sandstone and the bottom beds of the dolomite are very sandy. Sample 99 represents the 15 feet of dolomite.

Back from the shore many boulders of grey calcium limestone are found but no actual ledges were seen.

West of Catalone Lake are a number of small deposits of calcium limestone, some of which seem quite pure but, because of their limited size, no samples were taken.

On the shore of Neil Cove on the south side of Mira Bay is a very small limestone deposit which, so it is claimed by residents of the locality, was utilized by the French to make lime for the building of Louisburg.

Sydney

The strata of the Windsor series south and west of Sydney Harbour include much limestone. The most important deposit—part of which is now being quarried by the Dominion Steel and Coal Corporation—extends for 3½ miles southeasterly across the peninsula between the northwest arm and the south arm of Sydney Harbour. It consists of a band, 25 to 28 feet thick, of grey (in places, reddish), oolitic, high-calcium limestone that dips to the northeast at an average angle of 10 degrees. It is overlain and underlain by shale. The band can be traced (though not continuously) from Limestone Point, on the shore of the northwest arm of Sydney Harbour at Edwardsville, to the old quarry known as the Ingraham quarry near Westmount on the south arm of the harbour. The structure of this area is that of an anticline pitching to the northeast.

Quarry of Dominion Steel and Coal Corporation. This quarry, ½ mile southeast of the village of Edwardsville, supplies flux for the open-hearth furnaces at Sydney. It begins ½ mile from the shore of the northwest arm of Sydney Harbour and extends for ⅔ mile southeasterly along the strike of the beds and is being worked down the dip. The stone quarried is a hard, dense, grey oolitic limestone in beds 3 to 8 feet in individual thickness. The deposit is 27 feet thick and dips to the northeast at an

PLATE VI

A. Quarry of Dominion Iron and Steel Corporation at Edwardsville, Cape Breton County, N.S. Southeast part of working-face showing dip of strata and depth of overburden.

B. Quarry of Dominion Iron and Steel Corporation at Edwardsville, Cape Breton County, N.S., showing overburden removed from part of the limestone preparatory to quarrying the latter.

angle of 12 degrees. It is underlain by shale and, along the greater part of the quarry face, is overlain by 15 feet of interbedded sandstone and shale and by an equal thickness of soil. (Plate VIA page 31.) The land surface behind the quarry slopes away to the northeast at an angle approximating to that of the dip of the strata, and thus the overburden will not greatly increase in thickness as the quarry is worked down the dip. At the south end of the face, which is also the south limit of the property, the overlying sandstone and shale, together with several feet of the limestone, have been removed, apparently by erosion, and the overburden consists of 20 feet of clay soil. A section of the face from top to bottom is as follows:—

6 feet of dark grey oolitic limestone in thick beds.
2-inch seam of red clay.
3-foot bed of brownish grey dense limestone containing many crystals of colourless calcite and some oolites together with other fossil fragments. It breaks with a conchoidal fracture.
12 feet of grey dense limestone composed largely of very small oolites and in beds 3 to 6 feet thick. It breaks with a conchoidal fracture.

Sample 100 is representative of the entire face at the south end of the quarry.

A section of the face 1,200 feet farther north is as follows:—

10 feet of grey dense limestone with reddish streaks. The top 1½ feet is sandy.
9 feet of reddish grey dense limestone.
8 feet of grey dense limestone.

The stone here is all heavily but irregularly bedded and breaks with conchoidal fracture. Very small oolites are present in zones through the beds but they are not so prominent as at the south end of the quarry. Sample 100A is from the top 10 feet excluding the sandy 1½ feet on the very top; 100B is from the middle 9-foot section of reddish stone and 100C from the bottom 8 feet. See table of analyses on page 40.

In working the quarry the soil and overlying rock (the latter requiring preliminary blasting) are removed by a Marion railway-type, steam shovel equipped with a 1¼-yard dipper (Plate VIB, page 31). The limestone is drilled by tripod air drills and blasted with dynamite. Considerable secondary blasting is required because of the limestone breaking in large blocks. The broken stone is loaded into wooden side-dump cars by another 1¼-yard, Marion steam shovel and taken to the crusher in trains of 3 cars pulled by steam dinky engines of which there are two in the quarry. The crushing plant is operated by steam and the equipment consists of a vibrating grizzly, a No. 8 Austin gyratory, and the necessary screens. Stone from 8 inches down to 4 inches in diameter is used for open-hearth flux. Material ranging in size from 4 inches to 1½ inches is utilized for blast-furnace flux along with the regular supply from Newfoundland. The undersize is for the most part discarded, though a small proportion of it is taken to Glace Bay and there pulverized for use in dusting the coal mines. Stone from the Point Edward quarry is also calcined at the steel plant for use in the open-hearth furnaces, the ammonium sulphate plant, and in the wire mill.

Shipments from this quarry are taken over a standard gauge railway line, 2¼ miles long, owned by the Steel Company, which connects with the Canadian National railway at Leitches Creek station, 10 miles from Sydney.

During the years 1924-1931 the Nova Scotia Department of Agriculture operated a plant at the Point Edward quarry for the production of agricultural limestone. Quarry waste used for this purpose was pulverized in a Jeffrey, Type D, swinghammer mill driven by a 38 h.p. gasoline engine and having an output of 15 tons per day.

Northeast of the Steel Company's quarry are two scarped ridges of limestone trending parallel to the ridge where the quarry is located. The first is 900 feet back from the present quarry face and the second 2,100 feet northeast of this again. Both are on lower ground than the present quarry but as the strata dip to the northeast both these ridges are stratigraphically higher than the stone being quarried. The limestone in the first ridge is exposed for a 10-foot thickness near the top of a 25-foot slope and in appearance is much like that in the quarry but is slightly less pure as the analysis of Sample 101 shows. It is overlain by sandstone. The steep face of the ridge is towards the southwest and the strata dip to the northeast at about 10 degrees which also corresponds closely to the slope of the land surface. A limestone quite like this, possibly the northwestern continuation of this band, is seen in the small abandoned quarry at Limestone Point, a short distance north of where the extension of the deposit quarried by the Steel Company appears on the shore.

In the second ridge the limestone is also exposed along the southwest face of a steep slope 30 feet high, and dips at a low angle to the northeast closely approximating the slope of the land surface. The stone here, however, is quite variable in both appearance and quality. At the top is 8 feet of fine-grained, light grey high-calcium limestone, containing small fragments of fossils, which weathers nearly white. Directly underlying are dark brownish strata composed in part of high-calcium limestone and in part of dolomite, the two components being intermixed in a complicated manner. A thin band of grey calcium limestone comes next and is in turn underlain by an impure, brown, earthy dolomite containing crystals of calcite and streaks of high-calcium limestone. Another bed of calcium limestone occurs beneath this again and it is underlain by sandstone. At Dixon Point on the northwest arm of Sydney Harbour is an exposure of limestone just as variable in composition and it is probably the northward extension of this deposit.

Out on the tip of the peninsula, $1\frac{1}{4}$ miles north of Point Edward village, 6 feet of limestone shows on the beach beneath 20 feet of soil. The stone is mostly fine-grained, grey calcium limestone but it contains irregular patches of brown-weathering dolomite, particularly in the lowest beds visible. It is apparently underlain by greenish grey, calcareous shale.

On the shore southeast of Crawley Creek an earthy, drab-coloured dolomite, that weathers deeply to a brown shade, is exposed.

Along the north shore of the Sydney River, $\frac{3}{4}$ mile below the bridge, a band of variable limestone, much like that composing the second ridge northeast of the Steel Company's quarry at Edwardsville, is exposed in the valley of a tiny brook. The strata dip southerly at an angle of 20 degrees. The topmost beds are composed of nodular masses of dark blue, fossiliferous calcium limestone and dark blue, brown-weathering, non-fossiliferous dolo-

mite. The contact between the nodular masses of different composition is very sharp and distinct. On the weathered surface all are very fine-grained. About 8 feet of this type of stone, in beds averaging 1 foot in thickness, is exposed. One hundred feet down the brook a thickness of 4 feet of finely granular, buff-coloured dolomite, containing a few fossils and tiny crystals of iron pyrites, is to be seen. It weathers deeply to an ochreous yellow colour and is quite different in appearance from the dolomite masses in the strata up the brook, which contain no fossils. Sample 102 shows the composition of the 4 feet of dolomite.

Half a mile to the north, the same band of limestone outcrops in the bed of another brook. The dip here is southeasterly at 15 degrees and the stone is visible for 600 feet west of the road. The top beds here also are composed of irregularly shaped masses of dolomite and calcium limestone, but immediately beneath them is 6 feet of heavily bedded, light grey, fine- to medium-grained, pure calcium limestone composed largely of fossil fragments. Sample 103 represents this latter stone. This is underlain by 8 feet of light grey, fine-grained magnesian limestone that weathers deeply to a yellow-brown colour; Sample 103A was taken from these strata. On the beach at the mouth of the brook is a shaly, greenish and reddish limestone conglomerate that also contains many pebbles of igneous rocks.

The limestone could easily be quarried at both locations as it is at a good elevation above the river and is only lightly covered with soil; in fact small amounts have been quarried at each place, but the variable nature of the limestone would prevent its being used for chemical and metallurgical purposes.

On the north bank of the Sydney River, just below the dam, a band of limestone 20 feet thick underlain by red, sandy shale and dipping toward the river at 45 degrees has been quarried and burned for lime. It is dark grey, dense, calcium limestone of good quality, but the quantity available is limited.

At the head of the northwest arm of Sydney Harbour limestone deposits are also plentiful. Between Watson Creek and Grantmire Creek a quarry was at one time worked on the western slope of a hillside, 40 feet above the Canadian National railway. The quarry is 100 feet square and shows the following section:—

5 feet of soil.
5 feet of sandy limestone in one bed.
8 feet of dense, brownish grey, brittle, calcium limestone containing films of green shale.

The strata dip northeasterly, or into the hillside, at an angle of 5 degrees and thus the overburden would rapidly increase if the quarry were worked back into the hill. It is doubtful if the limestone strata exceed 20 feet in thickness. Sample 104 represents the 8 feet of stone in the bottom of the quarry.

Opposite the old mill-dam on Ball Creek, 1½ miles southwest of the railway, the Dominion Iron and Steel Company[1] at one time operated an extensive quarry in a band of limestone 20 feet thick that dips at 38 degrees to the northwest down the side of the creek valley. The deposit has been

[1] Now Dominion Steel and Coal Corporation.

worked to its economic limit as it trends into the hillside at the west end and, though it can be traced southwesterly for more than a mile, much overlying shale and sandstone would have to be removed before more of the limestone could be quarried. An analysis supplied by the Steel Company shows the limestone to contain 3 per cent total impurities and 1 per cent magnesium carbonate. Northeast of here a band of less pure limestone overlies the Carboniferous conglomerate for a mile between the Scotch road and Grantmire Creek. The Steel Company's analysis of this band shows 4 per cent total impurities and 4·65 per cent magnesium carbonate.

Trending southwesterly for 1½ miles from a point on the railway, ⅓ mile north of Leitches Creek Station, is a deposit of dark grey, rather impure, calcium limestone dipping northwesterly at 20 degrees. Several small pits have been dug in this stone but no quarrying on any scale has been done. Sample 105 was taken from the few feet of strata exposed in a pit 1 mile southwest of the railway.

George River

Both Precambrian and Carboniferous limestones outcrop along the valley of the George River at a point about 2 miles south of George River Station on the Canadian National railway. The Precambrian limestone is found on the steep slopes of the Boisdale Hills west of the river, and the Carboniferous limestone is at the bottom of the valley where it directly overlies the Precambrian limestone. Several quarries have been worked in both types of rock but only one quarry, that of the Dominion Steel and Coal Corporation, is now in operation. (Plate VII, page 36.)

The Report of Commissioners of Mines for Nova Scotia, 1876, states that at that time a company known as the George River Marble and Lime Company quarried Precambrian dolomite at the site of the present quarries to supply two large lime kilns. The lime, packed in barrels, was shipped by water to Newfoundland and to various points along the coast of Nova Scotia.

Quarry of Dominion Steel and Coal Corporation. This is located on the steep, wooded slope of the Boisdale Hills immediately west of the valley of the George River, 1½ miles south of George River Station. The nearest settlement is Scotch Lake and the quarries are sometimes referred to as being at this latter place. The stone quarried is a medium-grained, bluish white, metamorphosed dolomite of Precambrian age that largely composes a ridge rising to a height of 300 feet or more above and parallel to the George River. Quarries have been worked in this deposit for many years and old workings extend for 900 feet along the base of the ridge. The deposit was originally quarried only at the base of the ridge but, as the working-face became too high, new benches were successively opened farther up the hill and waste material was deposited over the old faces. In this way much good stone has been covered up. The present workings—to obtain stone for making lime used in fettling the bottoms of the open-hearth furnaces at Sydney—are at the top of the ridge.

The dolomite is veined in an irregular manner with thick bands of green serpentine trending roughly parallel to the face of the ridge and is also spotted with small blebs of serpentine, ⅛ to ½ inch in diameter. One

PLATE VII

A. Dolomite quarry of Dominion Iron and Steel Corporation at George River, Cape Breton County, N.S.

B. Working-face in dolomite quarry of Dominion Iron and Steel Corporation at George River, Cape Breton County, N.S.

or two narrow bands of dense, black, ferruginous rock (possibly altered sediments) are also present in the dolomite. The serpentine masses are quite calcareous and the limestone in direct contact with them has the composition of magnesian limestone rather than dolomite. Sample 106 was taken across 40 feet of the face being worked at the top of the ridge, exclusive of the serpentine bands; No. 106A is an analysis supplied by the Steel Company as being representative of a shipment of 8 carloads of dolomite from this quarry.

Dominion Steel and Coal Corporation owns the deposit but it is worked on a contract basis by John S. Nairn of Sydney. The quarry is at the top of the ridge and a face averaging 30 feet in height is maintained, on top of which is about 2 feet of soil. Hand drills and dynamite are used in quarrying, and the broken rock is all hand-sorted in order to obtain material as free from serpentine as possible. The stone is loaded by hand into small, steel, side-dump cars, pushed to the edge of the quarry and dumped into a chute. There are 5 of these chutes one below the other and the stone is taken from the delivery end of each chute to the next chute in a steel, dump car. A standard-gauge spur track from George River Station to the quarry permits the stone to be loaded onto standard railway cars for transportation to Sydney, 27 miles distant. As the stone is all manufactured into lime at Sydney no pieces less than 3 inches in diameter are required and all smaller fragments are piled on the waste dumps.

Scotch Lake

Two small quarries in limestone of the Windsor series have been worked in the past at the village of Scotch Lake, ¾ mile south of the large dolomite quarry. One of these is on the northwest side of the George River along the foot of the Boisdale Hills. The deposit consists of dense-textured, dark grey calcium limestone resting on an uneven surface of white Precambrian dolomite and dipping at an angle of 20 degrees to the southeast. Sample 107 represents the stone in this quarry. How far the deposit extends on each side of the opening is not known, as the soil cover is from 3 to 10 feet thick. The metamorphosed dolomite underlying the Carboniferous limestone is of the same type as that at the George River quarries and contains many small blebs of serpentine. Analysis 107A shows the composition of the little that is exposed.

On the opposite side of the river, just north of the Scotch Lake school, a deposit of thinly bedded, dense, dark grey and tan, calcium limestone, trending northerly and dipping to the east at an angle of 65 degrees, is exposed across a width of 30 feet. The tan and grey stone have the same chemical composition and commonly occur in the same stratum. The tan colour is not due to weathering as it is present in the fresh stone as well as on weathered surfaces. Much secondary calcite is present in both tan and grey stone. Sample 108 was taken across the 30 feet of outcrops.

A short distance north of here the same band of limestone has been quarried to a depth of 20 feet across a width of 30 feet. The limestone is standing nearly vertically and the soil overlying the stone to a depth of 3 to 5 feet has slid over the quarry faces until very little stone is now showing. A few narrow veins of barite were observed in the quarry.

The George River limestone extends in a narrow belt southwestward from the Steel Company's quarry for 5 miles along the southeastern flank of the Boisdale Hills, and good sections are visible in all the principal brooks that cut across it. To quote Fletcher[1]

> They (the George River rocks of this belt) consist of highly crystalline limestone and dolomite, containing serpentine, talc, mica, tremolite, plumbago, galena, hematite, magnetite, and other minerals; interstratified with felsite, syenite, diorite, mica schist, quartzite and quartzose conglomerate; and dipping steeply to the south of east. The colour is variable but chiefly bluish.

The great proportion of the limestone in this belt is dolomitic or highly magnesian in character but much of it contains too great a percentage of silicate minerals to be of value for most of the uses to which dolomite is put.

Another belt of the George River series begins at the headwaters of Leitches Creek, about 1 mile east of where the above described belt ends, and extends southwesterly for 11 miles along the southeast flank of the Boisdale Hills nearly to the shore of East Bay. The limestone in this band is mostly of the calcium type and only rarely contains over 10 per cent magnesium carbonate. It, however, is mostly impure, being traversed by veins of quartz and tongues of granitic rocks and is filled with veins and blebs of serpentine.

Boularderie Island

Only the eastern part of the northern half of this island is in Cape Breton County—the remainder being in Victoria County. In the Cape Breton County portion, limestone occurs in the narrow strip of Windsor strata fringing the shore of Saunders Cove. At Shawfield Point on the west side of the cove a deposit of calcium limestone is exposed on the top of the cliff along the shore and is again seen in a series of outcrops along a low ridge, ¼ mile in length, paralleling the shore 800 feet inland. The deposit is undulating and in places has a domed structure, but in general it dips north or inland at angles varying from 10 to 20 degrees. Shawfield Point itself is composed of sandy and shaly nodular limestone and conglomerate that underlie the better grade stone. Along the beach, ½ mile northeast of the point, the limestone is much crumpled and folded. In general the better grade limestone is heavily bedded, dense-textured, and brownish grey in colour. A maximum thickness of 12 feet of this type of limestone is visible along the cliffs and it may be thicker inshore, but, on the other hand, owing to intervening low land and to faulting, the limestone may not extend continuously from the shore to the ridge 800 feet inland. Sample 109 was obtained from the outcrops along the ridge on J. G. McLean's property and 109 A from the continuation of the ridge on the land of Kenneth MacKenzie, including 11 feet of strata in a small quarry. The deposit is favourably situated for quarrying and it appears to be large.

On the eastern side of Saunders Cove, impure limestones outcrop along the road immediately west of Grove Point village and also at the tip of Grove Point itself. In both places shale is interbedded with the limestone. The deposit at the village is composed of dark blue, fine-grained calcium

[1] Geol. Surv., Canada, Progress Rept., 1874-76, p. 382.

limestone and dips northwesterly at 20 degrees, but at Grove Point interbeds of impure dolomite also occur with the limestone and shale. Sample 110 represents 14 feet of limestone strata at Grove Point village exclusive of the shale interbeds.

Eskasoni

From the head of Crane Cove on the north shore of East Bay, Bras d'Or Lake, geological maps show a band of the George River rocks about $\frac{1}{4}$ mile wide, trending northeasterly for more than a mile into the Boisdale Hills. Very little bedrock is to be seen but there is a great profusion of boulders of serpentinous, bluish white, metamorphosed calcium limestone. The limestone in many of these boulders contains stringers of quartz and feldspar and in general is quite impure and would contain on the average more than 10 per cent total impurities. Fletcher[1] reports that in this vicinity west of Bown Brook

> A marble of considerable range of colour and texture, but generally white, with brown, blue, greenish and canary-yellow streaks, susceptible also of a fine polish, has been quarried to a very limited extent on the hill near Bown's. It seems to be interstratified with a three-foot bed of red syenite.

Five miles east from Eskasoni at a point $1\frac{1}{2}$ miles inland along the Cossitt road, a large deposit of George River calcium limestone occurs, but it contains a great deal of serpentine and other silicate minerals.

Grand Narrows

In the first railway cut east of the Narrows, near Christmas Island, a band, about 8 feet thick, of impure, very fine-grained, dark grey magnesian limestone of the Windsor series, dips at 30 degrees northwestward toward the water. It is underlain by a quartzose conglomerate. The limestone is in beds from a few inches up to 20 inches thick and has been quarried to a small extent for building railway culverts in the vicinity. Sample 111 shows its composition. Only a small quantity is available.

At Shenacadie, 8 miles northeast of Grand Narrows, small deposits of Carboniferous limestone are reported to occur near the shore of Little Bras d'Or Lake.

[1] Geol. Surv., Canada, Progress Rept. 1876-78, p 411.

Analyses of Cape Breton County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
98	1·00	0·53	0·59	0·04	96·32	0·95	99·43	tr	53·96	0·45	120 : 1
98A	2·40	0·39	0·81	0·17	95·26	1·05	100·08	tr	53·45	0·50	107 : 1
98B	1·15	0·47	0·62	0·05	96·45	1·14	99·88	tr	54·04	0·54	100 : 1
99	4·70	0·89	0·85	0·07	54·04	39·41	99·96	0·03	30·30	18·85	1·60 : 1
100	2·04	0·35	1·03	0·10	94·70	1·47	99·69	0·02	53·02	0·70	76 : 1
100A	1·56	0·36	1·04	0·15	95·82	1·30	100·23	0·03	53·68	0·62	87 : 1
100B	0·92	0·33	0·65	0·12	96·52	1·07	99·61	0·04	54·08	0·51	106 : 1
100C	1·70	0·22	0·98	0·09	95·36	1·13	99·48	0·04	53·42	0·54	99 : 1
101	3·05	0·38	1·12	0·14	93·59	1·67	99·95	0·04	52·39	0·80	66 : 1
102	2·52	0·88	0·62	0·02	54·45	40·97	99·46	0·06	30·50	19·74	1·54 : 1
103	0·60	0·28	0·08	0·02	95·52	3·66	100·16	tr	53·51	1·75	30 : 1
103A	2·86	0·60	0·90	0·02	75·39	20·08	99·85	tr	42·22	9·60	4 : 1
104	3·64	0·37	1·37	0·09	93·55	1·22	100·04	0·07	52·44	0·58	90 : 1
105	6·42	0·79	1·25	0·11	89·28	1·97	99·82	0·09	49·99	0·94	53 : 1
106	2·70	0·45	0·30	0·20	54·22	41·65	99·52	0·07	30·36	19·93	1·52 : 1
106A	2·60	1·32	.....	.....	54·56	41·08	99·56	0·08	30·54	19·71	1·55 : 1
107	3·14	0·28	1·08	0·07	94·17	1·62	100·36	0·06	52·79	0·77	68 : 1
107A	6·08	0·45	0·69	0·14	54·17	38·21	99·74	0·04	30·33	18·28	1·66 : 1
108	1·98	0·37	0·83	0·15	95·60	0·85	99·78	tr	53·62	0·40	134 : 1
109	2·52	0·30	1·26	0·24	94·60	0·48	99·40	tr	53·11	0·23	231 : 1
109A	2·94	0·44	0·86	0·04	95·43	0·34	100·05	tr	53·45	0·16	334 : 1
110	6·40	0·58	1·08	0·07	88·68	1·18	98·59	0·23	49·70	0·56	89 : 1
111	6·18	0·91	2·27	0·07	69·58	21·51	100·52	0·05	39·01	10·28	4 : 1

98	East Bay.	Outcrops near junction of Meadow road and Glen Morrison road, 2½ miles southeast of East Bay village.
98A	" "	Strata near base of same deposit on Glen Morrison road.
98B	" "	Outcropping of same deposit on Morley road
99	Dixon Station.	Mira Bay. Fifteen feet of dolomite.
100	Edwardsville.	Dominion Steel and Coal Corporation quarry. Entire face at south end of quarry.
100A	"	Dominion Steel and Coal Corporation quarry. Top 10 feet of face, north end of quarry.
100B	"	Dominion Steel and Coal Corporation quarry. Middle 9 feet of face, north end of quarry.
100C	"	Dominion Steel and Coal Corporation quarry. Bottom 8 feet of face, north end of quarry.
101	"	Top 10 feet of ridge, 900 feet northeast of Steel Company's quarry.
102	Sydney River. North shore.	¾ mile below road bridge. Four feet of dolomite.
103	" "	½ mile north of deposit 102. Six feet of calcium limestone.
103A	" "	Eight feet of magnesian limestone underlying 103.
104	Sydney Harbour, Northwest Arm.	Eight feet of strata in bottom of abandoned quarry between Watson and Grantmire Creeks.
105	Leitches Creek Station.	Limestone band trending southwesterly for 1½ miles from a short distance north of the station.
106	George River.	Forty feet of strata, exclusive of serpentine, in dolomite quarry owned by Dominion Steel and Coal Corporation.
106A	" "	Analysis supplied by the Steel Company as being representative of shipments of dolomite from the George River quarry.

107	Scotch Lake.	Small quarry in Carboniferous limestone on northwest side of George River.
107A	" "	Precambrian dolomite in floor of above quarry.
108	" "	Thirty feet of Carboniferous limestone on southeast side of river near school house.
109	Boularderie Island.	Shawfield Point. Outcrops on J. G. McLean property.
109A	" "	Continuation of same deposit on K. MacKenzie property.
110	" "	Grove Point village. Outcrop immediately west of village.
111	Grand Narrows.	Eight feet of Carboniferous limestone in railway cut opposite Christmas Island.

Colchester County

Most of the limestone deposits in Colchester are found in the southern tip of the county within the large area of the Windsor series that also extends into the adjoining Counties of Hants and Halifax. Small outliers of the Windsor series containing limestones occur along the north shore of Cobequid Bay as far west as Lower Economy. Outliers also are found northeast of Truro as far as East Mountain. West of Acadia Mines is a belt of metamorphosed limestone long considered to be of Devonian age but now regarded as being probably of Carboniferous age. A metamorphosed limestone associated with diorite is also reported north of New Annan.[1]

The limestones are of many grades of purity, and range in composition from high-calcium shell limestone to dolomite. A deposit of shell dolomite occurs near Hilden. One of the largest quarriable deposits of Carboniferous limestone in the province lies south of Truro between Brookfield station on the Canadian National railway and Green Oaks station on the Dominion Atlantic railway (C.P.R.).

Within recent years limestone has been quarried only to a very small extent at Upper Economy and near East Mountain, at which latter place agricultural limestone for local use is still produced as the demand warrants. In the past, several deposits were worked for lime-burning and for flux to supply the blast furnace formerly in operation at Londonderry.

Upper Economy

Several outliers of the Windsor series consisting largely of limestone occur at Upper Economy, a short distance north of Cobequid Bay shore. On the land of Mrs. Jas. E. Brown, at the head of Jackson Brook, slightly over 1 mile from the shore, a small quarry for the production of agricultural limestone has been opened in a band of soft, brown magnesian limestone that trends east and west and dips southerly at an angle of 60 degrees. The limestone is composed of a mixture of extremely small crystals of dolomite and calcite in which are embedded fragments of calcite fossils. It is very fine-grained but rather porous and is traversed by many tiny veinlets of colourless calcite. Bedding is poorly developed and the whole deposit is much cracked. (Plate VIII A, page 42.) The chemical composition is shown by the analysis of Sample 7 which was taken from 30 feet of strata exposed in the excavation.

[1] Geol. Surv., Canada, Ann. Rept., vol. V, pt II, p. 156P (1891).

PLATE VIII

A. Carboniferous limestone in quarry at Upper Economy, Colchester County, N.S. Note the irregular fractures in the stone.

B. Thinly bedded, argillaceous Carboniferous limestone, west of Brookfield, Colchester County, N.S.

The quarry has been opened for a width of 30 feet along the strike and near the foot of a low hill into which the band trends. Overburden amounts to only a few inches and a quarry face of 35 feet or more could be developed and still possess natural drainage. A Gruendler swing-hammer pulverizer was used to prepare the stone for agricultural use but there has been no production for the past several years. Many other outcrops of limestone are to be seen in the vicinity, and the band in which the quarry is opened may be more than 30 feet thick.

One-half mile farther north, also on Mrs. Brown's land, is a deposit of siliceous, calcium limestone that at one time was quarried and burned for lime. There are numerous exposures visible over an area several hundred feet square that could easily be quarried. The dip and strike of the strata vary greatly in the different outcrops. Analysis of Sample 8 shows the stone to contain a high percentage of impurities.

Lornevale

A deposit of dense, white, metamorphosed limestone occurs along the side of Cobequid Mountain, ½ mile north of Lornevale, which is 5 miles northwest of Londonderry station on the Canadian National railway. It was quarried for flux when the iron furnaces were first in operation in the district, but the quarry faces are now covered with soil and very little of the limestone is visible. Thus nothing can be stated about the extent of the deposit or its relation to the other rocks of the district. Such limestone as can be seen is much fractured and contains tiny crystals of pyrite, which give it a rather rusty appearance and cause it to weather very dark. Sample 9 was obtained from a small quarry on the land of Raymond McCabe, 1 mile northwest of Lornevale post office. Three-quarters of a mile east of here a large quarry was worked in this same stone for flux, and the ruins of an old field kiln nearby show that it was also burned for lime. Sample 10 was taken from a pile of limestone excavated from a quarry 1½ miles east of where Sample 9 was obtained, and close to the spur track that served No. 6 level of the Acadia iron mines. Wherever seen along the mountain-side the limestone is of the same type, and the analyses of the two samples obtained show it to be a fairly pure, high-calcium limestone. An impure magnesian limestone is, however, associated with the iron ore of this district. The fact that during the latter period when the blast furnace was in operation, limestone for flux was obtained from Brookfield, south of Truro, and from South Maitland, may indicate that the limestone of the Lornevale district is not readily obtainable in quantity.

Five Islands

A fine-grained, white marble and a greenish one containing serpentine are reported[1] to occur in the valley of the North River, two miles from the shore of Minas Basin, but the extent of the deposits is not noted.

---

[1] How, Henry; Mineralogy of Nova Scotia, p. 155 (1868).
Geol. Surv., Canada, Ann. Rept., vol. V, pt. II, p. 160P. (1891).

Glenholm

On the east bank of Debert River, 2 miles from its mouth, a deposit of very argillaceous, thin-bedded, magnesian limestone lies beneath 3 feet of gypsum at the top of a 70-foot cliff. Talus hides most of the cliff and only 10 feet of the limestone is visible. Sample 11 was taken from the 10 feet exposed.

Beaver Brook

A large deposit of impure limestone rises in a 40-foot cliff along the east branch of Beaver Brook, ½ mile east of the village of the same name. The stone is roughly and indistinctly bedded but seemingly lies nearly horizontally. Pebbles of other rocks are to be seen in the bottom beds. All the limestone is fine-grained but it differs in appearance and purity in the various outcrops along the brook. The exposures nearest the village consist of porous limestone, in part brown-grey and in part red, but all is red on the weathered surface. Sample 12 taken here shows that this stone is the best of any in the deposit, but even it is of poor quality. One thousand feet farther up the brook the limestone is all deep red in colour and is very argillaceous and otherwise impure, as the analysis of Sample 13 indicates. Midway between the two, the limestone is of the nature of a conglomerate composed chiefly of boulders of the red limestone seen to the east, with minor amounts of red shale, all held together with a red ferruginous and calcareous cement. A small amount was at one time quarried from the western end of the cliff and pulverized for agricultural use.

Hilden

A deposit of the rare, dolomitic shell limestone occurs near the roadside 3 miles west of Hilden on the land of W. J. Murphy. It is exposed across a width of 40 feet in a ridge 150 feet long and 20 feet high on which there is very little soil. Other exposures are visible in the level land to the east across the road. A small quarry was once worked in the ridge to obtain stone for burning in a nearby pot kiln now in ruins. It is stated that it made a light-coloured lime. The stone is of a peculiar type, the main part being composed almost entirely of shells replaced by black, crystalline dolomite and firmly held together by a cement of the same material. The cavities in and between the fossils are coated with tiny red crystals of calcite in some cases, and of dolomite in others. Around the margin of the ridge, and also filling some pockets in the shelly stone on top of the ridge, is a rock consisting of fragments of small crinoid stems held together by a fine-grained dolomitic cement. Like the shells, the crinoid stems also are composed of black crystalline dolomite. On the south side of the ridge, crystals of calcite are more prominent in the stone and here much of the fine-grained cementing material is magnesian, rather than dolomitic, in character, that is it consists of a mixture of tiny calcite and dolomite crystals. Sample 14 is from the south side of the ridge; Sample 14A is from the central portion and the north side. The analyses of these samples show that the deposit is slightly less pure than are most of the shell limestone deposits, it being characterized by

a higher content of iron oxide and by a slightly greater content of silica than is usual. The amount available cannot be foretold without further work. It is 3 miles by road from Hilden station on the Canadian National railway.

Green Oaks

The prominent cliff about 60 feet high, known locally as Anthony's Nose, that juts into the east side of the Shubenacadie River, 1½ miles above the bridge on the Midland division of the Dominion Atlantic railway, is composed of a nearly vertical band of limestone 40 feet thick. It is flanked on either side by soft shale, but on the southeast side it forms the river bank for a distance of 300 feet, and could easily be quarried and loaded on scows. That part of the limestone in contact with the shale is sandy and argillaceous and has the peculiar pillow structure shown in Plate V B, page 26, but the sandy stone is only an inch or so thick, after which the limestone is of a good degree of purity for the full width of the band as shown by the analysis of Sample 15. In places the limestone contains many shells and is rather porous and dark grey in colour, but the major part is fine- to medium-grained, light brown, and only sparingly fossiliferous.

A number of other deposits of limestone outcrop in this vicinity but they are all quite impure.

Brookfield

North of the road between Brookfield station on the Canadian National railway and Green Oaks station on the Dominion Atlantic railway (C.P.R.), a band of shaly, thin-bedded calcium limestone, 45 feet thick, blankets the north face of a prominent ridge 40 to 90 feet high, for a distance of more than 2 miles. The east end of the ridge is about 3 miles from Brookfield and the west end is about the same distance from Green Oaks station. Figure 3 shows the general location of the deposit with respect to the road and brooks. The dip varies from 20 degrees to vertical but, as the deposit in nearly all places forms the sloping face of the ridge, the dip would not interfere with quarrying. The stone is greyish brown in colour, dense-textured and occurs in thin rubbly beds with interbeds of calcareous shale, the proportion of shale increasing toward the base of the deposit. Plate VIII B, page 42, shows the appearance of the stone. Referring to Figure 3, the western end of the deposit is first seen about ¼ mile north of Greens Creek school, in the valley of a small brook which joins the brook that drains Shorts Lake and hereafter referred to as Greens Creek. Where it crosses Greens Creek just south of the mill pond ½ mile farther east, the limestone band dips northerly at 20 degrees down the north face of a 40-foot hillside. At this point there is a thickness of 30 feet of rather shaly limestone underlain by what is virtually a calcareous shale. Sample 16 represents the 30 feet of limestone. The eastward extension of this deposit for ½ mile consists mainly of very shaly limestone. Then the continuity is interrupted by a faulted area ¼ mile wide. The limestone is seen again at the south end of the old mill pond on the small brook from the north feeding Greens Creek where, dipping northerly at 80 degrees, it forms the face of a ridge 60 feet high.

Sample 17 was obtained at this point and represents 30 feet of the less shaly portion of the band. Beginning a short distance east of here the limestone blankets the steep face of a high escarpment on the south side of Greens Creek for over a mile to beyond the road to Brookfield. Sample 17A was obtained 200 yards southeast of Sample 17 and includes all strata across a width of 40 feet. Sample 18 represents the eastern end of the deposit where it is crossed by the road to Brookfield. The analyses show a uniformly low content of magnesium carbonate. Though none of the samples included much of the shaly strata, the shale interbeds also are low in content of magnesia—a partial analysis of the very shaly stone showing 15·86 per cent insoluble and 2·55 per cent magnesium carbonate. This deposit could be readily quarried, and there is a very large tonnage available. It is too impure for any chemical or metallurgical use but, owing to its low content of magnesium carbonate, the deposit is worthy of investigation as a source of stone for the manufacture of Portland cement.

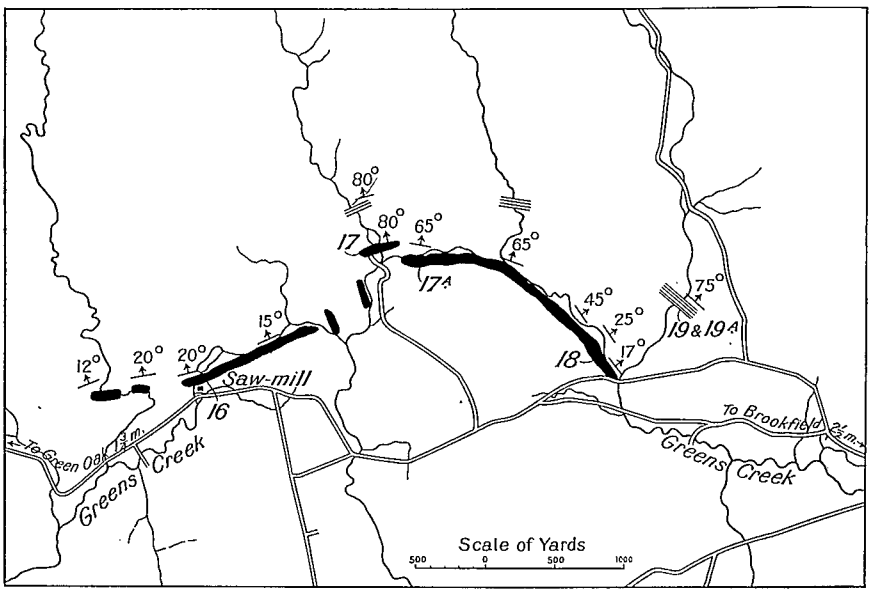


Figure 3. Limestone deposit west of Brookfield, Colchester County, N.S.

About $\frac{1}{4}$ mile north of this deposit, a 20-foot band of soft, dull-lustred, dark brown, impure dolomite, dipping northerly at a steep angle, parallels the calcium limestone just described. It is underlain by grey sandstone and overlain by 11 feet of impure, dark grey, thin-bedded calcium limestone, which in turn is overlain by red and green shale. Sample 19 represents the dolomite and 19A the overlying calcium limestone at the point shown in Figure 3.

One and one-half miles west of Brookfield station, a small quarry known as the Benjamin quarry was at one time worked in a deposit of shell limestone that outcrops along the south face of a low ridge immediately north of, and parallel to, the road from the two above-mentioned

villages. The limestone is dark grey and is composed of small shells and coral fragments bonded with a large proportion of dense matrix. It overlies an impure, shaly, magnesian limestone to a variable depth of 6 to 25 feet for a distance of perhaps 400 feet, as the ridge extends that far west from the small quarry which is at the east end, but the overburden increases toward the west. Sample 20 represents 25 feet of the shell limestone, and Sample 20 A the impure magnesian limestone underlying it.

A small outcrop of seemingly pure high-calcium limestone is visible in the bed of a small brook across the road and 200 yards south of the deposit just described.

Two and a half miles in a direct line northeast of Brookfield station, along the northern margin of the area underlain by the Windsor series, patches of fairly pure, brownish grey limestone rest on the older rocks of the Horton series forming the hillside north of the Little River. At the foot of the slope the limestone is underlain by shale, but farther up the hillside the limestone rests directly on the Horton and the basal beds are of the nature of a conglomerate and carry many fragments of the older rocks.

Brentwood

One mile south of Brentwood station on the Canadian National railway a quarry referred to as the McDonald quarry supplied flux to the blast furnace at Londonderry when the latter was in operation. The quarry was opened in a large deposit of very pure, high-calcium, shell limestone. The workings are now filled with water and the deposit is said to be nearly worked out.

Pennys Mountain

A fine-grained, grey, high-calcium limestone, tinged with red, blankets the slopes of the hill on the property of Scott Clifford. Toward the summit especially, the limestone is filled with pebbles of quartzite and other rock and the deposit is apparently thin.

East Mountain

About 7 miles east of Truro the highway from Truro to New Glasgow crosses a small outlier of the Windsor series and at this point, just south of the highway, is a deposit of very pure high-calcium limestone on the land of William Tamson. The limestone is exposed in a hillock, 125 feet long and 50 feet wide, that rises about 25 feet above the level of a small brook. Most of the limestone is dense to fine-grained in texture, blue and grey in colour and is much veined with thin seams of white calcite. Iron oxide in places imparts a rusty colour to some of the outcrops. Sample 21 represents about 20 feet of strata exposed on the north end of the hillock. The full extent of the deposit cannot be determined without trenching.

Several smaller outliers of the Windsor series occur a short distance south and east of deposit 21. In one of these outliers, along the road between East Mountain and Manganese Mines post office, is a quarry having a face of 22 feet which has been advanced about 75 feet into a limestone ridge that rises to a height of 40 feet on the south side of a small

brook. The limestone is apparently dipping steeply to the south. It is fine-grained, light brown in colour, and contains numerous small cavities encrusted with small crystals of black calcite. Some pyrolusite was observed in places. Sample 22 represents the strata now being quarried and crushed by J. B. Thompson for agricultural purposes. The pulverizing plant consists of a Jeffrey No. 2 Limepulver operated by a 25 h.p. gas engine. The pulverized stone is distributed by motor truck.

Analyses of Colchester County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
7	2·68	1·23	0·73	0·09	76·38	18·68	99·79	tr	42·82	8·94	4·8 : 1
8	8·18	1·25	1·31	0·11	86·41	1·68	98·94	0·27	48·45	0·80	61 : 1
9	1·22	0·34	0·28	0·07	97·27	0·67	99·85	0·06	54·51	0·32	170 : 1
10	1·66	0·78	0·08	0·09	96·63	0·76	100·00	0·05	54·16	0·36	150 : 1
11	9·26	1·56	3·34	0·07	53·76	32·04	100·03	0·08	30·15	15·33	1·97 : 1
12	6·32	0·82	0·68	0·13	91·30	0·95	100·20	0·02	51·20	0·45	114 : 1
13	20·12	1·72	3·24	0·11	72·30	1·68	99·17	nil	40·55	0·80	51 : 1
14	1·20	1·72	0·70	0·11	58·67	37·33	99·73	tr	32·91	17·86	1·86 : 1
14A	1·80	1·68	0·70	0·13	54·31	41·55	100·17	0·02	30·48	19·88	1·53 : 1
15	2·68	0·86	0·96	0·09	93·10	2·44	100·13	nil	52·15	1·16	45 : 1
16	4·70	0·76	1·70	0·09	90·95	1·03	99·23	0·17	50·98	0·49	104 : 1
17	7·92	0·32	1·54	0·09	88·64	0·69	99·20	0·06	49·69	0·33	151 : 1
17A	12·22	0·81	2·77	0·15	80·38	2·58	98·91	0·14	45·09	1·23	37 : 1
18	7·10	0·90	1·46	0·07	88·05	1·30	98·88	0·17	49·35	0·62	78 : 1
19	29·98	2·45	2·99	0·13	37·54	25·06	98·15	0·35	21·09	11·99	176 : 1
19A	17·76	1·64	4·24	0·13	69·25	4·94	97·96	0·50	38·85	2·35	17 : 1
20	1·22	0·62	0·38	0·11	94·45	2·71	99·49	tr	52·95	1·29	41 : 1
20A	9·52	1·87	3·09	0·15	66·00	18·57	99·20	0·06	37·04	8·88	4·2 : 1
21	0·78	0·52	0·94	0·07	96·10	0·69	99·10	tr	53·84	0·33	163 : 1
22	3·98	0·41	0·95	0·09	93·69	0·44	99·56	nil	52·51	0·21	250 : 1

7	Upper Economy.	Stone formerly quarried for agricultural use on property of Mrs. J. E. Brown.
8	" "	Small quarry, ½ mile north of the above quarry.
9	Lornevale	Quarry on land of Raymond McCabe, 1 mile northwest of Lornevale post office.
10	"	Quarry, 1½ miles east of the above.
11	Glenholm.	Ten feet of limestone on bank of Debert River, 2 miles from its mouth.
12	Beaver Brook.	Best quality limestone in 40-foot cliff in valley of Beaver Brook.
13	" "	Impure limestone in same cliff, 1,000 feet distant from 12.
14	Hilden.	South side of deposit of shell limestone on property of W. J. Murphy.
14A	"	Central part and north sides of same deposit of shell limestone.
15	Green Oaks.	Forty feet of limestone in cliff on east side Shubenacadie River, 1½ miles above railway bridge.
16	Brookfield.	West end of prominent ridge of shaly limestone.
17	"	Central part of same ridge, 1½ miles to the east of where Sample 16 was obtained.
17A	"	Same ridge 200 yards southeast of where Sample 17 was obtained.
18	"	Eastern part of same ridge where road to Brookfield crosses it.
19	"	Dolomite outcrop ¼ mile north of eastern end of above-mentioned ridge.
19A	"	Calcium limestone overlying the above dolomite.
20	"	Shell limestone, 1½ miles west of Brookfield station.
20A	"	Impure bedded limestone beneath the shell limestone.
21	East Mountain,	Deposit on land of Wm. Tamson.
22	" "	Quarry of J. B. Thompson.

Cumberland County

In this county limestone deposits of commercial size occur in the northern part and again in the vicinity of Parrsboro. All that were examined are of Carboniferous age. The majority are of calcium limestone but in some of the exceptionally thick deposits, for example, near Pugwash and Upper Nappan, impure dolomite occurs with the calcium limestone. No deposits of pure dolomite are known in Cumberland County.

Near Pugwash the Nova Scotia Departments of Highways and Agriculture jointly operate a limestone quarry for the production of road metal and agricultural limestone. From time to time a small quantity of agricultural limestone for local use is also produced at Upper Nappan.

Upper Nappan

One and a half miles south of Upper Nappan and 500 yards west of the road to Fenwick, is a large deposit composed of interbedded calcium limestone and dolomite, which has been quarried to a small extent for agricultural limestone. The strata strike N. 40° W. and dip southwesterly at an angle of 50 degrees. They compose a ridge about 70 feet high that terminates abruptly in a steep slope facing the southeast and along this a good cross-section of the deposit is exposed. Beginning at the northeast side of the face the following types of limestone are visible:—

13 feet of finely granular, brownish blue dolomite in beds up to 2½ feet thick with shale partings between. Sample 1A represents this part of the deposits. The full width of the dolomite band is not exposed, the northeastern edge being covered with soil.

4½ feet of brown and blue, fine-grained calcium limestone some of which is quite pure and some quite siliceous. Sample 1B represents the average of this band.

12-foot covered interval.

11 feet of heavily bedded, brown, fine-grained, impure limestone extremely variable in composition and containing streaks of green shale. Some of this part is dolomite and some is calcium limestone, the two types being intimately intermixed rather than in separate strata.

15-foot covered interval.

12 feet of nodular, dense-textured, blue-grey calcium limestone from which Sample 1C was obtained. This band forms the southwest side of the ridge and is exposed in the valley and bed of a small brook. On the opposite side of the brook is

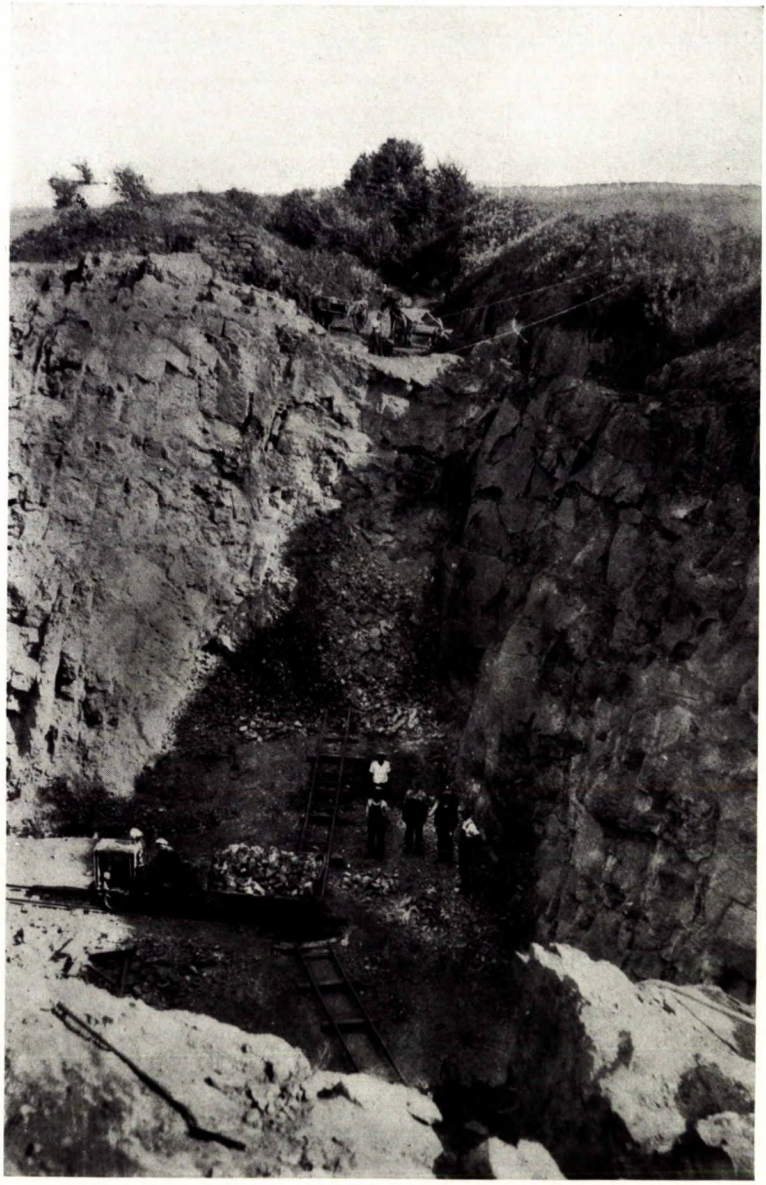
12 feet of shaly, nodular, blue-grey calcium limestone overlain by a soft red shale.

The total width of stone exposed including covered intervals is 80 feet—an exceptional thickness for a Carboniferous limestone deposit in Nova Scotia.

Brookdale

On land owned by Fred Shipley, 4½ miles southeast of Amherst and on the south side of the highway, is a deposit of dense-textured, reddish grey, calcium limestone interbedded with red shale and overlain by red grit. This limestone was formerly quarried to a small extent for road metal. Some of it is fairly pure but most of it is very sandy and otherwise impure.

PLATE IX



Carboniferous limestone in quarry at Pugwash, N.S., operated jointly by the Nova Scotia Departments of Agriculture and Highways.

Pugwash

Quarry Operated by the Government of Nova Scotia. At Dewar's Hill, 3 miles by road southeast of Pugwash, is a limestone quarry operated jointly by the Nova Scotia Departments of Highways and Agriculture for the production of crushed limestone for surfacing highways and pulverized

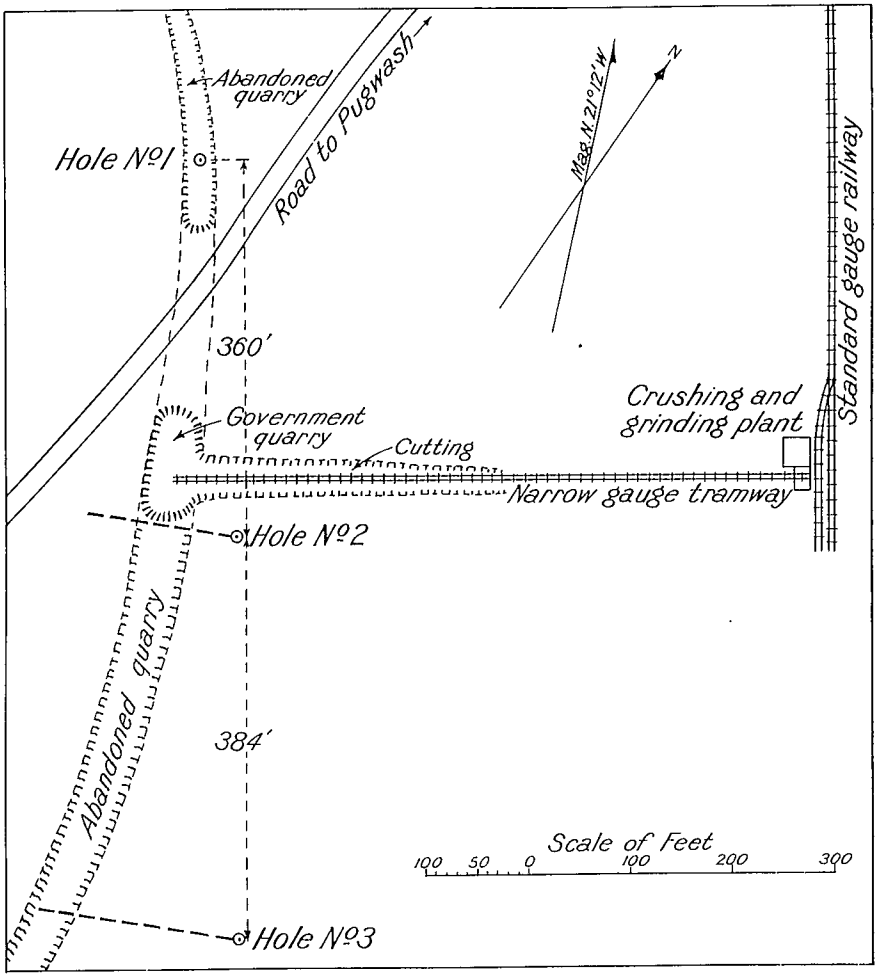


Figure 4. Plan of limestone deposit at Dewar's Hill, Pugwash, Cumberland County, Nova Scotia, showing approximate location of drill holes.

limestone for agricultural purposes. The deposit consists of a wide band of limestone dipping on the average 70 degrees to the northeast and striking S. 15° E. along the northeast side of the hill 200 yards west of Pugwash Inner Harbour. It is traceable by outcrops and old workings for

more than 600 yards, and probably extends much farther. The road from Pugwash to Upper Pugwash crosses it. Many years ago the calcium limestone in the deposit was quarried for stone for the making of lime and for shipment to Prince Edward Island. The old workings (see Figure 4) extend for 500 yards along the strike and have a width of 15 to 30 feet and a depth of 10 to 20 feet. Soil has fallen into the old quarry and hides most of the rock. The strike of the outcrops curves slightly, the direction of curvature being to the northwest.

Northwest of where the road crosses, the deposit consists of a band of reddish and brownish grey, high-calcium limestone flanked on both sides by impure dolomite and by red shale. The high-calcium limestone is dense-textured and occurs in beds up to 3½ feet thick, through which are occasional irregular films of red shale. Near the road this band has a width of 25 feet but at the north end of the excavation it narrows to 15 feet. Sample 2B taken across a width of 20 feet is representative of the stone in this band. On the southwest side, or foot-wall, of the high-calcium limestone there is about 2 feet of impure calcium limestone in which is a bed, 1 foot thick, composed of a great number of peculiar concretions of dense, reddish brown calcium limestone embedded in a red shaly matrix. (Plate X A, page 59.) The concretions are from ½ inch to 2 inches in diameter and in the centre of each is a small cavity nearly, and in some instances completely, filled with crystals of colourless calcite. Adjoining this to the southwest is 4 feet of rather impure, roughly bedded, grey ferruginous dolomite (Sample 2A) and then comes the red shale that forms the greater part of the hill. On the opposite side, or hanging-wall, of the high-calcium limestone is grey and blue-grey dolomite of a varying degree of purity, but mostly impure, containing many vugs partly filled with crystals of white dolomite and calcite. This type of stone has a thickness of at least 25 feet and possibly more but is apparently in contact with grey or red shale to the northeast. Sample 2C was taken at intervals across this dolomite band but can scarcely be considered fully representative as there were many concealed intervals between the outcrops sampled. Farther down the slope of the hill a few outcrops of impure grey dolomite occur along the course of a tiny brook but they are apparently part of a parallel belt of dolomite separated by red shale from the deposit above described.

Southeast of the road very little rock is seen in the old excavation, but core-drilling conducted by the Government of Nova Scotia shows that the band of calcium limestone is much thicker in this part of the deposit than northwest of the road and is also somewhat more impure. The location of the drill holes is shown in Figure 4, page 51, and the logs in Figures 5, 6, and 7. Through the courtesy of the Nova Scotia Department of Mines the cores were shipped to the Mines Branch, Ottawa, for examination and analysis.

Hole No. 1 was drilled vertically in the floor of the old excavation northwest of the Upper Pugwash road. Holes Nos. 2 and 3 were each drilled at an angle of 30 degrees to the horizontal from points on the downhill side of the deposit. Hole No. 2 passes about 25 feet beneath the floor of the old excavation and Hole No. 3 passes about 100 feet beneath. The strata are more steeply inclined in the southern part of the deposit than in the northern

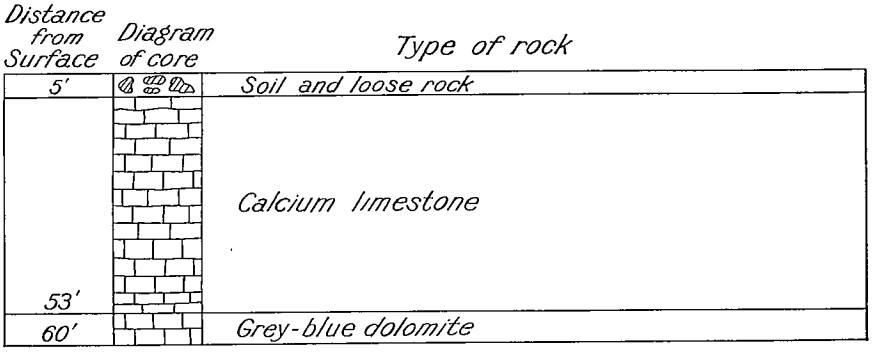


Figure 5. Hole No. 1. Drilled vertically into the deposit, from floor of old excavation north of the road at location shown in Figure 4.

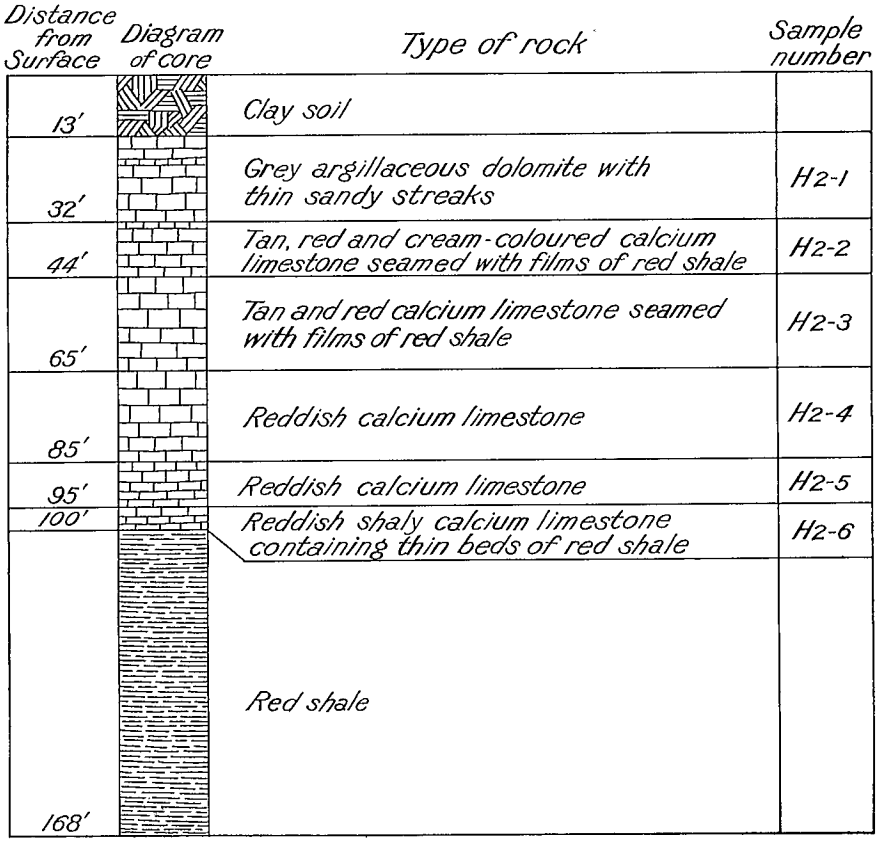


Figure 6. Hole No. 2, drilled at an angle of 30 degrees into the east side of the deposit, 360 feet southerly from Hole No. 1.

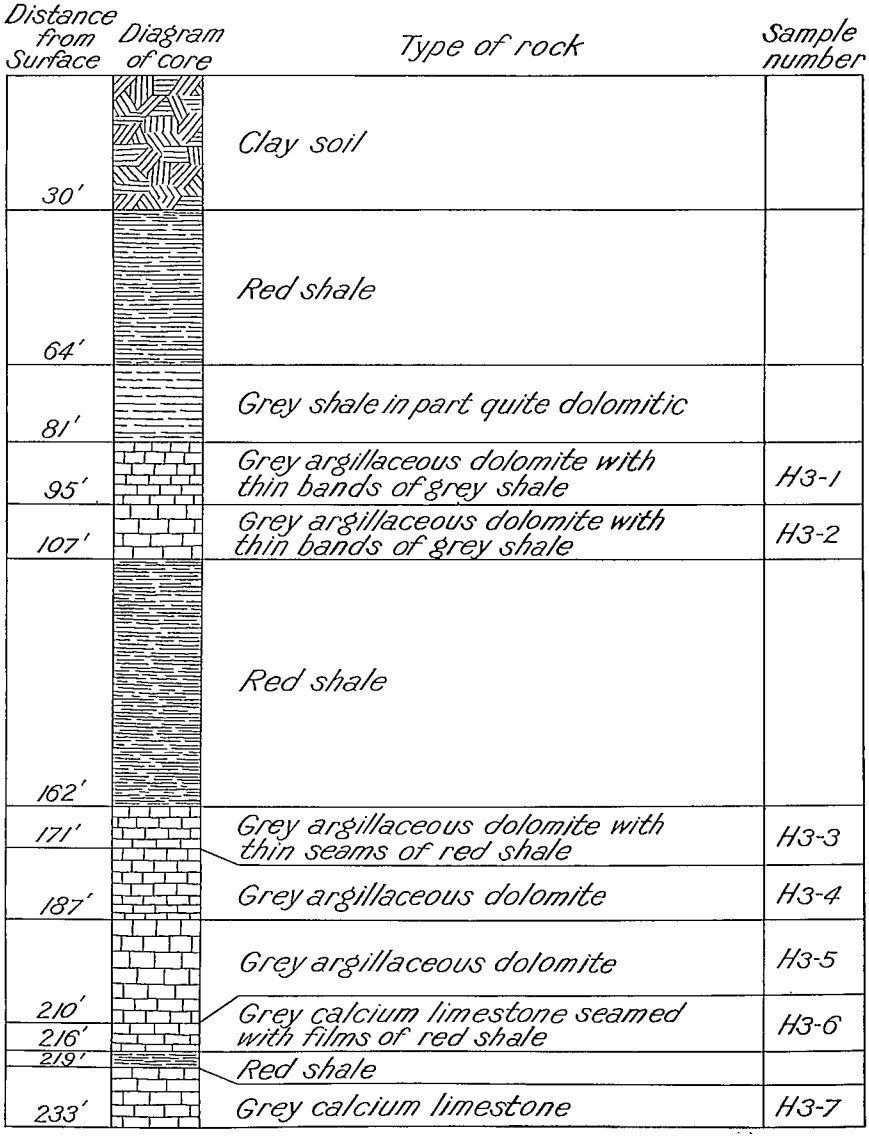


Figure 7. Hole No. 3, drilled at an angle of 30 degrees into the east side of the deposit, 384 feet southerly from Hole No. 2.

part, and, as shown by the bedding planes in the core sections, the drill in Holes Nos. 2 and 3 cut through the beds at an angle of about 20 degrees to the stratification. Thus the actual thickness of the various strata is slightly less than that shown in the logs of the holes.

The results of the drilling indicate a deposit having a maximum thickness (at right angles to the bedding) of slightly more than 100 feet made up of 62 feet of impure dolomite and 41 feet of calcium limestone, but the total thickness of the deposit, and also the proportions of calcium limestone and dolomite composing it, vary along its length. The purity of the limestone of both types also varies somewhat as shown by the analyses of the core sections in the table on page 57. Paralleling the deposit at a distance of about 50 feet to the northeast is a band of impure magnesian limestone and dolomite, 23 feet thick.

In 1931 development of this property was begun by the Nova Scotia Departments of Highways and Agriculture. An open cut was made by steam shovel into the deposit from the downhill side, as shown in Figure 4, and the band of calcium limestone is being quarried in a face 35 feet high, which is being extended along the strike of the strata. Drilling is done by jackhammers driven from a portable air compressor and the stone is blasted with dynamite. The broken stone is loaded into side-dump cars and taken by gasoline locomotive over a narrow-gauge tramway through the open cut to the crushing and pulverizing plant, which is located at the shale pit formerly worked by the Nova Scotia Clay Works, Ltd., near the shore of Pugwash Inner Harbour and about 200 yards from the quarry.

The crushing and grinding plant consists of a jaw-crusher and a Sturtevant No. 1½ ring-roll mill. Two storage bins each with a capacity of 250 tons have been erected. Shipments are made over the standard-gauge railway spur, formerly serving the shale pit, to the Canadian National railway at Pugwash.

Roslin

A band of finely granular, hard, dark grey, brown-weathering dolomite, containing many small cavities, extends for 1,000 feet up the valley of Plaster Creek, from where the road paralleling the east side of River Phillip crosses the creek. It was at one time burned for lime. The dolomite has no distinct bedding but the deposit apparently dips to the southwest at an angle of 60 degrees. It is exposed in a series of knolls 15 to 25 feet high and 30 to 50 feet wide. Sample 3 was taken across a width of 12 feet of this dolomite as exposed in the mound nearest the road. On lower ground adjoining the dolomite are a number of outcrops of very impure, shaly calcium limestone.

Six Mile Road

Hard, brittle, dense-textured, purplish and yellowish grey calcium limestone is exposed ¾ mile east of the Six Mile Road post office, which is 2 miles southwest of Wallace station on the Pictou branch of the Canadian National railway. The strata lie nearly horizontally and cover a large area. Sample 4 was obtained from exposures of this limestone on the property of Fred Blackie, but it represents only 2 feet of strata. The high

content of argillaceous matter shown in the analysis of this sample is due to the presence of films and patches of purple shale present in all outcrops examined.

Malagash

Small deposits of sandy, calcium limestone were seen on Malagash Point and in several other places on the Malagash Peninsula but none of a high degree of purity was observed.

Parrsboro

Agricultural limestone for local use is produced by Robie Kirkpatrick from a deposit on his property at Kirks Hill, 3 miles by road north of Parrsboro. The deposit consists of a nearly vertical band of calcium limestone 50 feet thick, which trends nearly east and west for 1,000 feet or more along the side of a hill and outcrops about 75 feet above its base. The limestone is dense-textured and nearly black and occurs in flaggy beds, a few inches to 2 feet in thickness, across which, at right angles to the stratification, are numerous veins of white calcite. Two feet away from the south side of the limestone band is a thin seam of coal and it is possible that this limestone does not occur in the Windsor series, as do most of the Carboniferous limestones of Nova Scotia, but rather in one of the Pennsylvanian formations. Two small quarries have been opened along the strike of the deposit from which small amounts of stone for building purposes and for lime-burning have been quarried in addition to that quarried for agricultural use. Sample 5 represents the entire thickness of the deposit where exposed in the quarry nearest to Mr. Kirkpatrick's house. The agricultural limestone is prepared in a Jeffrey No. 2 Limepulver.

Partridge Island

In a field adjoining the shore of West Bay, ¾ mile northwest of Partridge Island and 2½ miles south of Parrsboro, is a deposit of limestone quite similar in appearance to that on the Kirkpatrick property. It dips southerly at an angle of 38 degrees. A number of years ago it was quarried to a small extent for making lime. Sample 6 was obtained in the small quarry.

Clarke Head

Patches of Carboniferous limestone, none of which appears to be of large extent, occur along the shore of the Bay of Fundy between Parrsboro River and Clarke Head. At the latter place a band of blue-grey, dense-textured calcium limestone 50 feet thick, and dipping seaward at 55 degrees, forms a prominent headland. The limestone is veined with white calcite, is much fractured and contains many sandy and ferruginous streaks.

Springhill

A ridge of limestone is reported[1] to occur immediately east of the track of the Cumberland Railway and Coal Co., about 1 mile north of Springhill.

[1]Geol. Surv., Canada, Ann. Rept., vol. I, pt. E, p. 26 (1885).

Salt Springs

A band of limestone, 12 feet thick, is said to outcrop on Lime Creek ¼ mile south of the Canadian National railway, 2 miles east of Salt Springs station. Outcrops of limestone are also reported on the opposite side of the track, 2 miles to the northeast of the above.

Analyses of Cumberland County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
1A	5·00	1·16	1·44	0·11	52·23	40·32	100·26	0·28	29·31	19·20	1·53 : 1
1B	13·58	1·26	3·60	0·13	79·86	0·84	99·27	0·09	44·79	0·40	112 : 1
1C	6·64	0·74	1·98	0·07	88·01	2·06	99·50	0·13	49·33	0·98	50 : 1
2A	1·62	4·49	0·41	0·02	54·50	36·62	97·66	tr	30·53	17·51	1·75 : 1
2B	1·73	0·68	0·16	0·15	96·57	0·29	99·61	tr	54·16	0·14	387 : 1
2C	8·02	1·51	2·31	0·07	51·04	36·73	99·68	0·25	28·62	17·56	1·63 : 1
H2–1	15·82	2·07	4·73	tr	53·03	24·79	100·44	0·25	29·62	11·85	2·5 : 1
H2–2	7·20	0·60	1·84	0·07	88·21	1·58	99·50	0·04	49·44	0·76	65 : 1
H2–3	6·70	0·53	2·17	0·05	87·23	2·88	99·56	tr	48·88	1·38	35 : 1
H2–4	3·30	0·60	0·50	0·03	93·98	0·96	99·37	0·02	52·63	0·46	114 : 1
H2–5	4·74	0·24	1·94	0·02	91·21	1·06	99·21	tr	51·09	0·51	100 : 1
H2–6	6·16	0·49	1·87	0·03	90·23	1·14	99·92	0·03	50·53	0·55	92 : 1
H3–1	22·30	3·21	8·49	0·09	34·44	30·07	98·60	0·50	19·26	14·39	1·34 : 1
H3–2	9·30	2·37	2·54	0·09	49·44	36·68	100·42	0·38	27·72	17·55	1·58 : 1
H3–3	30·30	2·80	10·70	0·13	29·80	25·60	99·33	0·81	16·86	12·25	1·39 : 1
H3–4	20·50	2·47	5·33	0·09	40·26	31·06	99·71	0·84	22·60	14·86	1·52 : 1
H3–5	8·16	0·81	2·19	0·03	51·10	38·37	100·66	0·05	28·62	18·23	1·57 : 1
H3–6	6·30	0·69	1·81	0·04	87·98	3·20	100·02	0·05	49·27	1·53	32 : 1
H3–7	2·80	0·20	1·44	0·03	94·00	2·06	100·53	0·02	52·65	0·98	54 : 1
3	3·54	0·98	1·16	0·09	52·92	41·45	100·14	tr	29·68	19·74	1·5 : 1
4	6·70	0·39	1·85	0·09	88·96	1·07	99·06	tr	49·87	0·51	98 : 1
5	6·60	1·22	4·52	0·42	83·78	1·39	97·93	0·64	47·14	0·66	61 : 1
6	8·62	1·11	2·17	0·07	82·84	4·54	99·35	0·32	46·43	2·16	22 : 1

1A.	Upper Nappan.	Thirteen feet of dolomite on northeast side of outcrop 1½ miles south of the village.
1B.	" "	Four feet 6 inches of calcium limestone adjoining the above to the southwest.
1C.	" "	Twelve feet of calcium limestone near southwest side of the outcrop.
2A.	Pugwash.	Four feet of ferruginous dolomite on southwest side of and near northwest end of the deposit at Dewar's Hill.
2B.	"	Twenty feet of high-calcium limestone adjoining the above to the northeast.
2C.	"	Dolomite on northeast side of same deposit.
H2–1.	"	Core No. 2 from deposit at Dewar's Hill, section 13 to 32 feet from surface.
H2–2.	"	Core No. 2, section 32 to 44 feet from surface.
H2–3.	"	Core No. 2, section 44 to 65 feet from surface.
H2–4.	"	Core No. 2, section 65 to 85 feet from surface.
H2–5.	"	Core No. 2, section 85 to 95 feet from surface.
H2–6.	"	Core No. 2, section 95 to 100 feet from surface.
H3–1.	"	Core No. 3, from deposit at Dewar's Hill, section 81 to 95 feet from surface.
H3–2.	"	Core No. 3, section 95 to 107 feet from surface.
H3–3.	"	Core No. 3, section 162 to 171 feet from surface.
H3–4.	"	Core No. 3, section 171 to 187 feet from surface.
H3–5.	"	Core No. 3, section 187 to 210 feet from surface.
H3–6.	"	Core No. 3, section 210 to 216 feet from surface.
H3–7.	"	Core No. 3, section 219 to 233 feet from surface.
3.	Roslin.	Deposit on Plaster Creek.
4.	Six Mile Road.	Deposit on land of Fred Blackie.
5.	Parrsboro.	Quarry on property of Robie Kirkpatrick, Kirks Hill.
6.	Partridge Island.	Quarry near shore of West Bay.

74471—5½

Guysborough County

The few deposits of limestone in this county occur in outliers of the Windsor series near Mulgrave and at Guysborough. None of the limestone is of a high degree of purity. No quarries are in operation though, at one time, the limestone at Mulgrave was quarried fairly extensively.

Mulgrave

One mile south of the village and extending southward for a mile, a band of impure, blue limestone is exposed at intervals along the side of the hill facing the Strait of Canso and inland ¼ mile from the shore. The band is 25 feet thick and dips eastward, or down the slope, at an angle of 70 degrees. It is composed of hard, very fine-grained, dark blue calcium limestone in wavy beds up to 18 inches thick. (Plate XB, page 59.) Closely spaced laminæ of shaly material (that weathers brown and projects slightly on the weathered surface), impart a slaty structure to the stone. Cross fractures filled with white, secondary calcite containing cubical crystals of purple fluorspar are common. The band is underlain by grey sandstone and in all respects it resembles the band of limestone exposed between James River Station and Rights River in Antigonish County (page 22). Quite large quarries were worked 50 years ago in this band—one on the land now owned by Mrs. Barrie, near the northern end of the band, and the other near Pirate Harbour to the south. The stone was used for rough construction, for lime-burning, and also was shipped to Prince Edward Island where it was burned preparatory to being used for agricultural purposes. Sample 84 represents the full width of the band as exposed in the quarry on Mrs. Barrie's land.

Steep Creek

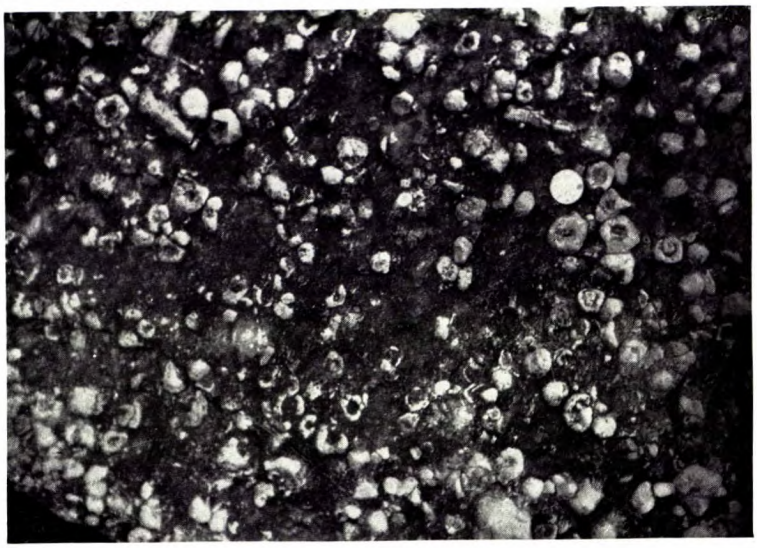
A small deposit of red limestone conglomerate of a type similar to that at Guysborough is visible west of the highway in the bed of a small brook (Steep Creek) that runs into the Strait of Canso, 3¾ miles south of Mulgrave. The limestone is impure and of little or no commercial value.

Guysborough

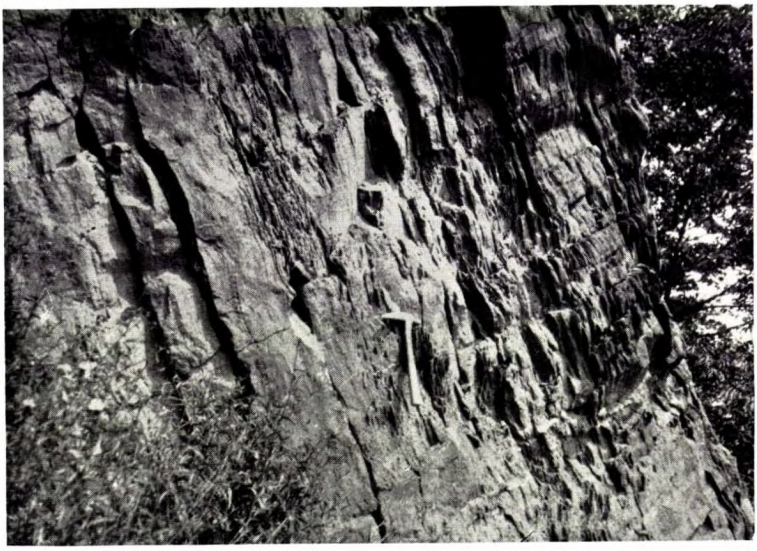
Small patches of red limestone, probably of Windsor age, occur along both shores of Guysborough Harbour, south of Boyleston bridge. The greater part is very fine-grained, soft, and of the nature of a conglomerate in which are fragments of an older limestone conglomerate and pebbles of both red and blue limestone. Parts of some deposits, though, are shaly or slaty and not conglomeratic. The prevailing red colour is intensified by films and patches of soft, bright red shale. Dips and strikes vary widely throughout the deposits but usually the strata are steeply inclined.

At the west side of the harbour, near the entrance, a small deposit of the red conglomerate forms a cliff 15 feet high along the south shore of Hart Cove but decreases in elevation back from the shore. Sample 85 shows the composition of the stone in the cliff face.

PLATE X



A. Nodular concretions in Carboniferous limestone at Pugwash, N.S. The relative size of the concretion is shown by the 25-cent piece.



B. Laminated, flaggy, steeply dipping Carboniferous limestone in Peebles quarry, Mulgrave, Guysborough County, N.S.

On the opposite shore of the harbour at Marshall Point and at Katon Point, low-cliffs of the same kind of limestone fringe the shore but the stone is obviously more impure than that at Hart Cove.

North of Katon Point at the head of Lime Cove a domed deposit of slaty, red limestone rises to a height of 30 feet, a short distance back from the beach, and is exposed in lesser height along the shore. Sample 86 represents the stone in this deposit.

Just beyond the northern limits of the town of Guysborough, on land belonging to Hon. J. C. Tory, a band of red limestone conglomerate 40 feet thick, flanked on either side by an equal thickness of thinly laminated, red, slaty limestone, outcrops in a knoll on the hillside about ½ mile back from the shore. The strike of the slaty limestone on the northwest side is N. 35° E. and the dip is vertical, but on the opposite side the strike is N. 70° E. and the apparent dip is 55 degrees to the northwest. Particularly on the southeast side the slaty limestone contains streaks of soft, red shale. Sample 87 is of the purer limestone conglomerate in the centre and No. 87A represents the slaty limestone on both sides. Nearby are the ruins of a field kiln in which stone from this deposit was at one time burned.

Havendale

A deposit of hard, brittle, greyish white, metamorphosed limestone of very fine grain occurs at Havendale, near the south shore of Guysborough Harbour, 7½ miles northwest of Guysborough. The extent of the deposit was not determined and the only sample secured (No. 88) consisted of a few pieces from a pit on the land of Robert Cunningham. An outcrop of the same type of limestone is said to appear in a brook on the farm of Mrs. John Dunn, 1 mile farther west. This limestone is identical in appearance with the limestone seen at Lornevale, Colchester County (page 43), and does not differ greatly from it in chemical composition.

Analyses of Guysborough County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
84.....	9·36	0·90	2·96	0·13	83·86	1·83	99·04	0·24	47·03	0·87	54 : 1
85.....	5·00	0·68	1·72	0·04	92·18	0·34	99·96	nil	51·64	0·16	324 : 1
86.....	7·34	0·70	1·46	0·09	89·33	0·76	99·68	nil	50·36	0·36	140 : 1
87.....	3·04	0·74	1·36	0·07	94·61	0·29	100·11	0·02	53·02	0·14	379 : 1
87A.....	8·40	1·25	2·23	0·15	86·54	0·59	99·16	nil	48·54	0·28	173 : 1
88.....	4·80	1·01	1·41	0·06	90·18	2·97	100·43	0·15	50·53	1·42	36 : 1

84. Mulgrave. Twenty-five feet of strata in quarry on the land of Mrs. Barrie.
85. Guysborough. Fifteen feet of red limestone conglomerate on shore of Hart Cove.
86. " Slaty, red limestone at Lime Cove.
87. " Central 40 feet of deposit on property of Hon. J. C. Tory.
87A. " Slaty limestone on both edges of above deposit.
88. Havendale. Metamorphosed limestone on property of Robert Cunningham.

Halifax County

The only extensive area underlain by the Windsor series in this county is in the Musquodoboit Valley and here are found magnesian limestones and dolomites, nearly all of which have a fairly high content of impurities. Around the shores of St. Margaret Bay small patches of the Windsor series occur and, though no actual limestone in place was observed, the profusion of limestone boulders at Queensland and at Seabright indicates the presence of limestone in place beneath the soil. A steeply dipping band of Precambrian limestone about 3 feet thick occurs between the slate and quartzite divisions of the Gold-bearing series at Eastern Passage and at Preston Road, but it is of no economic value.

In the Musquodoboit Valley the terrain underlain by the Windsor series is of low relief and as most of the beds are horizontal, or nearly so, good cross-sections of the limestone deposits are rarely visible. All of the limestones are highly magnesian and most contain over 3 per cent total impurities, the uniformly high content of iron oxide being especially characteristic. At or near Meaghers Grant, Middle Musquodoboit, Brookvale and Upper Musquodoboit the outcrops of grey, porous dolomite, apparently occurring at or near the base of the Windsor series, are sufficiently alike in appearance and composition to allow of the assumption that they are parts of a continuous bed underlying a large area. The similarity between deposits at other horizons is not so marked. The purest dolomites seen were in the very poor exposures at Elderbank and at Newcombe Corner. The Musquodoboit Valley branch of the Canadian National Railways serves this area.

No quarries are operated in this county at the present time and aside from small-scale operations to obtain limestone for making lime or for pulverizing for agricultural purposes, very little use has been made of the limestone in the past. Statistics show important quantities of lime as having been made in Halifax county about the middle of the last century but, as How explains,[1] the limestone for this purpose was brought in by boat both from Mahone Bay and from the West Indies, and was burned at Halifax.

Lower Meaghers Grant

Outcrops of magnesian limestone are plentiful along the margin of the Windsor strata between Musquodoboit River and Lay Lake. The beds are flat, or nearly so, and in no case is more than a few feet of stone exposed in any one outcrop. In general the limestone is impure, fine-grained and moderately hard. It is drab-grey on fresh fracture but weathers to a brown. Sample 52 was taken from an outcrop immediately west of Lay Lake, where the limestone in flat beds is exposed on the top of the 20-foot slope along the south side of the brook issuing from the lake and also probably underlies the field to the south. Sandstone is seen at the brook level, and sandy streaks containing tiny flakes of white mica occur in some of the limestone beds. These sandy streaks are more

[1] How, Henry: Mineralogy of Nova Scotia, p. 130 (1868).

resistant to weathering agencies than is the remainder of the limestone, and on the weathered surface they stand out as ridges. (Plate XIA, page 64.) A lime kiln was at one time in operation here

Meaghers Grant

Oolitic dolomite outcrops in a wooded pasture at the south end of a tiny lake, known as Grassy Pond, 2 miles in a direct line southeast of the railway station. Eight feet of beds are exposed adjacent to a now disused lime kiln. The stone is fine- to medium-grained, dark grey on fresh fracture but weathers deeply to a brown colour, and occurs in solid but uneven beds that dip at 12 degrees to the west. Sample 53 represents all the strata exposed.

Two and one-half miles by road southwest of the railway station a hard, fine-grained, rather siliceous, blue-grey dolomite, in irregular, fractured beds dipping steeply to the west, is exposed in a wooded ridge, about 15 feet high and from 50 to 80 feet wide, that extends along the valley of a small brook on the land of Christopher Dillman. The dolomite is intersected at all angles by films of calcite, which weather more rapidly than the dolomite and give the exposed surface the deeply scarred appearance typical of many dolomite outcrops. (Plate IA, page 9.) These calcite films, by increasing the calcium carbonate content, place the stone in the magnesian limestone class, as shown in the analysis of Sample 54, which represents all the strata exposed in the ridge. The ridge is covered only by a foot of soil and makes a good quarry site. Two field kilns were formerly in operation here in which lime was made for agricultural purposes.

Along Dollar Lake Brook, $\frac{1}{4}$ mile from where it joins the Musquodoboit River, a brown-grey, fine-grained, porous dolomite, the outcrops of which are quite ochreous, is exposed in cliffs 25 feet high beneath a light covering of soil. The deposit lies nearly horizontally but the individual beds are gnarled and uneven. Sample 55 was obtained here. Only a thin deposit of dolomite conglomerate containing pebbles of slate and quartzite separates this dolomite from the underlying Gold-bearing series. Other outcrops are seen on the hillside south of where the wagon road crosses Dollar Lake Brook.

Elderbank

A fine-grained, buff porous dolomite, which, aside from its rather high content of iron oxide, is very pure, underlies a portion of a swampy field behind the Presbyterian church. The only place where the dolomite could be seen was in the bottom of a pit 5 feet deep, and from this pit Sample 56 was obtained.

Five hundred feet north of the railway station, and on the west side of the track, 2 feet of impure, thinly-bedded, fine-grained, buff-grey dolomite is exposed in flat beds beneath 2 to 3 feet of soil. Other small exposures of this deposit are to be seen at intervals for several hundred feet northward and also on the road running east from the station. The stone weathers smooth. Sample 57 was taken from the 2-foot exposure along the railway.

Slightly over 2 miles north of Elderbank outcrops of soft, impure, slate-grey, dull-lustred magnesian limestone in beds 2 to 6 inches thick occur along the side of the wagon road, known as the Back road, which here runs parallel to the railway. Sample 58 represents the 3 feet of limestone exposed. The strata lie horizontally and what is probably the same deposit has been quarried to a depth of 5 feet immediately south of where the Back road crosses the railway, $2\frac{1}{3}$ miles north of Elderbank. The stone in the quarry is quite similar in appearance to that in the exposures to the south but it is more fossiliferous and also, as shown by the analysis of Sample 59 taken from the quarry face, is of a higher degree of purity. It is probable that the quarried strata are slightly higher stratigraphically than those of the other outcrops.

Middle Musquodoboit

On the land of Wm. McFetridge, $2\frac{1}{2}$ miles by road northwest of the railway station, a buff dolomite of good quality is exposed in a small pit on the side of a low hill, but no other outcrops were seen and the size of the deposit is unknown. Sample 60 was taken from the rock in the pit.

One mile east of where Sample 60 was obtained is a good exposure of fairly pure dolomite on the land of E. W. Auser. The dolomite outcrops in rough uneven beds along the western face of a high hill and is in an excellent position for quarrying. Overburden does not exceed 3 feet. Three hundred feet north of the dolomite outcrop, and also on top of the hill, outcrops of the quartzite of the Gold-bearing series are visible, and in between are outcrops of a dolomite conglomerate containing pebbles of slate and quartzite. The dolomite is dark grey, hard, dense in texture, but has many small cavities some of which are partly filled with colourless calcite crystals. It also contains many small shells. The weathered surface is a drab-brown and quite rough. In general appearance this stone resembles that in the deposit along Dollar Lake Brook (page 62) and like the latter it occurs almost at the base of the Windsor series. In 1915 a small quarry was opened in this deposit to obtain stone for pulverizing for agricultural purposes. The ruins of a small kiln are also to be seen here. Sample 61 was obtained from the 25-foot face exposed in the quarry.

A quarter of a mile eastward very similar dolomite is exposed in a small quarry from which stone for making lime was at one time obtained.

Brookvale and Higgins Settlement

Deposits of the same type of dolomite as that on the Auser property occur at a number of places south of Brookvale and Higgins Settlement along the contact between the Windsor series and the Gold-bearing series. Lime was formerly burned at several of these deposits.

Newcombe Corner

On top of the hill at the junction of the Higgins road and the Elmsvale road, 2 miles southeast of the railway, pure, buff, porous dolomite similar to that at Elderbank occurs on the land of Fred Redmond, beneath 4 feet of soil. The stone is visible only in a small pit from which Sample 62 was obtained.

PLATE XI

A. Differential weathering in outcrop of siliceous Carboniferous limestone at Lower Meaghers Grant, Halifax County, N.S.

B. "North" quarry of Eastern Lime Co., Ltd., Windsor, N.S., in deposit of Carboniferous shell limestone.

South of Newcombe Corner, on the south side of Higgins Brook, are many boulders of a fine-grained, compact dolomite almost identical in appearance, and probably in composition, to the dolomite along Dollar Lake Brook at Meaghers Grant (see page 62.)

Fraser Settlement

A short distance west of where the road from Newcombe Corner crosses Fraser Brook a good exposure of hard, dense, brownish blue dolomite is to be seen in the valley of a tiny brook tributary to Fraser Brook. It differs in appearance from the other dolomites of the Musquodoboit Valley but, as shown by the analysis of Sample 63 which was taken from the outcrop, it differs but little in chemical composition, and it has the high content of iron oxide that characterizes the limestones of this area. Boulders of similar-looking dolomite are to be seen over a fairly large area in this vicinity.

Upper Musquodoboit

Several poorly exposed deposits of dolomite and magnesian limestone were observed in the low land $\frac{3}{4}$ mile east of the railway station.

Two miles northeast of the railway station, about midway between Mill Lake and Musquodoboit River, is an outlier of dolomite, very similar to that on the Auser property at Middle Musquodoboit.

St. Margaret Bay

The presence of many limestone boulders at Queensland and at Seabright, south of Blandford, is indicative of limestone in situ at these places.

At Queensland, on the northwest shore of the bay, the boulders are plentiful on the land at the west end of the gravel-bar beach. The stone composing them is grey-blue, dense-textured, and high-calcium in composition. A lime kiln was in operation here many years ago.

At Redmond Hill, 1 mile south of the village of Seabright on the east shore of St. Margaret Bay, boulders of limestone and conglomerate are to be seen on the land of Edward Redmond, and it is reported that solid beds of limestone were encountered in digging a well on this property. Sample 64 was obtained from boulders on the Redmond property.

Analyses of Halifax County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
52.....	5·62	1·63	1·47	0·09	58·67	32·59	99·87	nil	32·91	15·52	2·07 : 1
53.....	1·50	2·18	1·04	0·04	56·81	37·76	99·33	nil	81·83	17·98	1·76 : 1
54.....	4·22	2·34	0·78	0·28	54·23	37·25	99·10	tr.	30·52	17·74	1·72 : 1
55.....	2·68	1·98	0·46	0·04	55·03	39·88	100·07	nil	30·83	19·03	1·62 : 1
56.....	0·60	1·94	0·30	0·02	54·74	42·00	99·60	0·02	30·66	20·00	1·53 : 1
57.....	3·68	1·59	1·09	0·04	54·94	39·00	100·34	nil	30·79	18·57	1·66 : 1
58.....	9·90	1·46	2·72	0·09	53·41	31·88	99·46	nil	29·96	15·18	1·97 : 1
59.....	4·58	1·19	0·91	0·04	70·18	23·21	100·11	nil	39·32	11·05	3·55 : 1
60.....	1·20	1·19	0·33	0·07	54·24	43·09	100·12	nil	30·41	20·52	1·48 : 1
61.....	2·62	1·26	0·76	0·07	55·14	40·30	100·15	nil	30·88	19·20	1·60 : 1
62.....	0·56	1·38	0·46	0·09	54·89	41·61	98·98	tr.	30·79	19·81	1·55 : 1
63.....	2·70	1·91	0·83	0·02	54·80	40·07	100·33	nil	30·70	19·08	1·60 : 1
64.....	6·30	0·54	1·54	0·09	90·52	0·40	99·39	nil	50·73	0·19	267 : 1

52. Lower Meaghers Grant. Outcrop west of Lay Lake.
53. Meaghers Grant. Oolitic limestone at Grassy Pond.
54. " " Outcrop on land of Christopher Dillman.
55. " " " along Dollar Lake Brook.
56. Elderbank. Buff dolomite near Presbyterian church.
57. " Outcrop north of railway station.
58. " Three feet of strata along Back road, 2 miles north of the village.
59. " Five feet of strata in quarry at railway crossing, 2⅓ miles north of village.
60. Middle Musquodoboit. Dolomite from pit on land of Wm. McFetridge.
61. " " Twenty-five-foot face in quarry on land of E. W. Auser.
62. Newcombe Corner. Dolomite from pit on land of Fred Redmond.
63. Fraser Settlement. Outcrop where Fraser Brook crosses road to Newcombe Corner.
64. Seabright, St. Margaret Bay. Boulders on land of Edward Redmond.

Hants County

A large proportion of Hants County is underlain by rocks of the Windsor series and, particularly around the margin of the area where the lower strata are exposed, deposits of limestone are very abundant. The Windsor series takes its name from the town of Windsor, in the vicinity of which are typical exposures of the limestone, gypsum, anhydrite, shale, and sandstone that compose it. The limestones of the county include bedded limestones of all varieties and degrees of purity, as well as many deposits of pure, high-calcium shell limestone and at least one of dolomitic shell limestone. Deposits examined and sampled were those close to rail transportation and also those close to water transportation along the shores of Minas Basin and Cobequid Bay and rivers tributary thereto. Many other deposits not so favourably located for shipping are known to occur throughout the county.

At various times in the past limestone deposits in many parts of the county have yielded stone for lime, agricultural limestone, foundation stone, road metal, flux, and, in one instance, marble, but at present the only active quarry is that of the Eastern Lime Company at Windsor.

Windsor

At Windsor are found the only limestone deposits along the Dominion Atlantic railway (C.P.R.) between Halifax and Yarmouth. The shell limestone now quarried by the Eastern Lime Company has been utilized for lime for building and agricultural purposes since the district was first settled. Small quarries have also been worked in the deposit of shell limestone at Maxner Point on the Avon River, and in the deposit of bedded limestone at Pemberton station on the eastern outskirts of the town. Limestones also occur in the gypsum area east of the town.

Eastern Lime Co., Ltd., Windsor, N.S. The deposit of high-calcium shell limestone owned and quarried by this company is situated on the east bank of the Avon River just above the railway bridge, and is being used in the manufacture of quicklime, hydrated lime, agricultural limestone, and asphalt filler. The products are shipped from a siding on the Dominion Atlantic railway which is connected with the plant by a narrow-gauge tramway 1,700 feet long.

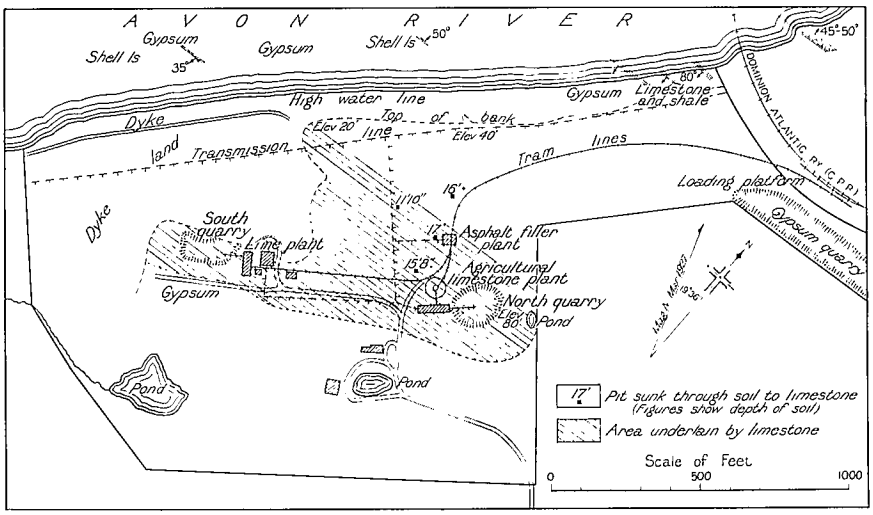


Figure 8. Plan of property of Eastern Lime Company, Ltd., Windsor, N.S.

The limestone is brown-grey in colour, soft, and very pure, and consists largely of shells and coral fragments cemented by a dense, high-calcium matrix (Plate IIIA, page 15). Cavities in and between the fossils are encrusted with secondary, white calcite which is brownish on the surface. Red clay covers most of the deposit to an average depth of 15 feet and outcrops are not numerous, but, as shown in Figure 8, test pits have proved that the limestone underlies at least 8 acres of quarriable land on the property and there are indications that the deposit is much more extensive. The highest point is 80 feet above high water and the average elevation is about 45 feet. The shell limestone apparently occupies a synclinal fold trending nearly east and west and is underlain by a few thin beds of dense, brown limestone which in turn is underlain by gypsum.

Two quarries—referred to as the "North" quarry and the "South" quarry—are being worked.

The "North" quarry is of the pit type and is 175 feet in diameter and has been worked to a depth of 40 feet in the limestone (Plate XIB, page 64). Clay overburden here averages 12 feet. A wide fissure extends for 42 feet beneath the present quarry floor. The bottom 16 feet of the fissure is filled with water, but down to the water level the walls are of stone similar in appearance to that being quarried. This gives a depth of at least 66 feet of limestone at this point. Sample 27 is representative of the 40-foot quarry face above the fissure.

The "South" quarry is 800 feet southwest of the "North" quarry and is of the sidehill type. A face 15 to 20 feet high and 150 feet long has been worked southeasterly for 80 feet into the low hillside. Sample 27A is from this quarry. Clay covers the rock to a depth of from 4 to 10 feet along the face and is increasing in depth as the quarry is worked to the southeast, in which direction outcrops of gypsum occur at a distance of 70 feet from the present face, thus limiting the size of the quarry.

Quarrying is done with air drills and dynamite, and at both quarries the broken rock is loaded by hand into small cars which are pulled up inclined tracks by electric hoists. All stone from the "North" quarry is taken to the agricultural limestone plant located immediately adjacent to the quarry, where it is pulverized in a swing-hammer mill operating in closed circuit with a screen, the capacity of the pulverizing unit being 3 tons per hour of material all passing a 10-mesh screen. All the output of the "South" quarry, excepting the spalls which are sent to the agricultural limestone mill, is made into lime. The lime plant is situated at the "South" quarry and the equipment includes 1 mixed-feed kiln having a capacity of 9 tons of lime per 24 hours, a Clyde hydrator, and a Raymond air separator. Asphalt filler is made in an air-swept ball-mill equipped with an air separator. The feed of the ball-mill is pulverized limestone from the agricultural limestone plant. All equipment is operated electrically.

At the north end of the property thin-bedded, impure limestones (some of which are dolomitic), interstratified with shales and calcareous sandstone, outcrop along the river bank beneath 20 feet or more of clay. A great deal of faulting has occurred here.

North of the railway bridge, just outside the limits of the property of the Eastern Lime Co., a band of impure, blue and brown, thin-bedded limestone, 22 feet thick, with shale on either side, juts out of the river bank. It dips at an angle of 50 degrees to the north.

Maxner Point

At Maxner Point, on the Avon River 1 mile above the property of the Eastern Lime Company, is a deposit of shell limestone consisting in part of high-calcium limestone and in part of dolomite. As shown in Figure 9, page 69, the high-calcium stone overlies the dolomite, and the latter is in direct contact with gypsum. The high-calcium limestone deposit is 50 feet

thick[1] and, as shown by the analysis of Sample 28, it is very pure. It is much like that on the property of the Eastern Lime Company, being brown in colour and consisting largely of shells bound together by dense, high-calcium material. The dolomite band is 25 feet thick where exposed on the river bank but inland it is covered by soil and so its extent is not known. Shells are also prominent but it contains a much greater proportion of cementing material than the high-calcium stone and it is yellow in colour. No sharp line of demarcation exists between the two types of limestone, but rather there is a transitional zone in which the stone adjacent to fracture planes is yellow dolomite and the interiors of the unfractured blocks consist of high-calcium shell limestone not altered as regards either colour or composition. Thus the dolomite in this instance is apparently of secondary

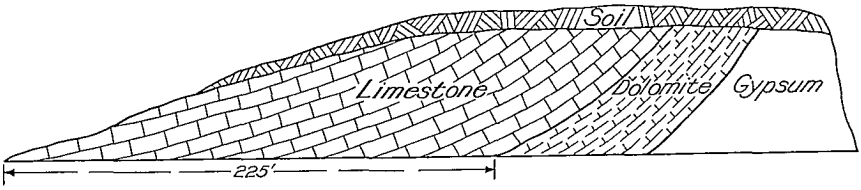


Figure 9. Diagrammatic sketch of shell limestone deposit at Maxner Point, Windsor, N.S., showing the relation of the dolomite to high-calcium limestone and gypsum.

origin. Sample 28A was obtained at right angles to the dip across a thickness of 20 feet of the completely dolomitized section of the deposit. Outcrops of the dolomite extend for 50 feet along the river bank, and outcrops of the high-calcium stone for 225 feet. The latter is also to be seen inland for 300 feet back from the shore and over the most of this area the covering of soil is very light. Stratification is quite apparent. At the south end, where the dolomite is in contact with the gypsum, the dip is 45 degrees to the north and at this point the deposit rises 40 feet above tide-water. Northerly, however, the dip gradually flattens out to 15 degrees and the stone dips into marshland. Fifteen hundred feet north a reef of similar shell limestone is seen in the bed of the river near the east shore.

A small quantity of high-calcium limestone from the Maxner Point deposit was at one time quarried for surfacing streets in Windsor, but it proved too soft to be of value for this purpose.

Pemberton

At Pemberton flag station on the Dominion Atlantic railway, at the southeast limit of the town of Windsor, a nearly flat-lying deposit of calcium limestone is exposed for nearly $\frac{1}{4}$ mile along the north side of the railway. The stone is mostly dense-textured, moderately hard, and is blue-grey on fresh fracture but weathers brown. The majority of the beds do not exceed 6 inches in thickness. Where seen in the hillside above the railway, at the east end of the outcrops, the stone is quite oolitic. At the west end of the exposures a small quarry having a face of 12 feet has been opened in the south side of a ridge rising about 25 feet above the brook.

[1]At right angles to the stratification.

It was worked chiefly for road metal, but a small quantity of foundation stone has also been obtained. Sample 29 represents the stone obtainable in the quarry, and 29A that in the eastern outcrops.

Falmouth

A small outcrop of pure, high-calcium shell limestone occurs on the property of the Baptist church about 1 mile southwest of the railway station. It is much like that exposed on the opposite side of the river at Windsor.

Deposits Along the Midland Division of the Dominion Atlantic Railway

Brooklyn

At Brooklyn a great deal of very impure, thin-bedded, calcium limestone is exposed on both sides of Hebert River. At the station it is exposed in flat-lying beds in a cliff rising 50 feet above the track. Talus covers the lower slopes and the strata are visible only in the upper part of the cliff, beneath 10 to 15 feet of soil. The stone is very fine-grained, soft, and dull-lustred; when fresh it is dark grey in colour but it weathers to a brown. As shown by the analysis of Sample 30, representing the top 5 feet only, it contains much sand and clayey material. On the south side of the river, beds of similar stone dip northerly at an angle of 70 degrees.

Along Hebert River, for 5 miles above Brooklyn, outcrops of limestone are very numerous. The deposits, in general, strike northeast, or parallel to the general course of the river. Some dip to the northwest, others to the southeast. Sample 31 was obtained from a deposit of impure limestone that outcrops along the southeast side of Hebert River, 1¼ miles above Brooklyn. The beds dip southeasterly at an angle of 10 degrees and are exposed over an area 1,500 feet long and 300 feet wide, that has an average elevation of 50 feet above the river. The limestone is brownish grey in colour, soft and rather earthy, and occurs in thin beds. The sample is not representative of the entire deposit as many of the beds are concealed and could not be sampled. Most of the limestone seen elsewhere along the river is similar in appearance and composition to that above described. Though too impure for chemical use this limestone would be suitable for the manufacture of Portland cement, provided a sufficient tonnage could be proved.

On Meander River to the south, outcrops of rather impure, calcium limestone are also very plentiful from near Brooklyn to McKay Settlement, but they are not close to rail transportation. The only deposit sampled was on the north bank of the river on the land of Morley Harvie, where a small quantity was at one time quarried for making agricultural limestone. The limestone is much like that in the quarry at Pemberton (page 69). It lies in flat beds to a depth of 17 feet along the top of a 40-foot cliff and is underlain by red shale. At the contact with the shale is a 1-foot bed of extremely porous, pure high-calcium limestone, very light grey in colour. Sample 32 includes all the beds in the 17 feet exposed.

Two miles directly west of Brooklyn station, on the south side of the road between Millers Creek and Ross Corner, is an outcrop of dense

blue-grey calcium limestone that weathers to a buff shade. It is dense-textured and occurs in thin beds with numerous shells along the bedding planes. The strata dip northwesterly at an angle of 45 degrees and are apparently overlain by gypsum, which is visible in a small quarry on the north side of the road. Sample 33 was taken here from the few beds exposed.

Two and a half miles northwest of Brooklyn station an impure dolomite is exposed to a very limited extent at the end of a farm road, which at this point goes south $\frac{1}{4}$ mile from the road to Highfield. The stone is buff in colour, very porous, and rather earthy, but ruins of a field kiln nearby show that it was once burned for lime. Sample 34 was obtained from the small exposure in a hillock on the bank of a tiny brook. A short distance to the north are outcrops of gypsum.

Clarksville

A large deposit of very pure, shell limestone, in a good position for quarrying, occurs on the land of Fred Campbell just east of the Rawdon road, about 1 mile due south of the railway station, or $1\frac{1}{2}$ miles by road. The limestone is fine-grained, very cavernous, and on fresh fracture is nearly white but the weathered surface and numerous joint-planes are coloured dark brown. It is visible for 700 feet from the road along a wooded ridge, which in places rises 60 feet above the bed of a tiny brook. The full width of the deposit could not be determined but there is a large tonnage indicated. The analysis of Sample 35 shows it to be very pure. Lime was made from this stone many years ago.

Two and a half miles west of Clarksville (just west of Cayley Brook) and $\frac{3}{4}$ mile south of the railway is a small exposure of grey calcium limestone quite like that sampled at deposit 31 northeast of Brooklyn. Nearby are the ruins of a field kiln.

Riverside Corner

A deposit of shell limestone favourably situated for quarrying is exposed in a railway cutting 1 mile east of the village of Riverside Corner, or 3 miles west of the railway station at Kennetcook. The deposit has an anticlinal structure, the axis of which is at right angles to the railway. Along the track the limestone is exposed for 180 feet and the maximum face visible is 22 feet. The Kennetcook River flows parallel to and but a short distance southeast of the railway and thus would terminate any possible extension of the deposit in that direction, but on the opposite side of the track the land probably underlain by limestone rises gradually to a height of 80 feet. A light covering of soil hides all rock on the high land and thus the extent of the deposit cannot be definitely determined without digging test pits. Where the limestone is exposed in the cutting, the top 12 feet is grey in colour, very fossiliferous and full of cavities. The next 4 feet is brownish grey, thinly bedded, quite compact and nearly devoid of shells. Beneath this, at the track level, as seen at the north-eastern end of the outcrop, is 6 feet of grey, sparingly fossiliferous limestone. The beds dip slightly toward the track except at the southwest end

where they dip to the southwest at an angle of 60 degrees. Sample 36 is from the top 12 feet; No. 36A from the middle 4 feet; and No. 36B from the bottom 6 feet of the outcrop. The deposit is owned by H. C. Burchell of Windsor.

Noel Road

A number of small exposures of limestone are to be seen ½ mile east of the village of Noel Road. On the property of James White a thinly bedded, argillaceous, drab dolomite was formerly quarried on a small scale and burned in a nearby field kiln, now in ruins. The beds dip southerly at an angle of 35 degrees. Sample 37 was obtained from the strata near the kiln.

Rhines Siding

A deposit of grey shell limestone is exposed at intervals from near the top to the bottom (a distance of 250 feet) of the south side of a low hill on the property of William Nolan, ¼ mile south of the railway, and it is stated that the limestone underlies most of the farm. The stone does not contain many cavities compared with most other deposits of shell limestone and in fact is quite compact. Sample 38 represents material from all outcrops.

Between this and the railway a pit near the Fraser road shows a thin-bedded, sparingly fossiliferous, dense, grey limestone having the appearance of a conglomerate. The analysis of Sample 38A, taken here, shows that this stone contains more siliceous matter than does Sample 38. It has been made into lime for plastering purposes but the lime is light brown in colour. Along the Fraser road on the east edge of this property small exposures of less pure, dense, blue limestone are visible.

Patterson Station

About ½ mile south of Patterson station a deposit of blue-grey, brown-weathering, calcium limestone, underlain by purplish red shale, is exposed on both sides of a cutting along the King road. The strata dip north-easterly at 20 degrees and this dip corresponds to the slope of the hillside. A thickness of only 10 feet of limestone is exposed in the cutting, but the full thickness of the deposit may be considerably more than this. It is again visible in the brook 300 yards to the southwest and probably underlies the intervening ground. The stone is hard and tough, fine-grained to dense in texture and forms rather rubbly, broken beds traversed by a network of shale films. The analysis of Sample 39 taken in the road cutting shows that it is somewhat siliceous.

Five Mile River

In the banks of the second small brook crossing the Maitland road just east of the village of Five Mile River, outcrops of reddish and blue calcium limestone, enclosing a band of blue magnesian limestone and a band of shale, are to be seen. The strata dip northwesterly at various angles, but the average is 18 degrees. From immediately north of the road the strata exposed in descending order are as follows: dense, blue calcium limestone

containing about 10 per cent total impurities; thin band of reddish calcium limestone; sandy, red shale; thin-bedded, brown-weathering, blue-grey, compact, magnesian limestone, the composition of which is shown by Sample 40. Beneath this is 20 feet of dense, reddish, calcium limestone containing thin films of red shale and underlain by red, sandy shale. Sample 40A represents the 20-foot thickness of red limestone. The exposures in each instance are small, and between them the rock is concealed by soil so it is impossible to state the thickness of each type of stone exposed. When etched with dilute acid the magnesian limestone is seen to be composed of tiny crystals of dolomite and calcite intimately intermixed with small sand grains and silt.

North of here, 2½ miles, and also at Northfield, 3 miles northwest, deposits of limestone have been quarried to a small extent for stone for lime-burning.

Latties Brook

East of this village and adjacent to the railway line are a great many exposures of calcium limestones of fair quality, chiefly in the beds of brooks where they could be quarried only with difficulty. One and a half miles east of the station, a band of dense, dark blue calcium limestone underlain by 5 feet of fine-grained, drab, impure dolomite, in turn underlain by red, sandy shale, outcrops on top of a hill about 100 feet above the river level. The limestone is covered with 10 feet of soil and as it dips back into the hillside at an angle of 12 degrees it is not in a good position for quarrying. At the base of the same hill, a little farther east and alongside the railway track, is a ridge of brown-weathering, drab-grey dolomite, that could readily be quarried. The dolomite is in thin, horizontal beds with layers of shale between. Sample 41 represents the calcium limestone at the top of the main hill; No. 41A, the 5 feet of dolomite beneath the former; and No. 41B is from the ridge below, but it represents only the dolomite beds, as the interbedded shale was not included.

South Maitland

A quarter of a mile north of the railway station, a quarry on the land of J. H. Waddell was operated in 1904 for flux for the blast furnace at Londonderry. The limestone, about 35 feet thick, is visible beneath a light covering of soil for about 300 feet along the course of a small brook. It dips at 25 degrees into the north bank of the brook and is overlain and underlain by coarse-grained, red sandstone. The limestone is heavily bedded, fine-grained to dense in texture and generally grey in colour with mottlings of red, but all exposed surfaces are stained brick-red. Veinlets of white calcite are common and crystals of calcite fill many vugs present in the stone. Sample 42 is from the 30 feet of strata composing the deposit. Though the full extent of the deposit could not be determined there is apparently a large tonnage of stone still available.

About 1 mile east of South Maitland, shaly, calcium limestones in steeply dipping bands outcrop in the banks of the river in three places. In each outcrop the limestone is underlain by reddish shale.

Deposits Along Avon River, Minas Basin and Cobequid Bay

Avondale

Along the shore from the Government wharf northerly to Wallace Point a variety of limestone is exposed, some of it being shell limestone, but it is covered by from 30 to 70 feet of clay soil. Outcrops on the beach at Wallace Point are of very impure, sandy, grey limestone. Deposits of shell limestone are reported to occur in the wooded country east of the village.

Lower Burlington

A small outcrop of pure high-calcium limestone overlain by argillaceous calcium limestone occurs east of Lower Burlington along the road to Summerville on the land of Palmer Burgess. The stone is exposed in a ridge rising about 25 feet above a tiny brook but very little of the limestone is actually to be seen, most of it being hidden by soil. The apparent dip is due north at 30 degrees. At the top of the outcrop the limestone is very fine-grained to dense, blue on fresh fracture but weathers brown, and is in thin beds. Beneath this comes rather porous, grey, fine-grained limestone in beds up to 1 foot thick, some of which are composed largely of fossil fragments. Sample 43 is from the argillaceous top beds and No. 43A from the pure stone at the base.

Summerville

On the shore of Avon River, 1 mile south of the village, two bands of calcium limestone, with a bed of gypsum between, are exposed in the valley of a small brook. The top limestone, which has an exposed thickness of 15 feet, is fairly pure, fine-grained, drab-coloured, calcium limestone in thin, broken beds; the bottom limestone band about 4 feet thick is largely composed of oolites. It becomes shaly at the base and is underlain by a soft, greenish blue shale. There is much evidence of folding and faulting here and the limestone is covered by 40 feet of clay soil.

A sandy limestone overlain by red shale outcrops at the northwest side of the abandoned gypsum quarry a short distance north of the wharf from which the gypsum was formerly shipped.

Kempt Shore

Reddish grey, fine-grained, calcium limestone in flat-lying beds extends over a large area on the properties of E. E. Skaling and George Brown, $\frac{1}{2}$ mile east of the shore road. On the Skaling property two small quarries were opened to obtain stone for agricultural use. Small films of bright-red shale occur through most of the limestone and, in general, the limestone itself is closely laminated and thin-bedded. The stone is in a good position for quarrying but the depth of the deposit may not be very great. Sample 44 was obtained from the 5-foot face of the quarry alongside the crusher and represents the best grade material obtainable from the deposit.

Cheverie

A little over $\frac{1}{4}$ mile west of the wharf from which gypsum is shipped, a ridge of reddish, conglomeratic fine-grained limestone extends from the shore southeastward for $\frac{1}{2}$ mile. The ridge is from 20 to 40 feet high and averages 200 feet in width. Where bedding is visible there is a slight dip to the northeast. The quality of the stone is extremely variable, and along the shore, slabs of slate and large boulders of red and brown sandstone are included in the conglomerate, but in other parts it is very shaly. All through the ridge are veins and pockets of manganese (pyrolusite) and a number of pits have been dug in the limestone to recover this mineral. Thick veins of white dog-tooth spar, the individual crystals of which are concentrically banded with dark lines and usually coated with pyrolusite, are also prominent. Sample 45 represents a thickness of 12 feet of strata from the southern end of the ridge, where the limestone is of much better quality than elsewhere.

Walton

A ridge, 20 to 40 feet high and several hundred feet long, of red limestone conglomerate very similar to that at Cheverie is to be seen southeast of the village along the north bank of the Walton River and west of the gypsum quarry. It, also, has been worked for manganese. Sample 46 was obtained from the 12-foot face of a small quarry in this ridge. Across the river the same kind of stone has been quarried for marble but the deposit is not of the type that would yield the large sound blocks so essential in the marble industry.

At Whale Cove, 1 mile north of Walton, a hard, siliceous, medium-grained, blue dolomite, veined with white secondary dolomite and containing a great deal of iron pyrites, and also manganese, is exposed on the north bank of Whale Creek, at the base of a small outlier of the Windsor series. A few hundred yards farther east along the base of the same outlier, a reddish grey, laminated calcium limestone is visible in a high, narrow ridge close to the shore road.

Between Cheverie and Noel, at from 1 to 4 miles back from the shore of Minas Basin, an apparently continuous band of impure, reddish limestone at the base of the Windsor series has been worked in several localities for manganese which occurs in veins and pockets through the limestone. In some exposures this limestone is of the calcium variety but in others it is dolomitic.

Maitland—Selmah

Four small limestone quarries have been opened along the northern edge of an outlier of the Windsor series west of Maitland; three are 1 mile west of Maitland, the other being $1\frac{1}{4}$ miles farther west at Selmah. The quarries near Maitland have been worked to a maximum depth of 8 feet in a band of closely laminated, but nevertheless heavily bedded, dark grey, very fine-grained calcium limestone that dips southerly at 12 degrees. The limestone is visible for more than 400 yards westerly along the side of a gentle south slope and, as overburden does not exceed 5

feet, much stone is available. Between the laminæ are films of red shale which stand out on the weathered surface to a slight extent. Sample 47 was obtained from the 8-foot face in the quarry owned by Richard Walker, and No. 48 from the 3 feet of stone exposed in the quarry of O. F. O'Brien.

The same type of stone is seen on the property of Perley Sanford at Selmah where it has been quarried to a small extent, but here the strata are dipping at a much steeper angle.

Deposits Along the Shubenacadie River

Admiral Rock

Two large deposits of very pure shell limestone occur north of this village; the first is on the west bank of the Shubenacadie River, 1½ miles below the village, and the second is 1¼ miles inland from this deposit. In both places the limestone is closely associated with gypsum.

The deposit on the river bank is owned by Geo. Brimicombe. It outcrops in two wooded knolls, 40 to 50 feet high, separated by the flat valley of a small brook. In the knoll to the north, a quarry of considerable size has been worked, and the ruins of several kilns nearby show that the stone has been used for making lime. The southern knoll is the larger of the two, and shell limestone is to be seen continuously for 200 feet where this knoll fronts on the river. How far back from the river the limestone extends could not be ascertained owing to a light covering of soil. The limestone is grey in colour and is almost entirely composed of shells and fragments of corals. Many of the interstices between the fossils are filled with white calcite, and the rock shows no tendency to crumble. Sample 49 is a composite sample taken from the quarry face in the south knoll and along the river bank in the north knoll. The distance by road to South Maitland station on the Midland division of the Dominion Atlantic railway is 7 miles, and it is a mile farther to Shubenacadie on the Canadian National railway, but the rock could be transported in large scows down the river at high tide.

The deposit, 1¾ miles inland from where Sample 49 was taken, is exposed both on the property of William Webb and on that belonging to the heirs of the late John A. McDonald. On the Webb property the only outcrop seen is in the west bank of a small brook, but it is stated that fragments of shell limestone are ploughed up on the hillside for a distance of 500 feet west of the brook. As seen in the 10-foot face of limestone exposed at the brook, the stone is brown-grey in colour and mainly composed of shells about ½ inch long together with a minor amount of coral fragments. Very little calcite was observed and most of the shell cavities are devoid of any filling other than a brownish film of minute calcite crystals. The stone, however, is not crumbly. Sample 50 was obtained from the 10-foot face along the brook.

Across the road, on the McDonald property, the same type of shell limestone is to be seen for 300 feet along a low ridge, 50 feet wide, that strikes northeasterly and ends in a cliff standing 30 feet above the valley of a brook. It has been quarried to a small extent along this ridge. Sample

50A represents the stone exposed across a width of 40 feet at the base of the northeast end of the ridge, and 50B represents the outcrops along the top of the ridge. It is 6½ miles from the deposit to Shubenacadie station and 1 mile farther to South Maitland.

Mill Village

Just west of this village, on the south side of the road to Nine Mile River, a deposit of grey, shell limestone was quarried a number of years ago by Frederick Chapman who pulverized the stone for agricultural use in a Jeffrey No. 2 Limepulver. The quarry, 80 feet in diameter and with a 10-foot face, has been worked southerly into the gently rising land south of a small brook. Sandy soil, 2 to 5 feet deep, covers all the rock in the immediate vicinity and the extent of the deposit could not be determined but it is well situated for quarrying. The distance to Shubenacadie on the Canadian National railway is about 2 miles. The limestone contains a large amount of very fine-grained matrix in proportion to shells, and a very little secondary calcite. Sample 51 obtained from the 10-foot face in the quarry shows the stone to be exceptionally pure.

One-half mile to the east of the shell limestone, outcrops of fine-grained, hard, blue calcium limestone show in the banks of a brook where it was quarried years ago to a small extent for lime-burning and for foundation stone. A short distance north of these outcrops a shaly, impure calcium limestone is to be seen.

Elmsdale

A deposit of blue-grey, shell limestone containing much secondary calcite occurs 2½ miles northeast of Elmsdale on the land of Wm. Hennigar, Lantz Siding. The only outcrop seen was in the bank of Barney Brook, where there is 6 feet of stone exposed, but elsewhere it is covered with soil. If the deposit extends southward it could readily be quarried. The distance to Lantz Siding on the Canadian National railway is ¾ mile.

On the Halifax County side of the Shubenacadie River, opposite Lantz Siding, pure, fine-grained, high-calcium limestone is exposed just at the water level, where it is not in a quarriable position. It is possible, however, that stone of the same type may be found underlying the higher land ½ mile or so to the east.

Analyses of Hants County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
27	0·96	0·44	0·62	0·04	95·95	1·72	99·73	tr.	53·73	0·82	65·5 : 1
27A	0·48	0·31	0·37	0·09	97·18	0·76	99·19	0·02	54·47	0·36	151 : 1
28	0·52	0·35	0·11	0·30	97·27	1·32	99·87	0·06	54·68	0·63	86·8 : 1
28A	0·12	0·91	0·29	0·09	56·95	41·45	99·81	0·04	31·94	19·82	1·61 : 1
29	5·32	0·69	2·15	0·04	89·36	2·33	99·89	0·23	50·06	1·11	45·1 : 1
29A	2·16	1·09	1·19	0·07	93·14	2·06	99·71	0·08	52·20	0·95	55 : 1
30	33·38	1·44	4·26	0·13	57·34	1·09	97·64	0·07	32·18	0·52	61·9 : 1
31	5·02	0·66	1·62	0·04	90·50	1·60	99·44	0·06	50·70	0·76	66·7 : 1
32	3·30	0·58	1·10	0·04	94·07	0·36	99·45	0·05	52·70	0·17	310 : 1
33	10·04	0·88	2·72	0·17	83·13	1·43	98·37	0·06	46·64	0·68	68·6 : 1
34	11·42	2·24	3·98	0·11	47·41	34·30	99·46	0·26	26·57	16·41	1·62 : 1
35	0·94	0·58	0·42	0·09	95·79	0·82	98·64	tr.	53·69	0·39	138 : 1
36	1·26	0·28	0·82	0·07	95·85	1·97	100·25	0·08	53·71	0·94	57 : 1
36A	2·04	0·46	0·44	0·11	94·10	2·44	99·59	tr.	52·75	1·16	45·5 : 1
36B	1·74	0·36	0·66	0·09	94·80	0·76	98·41	0·03	53·14	0·36	148 : 1
37	3·46	1·75	1·53	0·04	52·79	40·15	99·72	tr.	29·59	19·20	1·54 : 1
38	1·16	0·35	0·69	0·07	95·81	1·20	99·28	tr.	53·75	0·57	94 : 1
38A	3·38	0·58	0·96	0·13	92·89	1·34	99·28	tr.	52·08	0·64	81 : 1
39	4·58	1·89	0·37	0·09	90·69	1·28	98·90	0·12	50·84	0·61	83 : 1
40	18·38	2·10	4·08	0·07	46·64	27·52	98·79	0·37	26·16	13·16	1·98 : 1
40A	3·20	1·04	0·80	0·13	93·46	1·47	100·10	0·06	52·41	0·70	78·9 : 1
41	2·72	0·56	0·34	0·07	93·25	1·41	98·35	0·06	52·25	0·67	78 : 1
41A	3·96	2·34	1·58	0·11	54·67	36·94	99·60	tr.	30·67	17·66	1·7 : 1
41B	6·40	1·34	1·44	0·11	52·23	38·18	99·70	tr.	29·31	18·26	1·6 : 1
42	1·60	0·39	0·77	0·04	96·55	0·92	100·27	0·03	54·08	0·44	123 : 1
43	5·50	0·89	2·49	0·07	88·04	1·76	98·75	0·13	49·34	0·84	59 : 1
43A	1·40	0·48	0·50	0·07	95·96	1·30	99·71	0·03	53·78	0·62	87 : 1
44	3·38	0·51	1·49	0·09	93·23	1·30	100·00	0·13	52·26	0·62	84 : 1
45	2·99	0·57	1·31	0·09	93·68	0·92	99·56	0·07	52·51	0·44	116 : 1
46	2·72	0·90	0·88	0·04	94·51	0·67	99·72	tr.	52·95	0·32	165 : 1
47	6·46	0·74	2·64	0·15	88·13	1·41	99·53	0·08	49·44	0·67	74 : 1
48	4·36	0·58	1·44	0·09	91·43	0·78	98·68	0·10	51·25	0·37	139 : 1
49	0·50	0·28	0·18	0·13	97·28	0·80	99·17	tr.	54·55	0·38	144 : 1
50	0·54	0·17	0·21	0·07	97·97	1·26	100·22	tr.	54·91	0·60	92 : 1
50A	1·14	0·34	0·52	0·15	96·99	1·18	100·32	tr.	54·39	0·56	99 : 1
50B	0·20	0·27	0·13	0·11	96·74	2·36	99·81	tr.	54·18	1·13	49 : 1
51	0·30	0·40	0·18	0·07	97·93	0·65	99·53	tr.	54·87	0·31	177 : 1

27. Windsor. Eastern Lime Co., North quarry, 40-foot face.
27A. " " " " South quarry, 20-foot face.
28. " Maxner Point. High-calcium, shell limestone, 50 feet of strata.
28A. " " " Dolomitic shell limestone, 20 feet "
29. " Pemberton. Twelve feet of strata in quarry.
29A. " " Outcrops east of quarry.
30. Brooklyn. Top 5 feet of cliff at railway station.
31. " On Hebert River bank, 1¼ miles above Brooklyn station.
32. " On Meander River on land of Morley Harvie.
33. " Two miles due west of station.
34. " Two and a half miles northwest of station.
35. Clarksville. Shell limestone on land of Fred. Campbell.
36. Riverside Corner. Top 12 feet of shell limestone along railway, 1 mile northeast of the village.
36A. " " Middle 4 feet of shell limestone.
36B. " " Bottom 6 feet of shell limestone.
37. Noel Road. One-half mile east of village.
38. Rhines Siding. Shell limestone on land of Wm. Nolan.
38A. " " Bedded limestone nearer railway.
39. Patterson. Cutting on King road, ½ mile south of station.
40. Five Mile River. Second brook east of village. Blue magnesian limestone.
40A. " " " " " Red calcium limestone.

41.	Latties Brook.	One and a half miles east of village.	Calcium limestone on top of hill.
41A.	" "	" " " "	Dolomite beneath 41A.
41B.	" "	" " " "	Dolomite at base of hill.
42.	South Maitland.	J. H. Waddell quarry, 30-foot face.	
43.	Lower Burlington.	Palmer Burgess property.	Argillaceous stone at top of ridge.
43A.	" "	" " "	Pure stone at base of ridge.
44.	Kempt Shore.	Small quarry on land of E. E. Skaling.	
45.	Cheverie.	Ridge of red limestone conglomerate.	
46.	Walton.	" " "	
47.	Maitland.	Richard Walker quarry, 8-foot face.	
48.	"	O. F. O'Brien quarry, 3-foot face.	
49.	Admiral Rock.	Shell limestone on land of Geo. Brimicombe.	
50.	" "	" " " Wm. Webb.	
50A.	" "	" " estate of J. A. McDonald, base of ridge.	
50B.	" "	" " " " top of ridge	
51.	Mill village.	Shell limestone, 10-foot face in quarry, west of the village.	

Inverness County

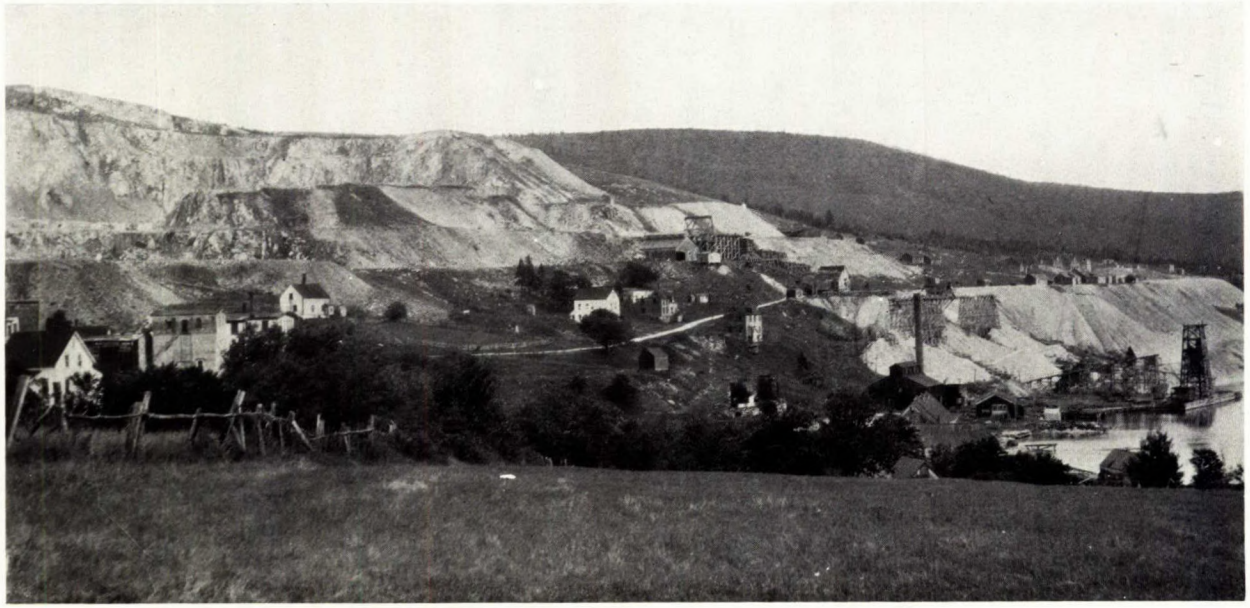
The resources of this county include both Precambrian and Carboniferous limestones. Those of Precambrian age (George River series) are found on the slopes of the North Mountain and the Creignish Hills in the southern part of the county. They include some of the largest deposits of calcium limestone and dolomite in the Maritime Provinces but their chief drawback is their variability in chemical composition, and, in the case of the Creignish Hills deposits, of their remoteness from cheap means of transportation facilities. At Marble Mountain, on the shore of West Bay, Bras d'Or Lake, a large deposit of George River limestone was quarried on an extensive scale for blast-furnace flux during the period 1906 to 1920, but, owing to siliceous limestone being encountered in increasing amount as the quarry was extended, the quarry was shut down and a new quarry opened on the west coast of Newfoundland, and this latter quarry is the source of supply of flux at the present time. A lime industry and a marble quarry were also in operation at one time at Marble Mountain. The only production from the Precambrian limestones at present is at Whycocomagh, where white dolomite is quarried to the extent of about 100 tons a year for the manufacture of whiting substitute.

Carboniferous limestones are plentifully distributed through the areas of Windsor strata, the location of which latter are shown on the map in the pocket at the back of this report, but the deposits are small and in nearly all cases impure, and have been quarried only on a very small scale to obtain for local use small quantities of foundation stone, agricultural limestone and stone for lime-making.

Port Hastings

One mile north of the village a small quarry was at one time worked in a nearly vertical band of impure, fine-grained, grey-blue calcium limestone at the base of the Windsor series. The stone is thinly laminated, with shale films between the laminæ, but major bedding planes are far apart and blocks 3 feet thick are obtainable. Sample 124 was taken across the 40 feet of strata composing the deposit. Outcrops occur for nearly ½ mile along the brook flowing south past the quarry, but the land in the vicinity is marshy and densely wooded.

To the north and east, along the contact between the Windsor strata and the underlying Horton strata, are a number of outcrops of limestone



Marble Mountain quarry at Marble Mountain, Inverness County, N.S., formerly operated by Dominion Iron and Steel Company.

so much like that at Port Hastings that possibly they are all parts of a continuous band. There is also a strong resemblance both in appearance and in composition between this limestone and that at the base of the Windsor series in Antigonish County and at Mulgrave, Guysborough County.

Morrison Station

Three hundred yards above the highway bridge, Donald Hughie Brook flows through a gap in a ridge of impure, Carboniferous, magnesian limestone that rises to a height of 25 feet above the broad valley. The limestone is nearly black and is very fine-grained but contains numerous tiny cavities and also many fossil fragments that show particularly plainly on the drab weathered surface. A thickness of 30 feet of strata dipping to the west at an angle of 75 degrees is exposed where the stream has cut a cross-section, and Sample 125 includes the total thickness.

North Mountain

North Mountain lies along the northwest shore of West Bay, Bras d'Or Lake. It consists of a ridge of Precambrian granitic rocks, 2½ to 4 miles wide, and rising to heights varying from 700 to 1,000 feet. The side facing West Bay is very steep, and elevations of 700 feet are common within ½ mile of the shore. Along this steep slope between West Bay marshes and Little Harbour, a distance of 11 miles, are many deposits of George River limestone in one of which, at Marble Mountain, the largest quarry in the Maritime Provinces was worked from 1906 until 1920 for blast-furnace flux by the Dominion Iron and Steel Company, Sydney (now Dominion Steel and Coal Corporation). But as the quarry was extended, an increasing amount of impure stone was encountered and this led to the transfer of the quarrying operations to Port au Port on the west coast of Newfoundland. As the latter quarry was developed, the output from Marble Mountain was gradually restricted until, in 1920, the quarry was shut down completely. Marble and stone for lime-burning have also been quarried at Marble Mountain. The Bras d'Or Lime Company operated two vertical kilns at Marble Mountain for a number of years and shipped their products to Newfoundland, Prince Edward Island, and various parts of Nova Scotia.

West Bay Marshes

There is a large area of dolomitic, Precambrian limestone along the course of McCuspic Brook on the mountain-side 1½ miles back from the shore of Bras d'Or Lake, but much of it is so filled with serpentine, mica, veins of quartz, and dykes of trap rock that it is valueless for chemical and metallurgical purposes. But on the "Ross property" west of the brook, it is stated, in a report made for the Steel Company at Sydney, that there is a deposit of white dolomite of good quality. Analysis No. 126 in the table on page 90 is an average of 9 analyses quoted in that report as being representative of the deposit.

Lime Hill

At this place the rocks of the George River series extend from the shore of West Bay up over the top of North Mountain and far down the opposite slope. Limestone bands are plentiful on the northwest slope, but they are far removed from transportation facilities. On the southeast slope only narrow bands of impure limestone were seen.

Between Lime Hill and Marble Mountain, the George River limestone occurs along the foot of the mountain in bands having a general trend parallel to the shore. A number of small quarries have been opened, but the stone is of poor quality and in many places beds of dolomite and calcium limestone alternate, and dykes of trap rock are numerous. Sample 127 was obtained from a band, 50 feet wide, of medium-grained, greenish blue calcium limestone, veined with flesh-coloured calcite, one-half mile back from the shore one mile west of Sydenham Brook.

Marble Mountain

The deposit at Marble Mountain that has been quarried for marble, lime, and flux, is in the shape of a huge, triangular-based pyramid set obliquely in the mountain with its apex about 500 feet above the lake and its lowest point near the base of the hillside. Within this deposit the strike and dip of the beds are extremely variable due both to faulting and to the contorted nature of the strata. Along the southeast edge is an impure, slaty limestone generally trending slightly east of north and dipping nearly vertically. On the opposite side is a band of quartzite and siliceous limestone 150 feet wide, trending east and west and dipping at 75 degrees to the south. Between the two, and originally having a maximum width of about 500 feet before quarrying was commenced, is a large body of white, semi-translucent, coarse-grained, pure calcium limestone bordered by blue-and-white-striped calcium limestone, along the bedding-planes of which are films of serpentinous material. The white limestone breaks in large, irregular masses but the blue stone tends to break into slabs as shown in Plate XIII, page 83. A very few thin dykes of trap rock cut through the deposit. The following samples are channel samples representative of the stone still visible in the quarry faces: No. 128, white limestone across a width of 200 feet; No. 128A, blue-and-white-striped limestone across a width of 100 feet; No. 128B, thinly bedded, slaty limestone at the back of the quarry. The quarry was worked in a series of benches as shown in Plate XII, page 80. This plate also shows the large piles of fines near the shipping dock. There is still a fairly large tonnage of pure stone available in the middle benches of the quarry, but the upper and lower benches have been worked out.

Above the main quarry, and on the north side of the broad band of quartzite previously referred to, a smaller quarry having a length of 200 feet and an 80-foot face, has been extended northward for 125 feet into the mountain-side, the face of which at this place is composed of a band of limestone that strikes east and west and dips southerly at an angle of 75 degrees. The stone at the front of this quarry is coarse-grained, white calcium limestone, and at the back it is coarse-grained, white dolomite. Very pure dolomite could be hand-picked from this deposit as the analysis of

PLATE XIII

A. Steeply dipping, fractured, platy beds of Precambrian limestone in the Marble Mountain quarry.

B. Precambrian dolomite altered to high-calcium limestone along fracture planes, Whycocomagh, Inverness County, N.S. The 25-cent coin shows the scale.

Sample 128C shows, but all through it are narrow veins and small blebs of serpentine. The calcium limestone is of indifferent quality and is interbedded with dolomitic bands. The quarry was opened to obtain dolomite.

Near the source of Mill Brook, on top of the mountain and $\frac{3}{4}$ mile north of the big quarry, are two or more bands of calcium limestone separated from each other, and from the deposit along the shore, by granitic rocks. Much of the limestone is impure, containing many slaty laminæ, but from the small lake, known as McDonald Lake, a band 75 to 100 feet wide of pure, white, coarse-grained limestone extends westerly for several hundred yards. Sample 129 represents channel samples taken at several places across the line of outcrop. On the east shore of McDonald Lake the same band is also seen, but here it consists of medium-grained, variously coloured magnesian limestone that tends to split into thin slabs and is also of a lesser degree of purity than that west of the lake, as is shown by the analysis of Sample 129A, representing the central 25 feet of the 75-foot band east of the lake. On both sides toward the contact with the granite the limestone becomes increasingly siliceous. The dip is apparently vertical or nearly so.

From Marble Mountain to the east end of North Mountain, no limestone deposits of any importance are known. A small amount of stone was at one time quarried from the west end of a band of Precambrian limestone that extends for $\frac{1}{4}$ mile along the shore on the Alex. K. Matheson property, $3\frac{1}{2}$ miles east of Marble Mountain village. The stone quarried was very fine-grained, hard, blue, impure dolomite, much veined with white calcite. Sample 130 was obtained from 20 feet of strata exposed in the quarry. One hundred and fifty feet south of the quarry there are outcrops of fine-grained, blue, calcium limestone much veined with white calcite and intruded by some dykes of trap rock. Sample 130A represents a width of 10 feet of this band. Easterly from this point the limestone becomes much more impure and is also variegated in colour. At the quarry the band appears to be dipping at 45 degrees to the north, but by the road it is vertical.

Little Harbour

Carboniferous limestone outcrops in the bed of the brook flowing into the northwest side of Little Harbour, $1\frac{3}{4}$ miles northwest of the above-mentioned Matheson quarry. The stone is dense-textured, hard, drab-grey in colour, contains many tiny cavities and occurs in beds up to 8 inches thick. Sample 131 was taken from the small outcrop.

Orangedale

Finely granular, brown, Carboniferous dolomite was quarried at Orangedale for several years by the Steel Company at Sydney for use in fettling the open-hearth furnaces, but the quarry is now abandoned. Analysis 132 was supplied by the Dominion Steel and Coal Corporation as being representative of the shipments from this quarry.

Between Orangedale and Alba small outcrops of brown, earthy, calcium limestone were seen at the following places: Gillis Cove, between the highway and the railway; along the highway, $3\frac{1}{4}$ miles southwest of the railway crossing at Alba; and at Alba village.

Wilburn

Pure, dolomitic shell limestone and impure, non-fossiliferous calcium limestone outcrop in a series of mounds on the land of Murdock A. McDonald at the village of Wilburn on the south side of Whycocomagh Bay. Both rocks are very fine-grained and brown, and there is little to indicate the difference in composition without the application of acid. Only two large outcrops of the shell dolomite were seen and they are 800 feet apart. The calcium limestone is exposed in a number of places in the near vicinity of the dolomite, but the relationship between the two was not determined. Calcium limestone also outcrops ¼ mile southeast of here in a brook valley, but it is very soft and ochreous. Sample 133 was taken from a 20-foot face of dolomite exposed in a mound near the road. Sample 133A represents the calcium limestone from a number of outcrops south of the dolomite. Opportunities for quarrying are only fair and the quantity of the dolomite cannot be foretold without digging pits and trenches.

Other outcrops of brown, calcium limestone occur in low, swampy ground 1 mile east of Wilburn just west of a long, narrow inlet from Whycocomagh Bay, and also along the shore of the bay 2½ miles east of Wilburn.

Creignish Hills

The Creignish Hills—a ridge of Precambrian rocks averaging 4 miles in width—extend for 30 miles from the Strait of Canso to the west end of St. Patrick Channel. They, like North Mountain, contain large areas of George River rocks which include some very large deposits of metamorphosed calcium limestone and dolomite—perhaps the largest in Nova Scotia, but in nearly all cases the deposits are too far removed from water and rail transportation to render them of value other than as a reserve supply.

Creignish

At the southwestern end of the Creignish Hills, 3½ miles by road east of Creignish village, a very large deposit of siliceous, bluish white, fine-grained Precambrian dolomite outcrops for ¾ mile along the Creignish road north of Queensville Brook. It is cut by many large dykes of igneous rock and is filled with veins of milky quartz, some of which are 10 inches thick. No sample was taken.

Glendale

One and a half miles northwest of the village, along Glendale Brook, white and bluish white, pure calcium limestone of Precambrian age is extensively exposed in quarriable location on the property of Alex. H. McInnes on the south slope of Creignish Hills. It is, however, 10 miles by road from rail transportation at West Bay station on the Canadian National railway, and for this reason was not examined in detail. Sample 134 is a general one of the stone.

A very large deposit of similar limestone is reported to occur on McEachren Brook, 2½ miles due north of Glendale. Pure dolomite is also reported in this vicinity.

Upper Glencoe

A large deposit of George River limestone of good grade is reported to be available at this village on the northwest side of the Creignish Hills, but it is nearly 11 miles from River Denys station on the Canadian National railway, the nearest shipping point.

Melford

Northwest of Melford about 2½ miles, in the valley of Diogenes Brook, along the road from the highway to the property of the River Dennis Sand and Clay Company, a cliff 80 to 100 feet high of fine-grained, flesh-coloured dolomite extends parallel to the road for several hundred feet, affording an excellent quarry site. However, it is 9 miles from River Denys station on the Canadian National railway and the stone is quite siliceous. Sample 135 was obtained from outcrops along the road at the base of the cliff. On the hillside to the north, and also in the bed of the brook just above the sand pit of the River Dennis Sand and Clay Co., are other exposures of dolomite, but some of the outcrops also contain an admixture of calcium limestone.

A traverse across the Creignish Hills on the road running northwesterly toward McLeod Settlement from a point 3 miles north of Melford, revealed very little limestone for the first 1½ miles but a great deal of metamorphosed Precambrian calcium limestone was seen in the next 3 miles. All the stone is light blue in colour and in places much invaded by dykes of trap rock, but otherwise is quite pure. The analysis of Sample 136 shows the composition of the limestone at a point 2 miles northwest of the Melford road, and No. 137 at a point 1 mile farther northwest.

Kewstoke

This village is on the north side of Creignish Hills and is just west of a large spur of Precambrian rock that extends north for 1½ miles from the main hillside. This spur is very largely composed of George River limestone including both calcium limestone and dolomite, much of which is of good quality, but it is nearly 9 miles by road from Whycocomagh, the nearest port from which water shipment is possible, and it is 16 miles from Orangedale, the nearest rail shipping point.

One mile northwest of Kewstoke, along the road to Mabou, and near the highest point on the above-mentioned spur, is an area about one-quarter of a mile square largely underlain by calcium limestone of good quality together with a small quantity of dolomite. Most of the calcium limestone is medium- to fine-grained, rather soft, and is blue in colour with many thin, parallel streaks of white, giving it a laminated and bedded appearance. In the best grade of stone the visible impurities consist of a few scales of specular hematite and white mica, but in other parts there are slaty seams parallel to the laminations. Some of the calcium stone is nearly pure white and consists almost entirely of calcium carbonate. The dolomite in this area is very fine-grained, of a lighter blue than the calcium limestone, is also much harder and more brittle and weathers to a rough, scarred, drab-grey surface in contrast to the blue calcium limestone which

weathers smooth and to a dark blue shade. The two types can be readily told apart on a weathered surface as is illustrated in Plate XXIXA, page 171. The scarring of the dolomite is caused by the presence of very thin veinlets of calcite that criss-cross the stone in all directions and which weather more rapidly than does the dolomite proper. Most of the outcrops examined were along the course of a brook tributary to Kewstoke Brook where hills of limestone rise to a height of 200 feet or so on either side, and thus there seems to be an enormous tonnage available, but it would have to be core-drilled before it could be certain that there were no undesirable variations in the stone beneath the surface. Sample 138 was channelled across 100 feet of the blue limestone. The following analyses are taken from the records of the old Dominion Iron and Steel Company as being representative of the better grade limestone in this area:—

Silica	Oxide of iron and alumina	Calcium carbonate	Magnesium carbonate	Sulphur	Remarks
1·2	0·68	96·76	1·50	0·02	Blue limestone
0·80	0·64	59·60	39·30	0·01	Blue dolomite
1·04	0·48	98·74	trace	0·03	White limestone

Along the road west from Kewstoke to Dunakym, a mile south of the above area, outcrops of George River limestone are very numerous, with blue, hard, very fine-grained dolomite predominating. Sample 139 represents the dolomite outcropping along the road almost continuously for 700 feet near the west edge of the Precambrian area 1½ miles west of Kewstoke. Sample 139A is from a small quarry in a band of laminated, blue calcium limestone adjoining the dolomite to the east.

Whycocomagh

Two miles northwest of Whycocomagh along the course of Brigend Brook, on the slopes of Creignish Hills, is a band of white, pure, rather coarsely crystalline, Precambrian dolomite, 200 to 400 feet wide, trending northwest-southeast and dipping northeasterly, or down the slope, at 65 degrees. Some of the dolomite is bluish and some is brownish, but most is white. Cutting through it, nearly parallel to the apparent bedding, are a few narrow dykes of dark green, trap rock. Outcrops and boulders indicate that the dolomite extends ¼ mile into the hills on either side of the brook and thus is in a good position for quarrying. On the south bank of the brook the dolomite is seen for a distance of 170 feet east of the schistose and granitic rocks, which seem to enclose it, and then after a covered interval of 300 feet in which no rock is seen, the dolomite is visible for a distance of 50 feet or more on the north bank of the brook, after which no more outcrops occur. Near the contact with the granitic rocks the dolomite becomes calcareous and also micaceous and otherwise impure. Sample 140 was taken along the 170-foot outcrop in the south bank of the brook.

On the hillside north of the brook, the dolomite is very similar in appearance to that just described. As on the opposite hillside, it becomes

rather calcareous adjacent to the contact with the granitic rocks, and near the contact a number of small stringers of milky quartz and spots of serpentine were also observed. In the immediate proximity to the dykes of trap rock some of the dolomite is of a beautiful blue tint, but there is very little so coloured. The deposit here is 250 feet wide.

Messrs. Brandram-Henderson, Limited, of Halifax, operate a small quarry in the white dolomite north of the brook to obtain material for making whiting substitute. The stone is shipped from Orangedale, 9 miles distant, to Halifax, where it is pulverized to the desired fineness. Sample 140A represents the 30 feet of strata being quarried.

An interesting example of the replacement of dolomite by calcite is to be seen in a dolomite deposit at the base of the south side of the Creignish Hills along the road to Melford, ½ mile west of where the road forks to Orangedale. The deposit is 100 yards north of the road in the valley of an unnamed brook 250 yards east of McAskill Brook. It consists of light grey, fine-grained, George River dolomite, but along numerous fracture planes the dolomite has been altered to high-calcium limestone. The phenomenon is well illustrated in Plate XIII B, page 83, in which the light-coloured streaks are the smooth, white-weathering, high-calcium material, and the dark, rough surface is the dolomite. The relationship of the high-calcium portions to fractures in the rock is quite apparent. What is probably the continuation of this deposit crosses the road to Melford, ¼ mile west of McAskill Brook.

A deposit of impure, dark blue Carboniferous limestone dipping south at 25 degrees, outcrops on the side of Salt Mountain a short distance east of the wharves at Whycocomagh. It has been quarried to a small extent for foundation stone and also for agricultural limestone, but is of too low grade to be of much value for the latter use. This deposit is apparently part of the Horton series.

Port Hood

At Ragged Point, 2½ miles south of the Port Hood railway station, a band of heavily bedded, brown, finely granular, hard dolomite, 30 feet wide, trending northerly and dipping easterly at 65 degrees, outcrops in the cliff that forms the point. The cliff is 20 feet high, the top 5 feet being soil. On the west side of the dolomite is red shale and gypsum; on the east side is a covered interval of 25 feet, and then a 25-foot band of gypsum. Sample 141 taken across the full width of the dolomite band shows it to be quite pure. The dolomite extends inshore from the beach in such position that it could be quarried without difficulty.

Mabou

A great many deposits of limestone occur in the Windsor strata of this district, but the majority are of poor quality and seemingly of small extent. For these reasons very few samples were obtained. The following notes will serve to give a general idea of the character of the Carboniferous limestone in this area.

In a brook 1 mile north of the village of Mabou Harbour, dense-textured, grey, siliceous calcium limestone in beds dipping westerly at an angle of 30 degrees is exposed. Sample 142 represents the 4 feet of strata in the outcrop.

Between the villages of Mabou Harbour and Mabou, and east thereof, several thin, steeply dipping bands of impure limestone are to be seen along the road and the shore of Mabou Inlet. Impure dark grey limestone also outcrops north of Mabou station on the south shore of Mabou Inlet.

Along the deep valley of Glendyer Brook, within 1½ miles of the head of Mabou Inlet, are many outcrops of Carboniferous limestone including some of dolomite. None is of a high degree of purity and many are covered by such a depth of soil, sandstone, and shale that they are not quarriable. Near Glendyer station a dolomite deposit, in the steep bank to the west of the Canadian National railway, has been quarried to a small extent and pulverized for agricultural purposes by Alex. Hawley of Glendyer.

Lake Ainslie

One mile south of McLean Point near the head of Lake Ainslie are several small outcrops and many huge boulders of blue, medium-grained, siliceous, calcium limestone of Carboniferous age. This stone was at one time burned for lime but, as the analysis of Sample 143 indicates, it is very impure.

Other outcrops of limestone occur at East Side Lake Ainslie, at Ainslie Point on the north shore of the lake, and also at Lake Ainslie Chapel, but they are only of local value.

Inverness

In the banks of Broad Cove River one mile south of Inverness are a number of outcrops of shaly, grey, fine-grained calcium limestone, obviously impure, and also covered by sand to depths varying from 40 to 70 feet.

About a mile north of Loch Ban a thin deposit of impure, dark blue, fine-grained, laminated calcium limestone containing tiny scales of mica lies on the steep west face of a hill 600 feet east of the Inverness branch of the Canadian National railway. It is underlain by sandstone.

Margaree River

Large areas of Windsor strata occupy the valley of Margaree River and both of its branches—Southwest Margaree and Northeast Margaree. Limestone deposits are very plentiful throughout these areas but the majority are of a low degree of purity and, on account of the distance from either rail or water transportation, they are of purely local value, chiefly for agricultural purposes. Although a number of the deposits were examined, a sample for analysis was taken only from one deposit near Margaree Forks. This deposit is by the roadside north of Southwest Margaree River, ½ mile west of the cross roads at Margaree Forks, and has been quarried to a small extent. The limestone is light grey in colour, earthy in texture, and outcrops in a knoll 35 feet high and 60 feet wide close to a deposit of gypsum. The beds strike north and south, and dip at 75 degrees to the east. Sample 144 was taken across the face of the small quarry. All the other deposits examined in this locality contain a greater percentage of impurities than this, and some are dolomitic.

On the coast north of the Margaree River a small deposit of impure, calcium limestone outcrops in the second brook north of Belle Côte.

Pleasant Bay

Several deposits of Carboniferous limestone and of Precambrian limestone are reported in the valley of Grand Anse River.

Analyses of Inverness County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
124.....	5·88	0·74	1·98	0·07	89·56	1·51	99·74	0·18	50·20	0·72	70 : 1
125.....	9·08	1·43	2·67	tr	61·12	25·18	99·48	0·28	34·22	12·04	2·8 : 1
126.....	1·84	0·84		n.d.	54·29	42·47	99·44	0·02	30·41	20·30	1·5 : 1
127.....	10·38	0·57	2·05	0·04	85·27	2·39	100·70	0·04	47·77	1·14	41 : 1
128.....	0·80	0·25	0·21	0·02	96·54	2·21	100·03	0·02	54·06	1·05	51 : 1
128A.....	2·44	0·28	0·62	0·09	95·30	0·97	99·70	0·06	53·36	0·46	116 : 1
128B.....	4·46	0·90	0·86	0·13	88·13	5·71	100·19	0·03	49·42	2·73	18 : 1
128C.....	1·00	0·57	0·31	0·04	57·04	40·72	99·68	0·03	31·96	19·47	1·58 : 1
129.....	0·64	0·40	0·10	0·02	96·33	2·86	100·35	0·02	53·96	1·37	39 : 1
129A.....	1·38	0·61	0·01	0·02	82·01	16·81	100·84	0·01	45·93	8·04	5·7 : 1
130.....	14·74	0·96	0·34	0·02	49·48	35·13	100·67	0·02	27·71	16·80	1·64 : 1
130A.....	6·36	0·50	1·20	0·07	86·24	5·63	100·00	tr.	48·34	2·69	18 : 1
131.....	3·64	1·22	1·16	0·04	86·59	7·82	100·47	0·03	48·51	3·74	13 : 1
132.....	0·88	1·76		n.d.	53·82	42·53	98·99	0·07	30·14	20·33	1·48 : 1
133.....	0·42	0·63	0·23	0·07	55·27	43·66	100·28	tr.	31·00	20·88	1·47 : 1
133A.....	6·32	0·42	1·58	0·04	89·63	2·63	100·62	0·07	50·15	1·25	40 : 1
134.....	1·04	0·42	0·59	0·05	96·17	1·48	99·75	0·04	53·86	0·60	90 : 1
135.....	6·52	0·85	0·41	0·07	54·71	37·62	100·18	0·02	30·67	17·98	1·7 : 1
136.....	3·36	0·25	0·62	0·04	91·43	4·45	100·15	0·02	51·43	2·13	24 : 1
137.....	1·80	0·24	0·20	0·04	94·55	3·13	99·96	0·02	52·95	1·50	35 : 1
138.....	1·60	0·49	0·11	0·04	94·73	2·98	99·95	tr.	53·05	1·42	37 : 1
139.....	1·20	0·47	0·63	0·11	56·19	41·32	99·92	nil	31·52	19·77	1·59 : 1
139A.....	2·00	0·24	0·48	0·02	95·85	1·37	99·96	nil	53·68	0·66	81 : 1
140.....	2·34	0·34	0·12	0·04	57·44	40·00	100·28	tr	32·18	19·12	1·68 : 1
140A.....	1·26	0·44	0·20	0·13	56·88	40·23	99·14	tr.	31·92	19·24	1·65 : 1
141.....	1·04	0·58	0·44	0·02	53·96	43·25	99·29	0·02	30·23	20·68	1·46 : 1
142.....	13·92	0·83	3·53	0·17	78·53	2·79	99·77	0·13	44·08	1·33	33 : 1
143.....	11·08	0·95	3·91	0·24	78·53	3·82	98·53	0·27	44·10	1·83	24 : 1
144.....	3·80	1·09	1·11	0·04	92·25	1·30	99·59	0·08	51·68	0·62	83 : 1

124.	Port Hastings.	Forty feet of strata in quarry 1 mile north of the village.
125.	Morrison Station.	Thirty feet of strata in valley of Donald Hughie Brook.
126.	West Bay Marshes.	Dolomite on Ross property. Analysis supplied by Dominion Steel and Coal Corporation, Sydney.
127.	Lime Hill.	Band of limestone 1 mile west of Sydenham Brook and ½ mile from shore of Bras d'Or Lake.
128.	Marble Mountain.	White limestone in Marble Mountain quarry.
128A.	" "	Blue-and-white-striped limestone in same quarry.
128B.	" "	Slaty limestone at back of same quarry.
128C.	" "	White dolomite from quarry on top of mountain.
129.	" "	Band of limestone extending westerly from McDonald Lake on top of mountain.
129A.	" "	Same band east of McDonald Lake.
130.	" "	Band of impure dolomite near shore, 3½ miles east of Marble Mountain village.
130A.	" "	Calcium limestone adjacent to the above dolomite.
131.	Little Harbour.	Outcrop in valley of brook flowing into northwest side of the harbour.
132.	Orangedale.	Dolomite formerly quarried by the Steel Company. Analysis supplied by Dominion Steel and Coal Corporation, Sydney.
133.	Wilburn.	Shell limestone on land of M. A. McDonald.
133A.	"	Bedded limestone adjoining the above deposit.
134.	Glendale.	Deposit along Glendale Brook 1½ miles northwest of the village.
135.	Melford.	Dolomite along Diogenes Brook 2½ miles northwest of the village.

136.	Creignish Hills.	Limestone on road to McLeod Settlement from Melford at point 2 miles northwest of the main road.
137.	" "	Limestone 1 mile farther northwest along same road.
138.	Kewstoke.	Deposit 1 mile northwest of village.
139.	"	Dolomite on road to Dunakym 1½ miles west of Kewstoke.
139A.	"	Calcium limestone immediately east of the dolomite.
140.	Whycocomagh.	Dolomite in south bank of Brigend Brook 2 miles northwest of the village.
140A.	"	Quarry of Brandram-Henderson, Ltd., in same band of dolomite.
141.	Port Hood.	Thirty feet of strata at Ragged Point on sea coast.
142.	Mabou Harbour.	Outcrop in brook 1 mile north of the village.
143.	Lake Ainslie.	Outcrop on east side of the lake 1 mile south of McLean Point.
144.	Margaree Forks.	Small quarry ½ mile west of the cross roads at the village.

Lunenburg County

Within this county are the only limestone deposits of commercial importance to be found along the entire south shore of the mainland of Nova Scotia, and also one of the larger quarries in the province, that of the Mersey Paper Company at East River station, where limestone for use in the sulphite mill at Liverpool is being quarried. The deposits occur in small outliers of the Windsor series around the shores of Mahone Bay and on some of the islands thereof, and consist almost entirely of high-calcium limestone—the only dolomite observed being that encountered in the deepening of the quarry at East River station. All deposits examined by the writer were of the bedded type, but Faribault[1] records the occurrence of shell limestone on Goat, Sheep, and Stephen Islands in Mahone Bay. Limestone deposits are also reported near the Government wharf on Second Peninsula, and also north of the village of Chester Basin. The limestone in the latter deposit is stated by Dawson[2] to have been so ferruginous that on weathering it left a deposit of ochre that was suitable for the manufacture of paint.

Though the areal extent of the outliers of the Windsor series in this county is small, the thickness of the limestone therein may be very considerable, as for instance at East River station where, close to the margin of the outlier, a depth of 45 feet of limestone has been quarried without reaching the underlying rock—the limestone apparently having been deposited in a rather deep depression in the granite.

The above-mentioned quarry is the only one in operation. Many years ago quarries were worked both at East River and at Frail Cove to supply lime, and also stone for lime-burning, to the Halifax market where it was highly esteemed,[3] and small quantities of lime, chiefly for agricultural use, have been made in the past at a number of the other deposits.

East River

One mile east of East River station on the Canadian National railway, an outlier of the Windsor series extends from the tip of Indian Point on Mahone Bay, northeasterly for a mile or so into considerably higher land. It is crossed by both the highway and the railroad. Outcrops of limestone are visible at intervals from the water's edge to near the far extremity of the outlier. At the tip of Indian Point the limestone is

[1] Faribault, E. R.: Sum. Rept.; Geol. Surv., Canada, 1907, p. 79.
[2] Dawson, J. W.: Acadian Geology, p. 274 (1855).
[3] How, H.: Mineralogy of Nova Scotia, p. 152 (1868).

continuously exposed across a width of 275 feet with granite outcropping on either side, and northeast of the road the limestone band is apparently much wider than this. At the railroad the stone is concealed, but on the higher wooded land to the northeast, outcrops are visible on the property of Zenas Meisner. The whole outlier rests on the granite rocks of the district and granite boulders are very numerous in the soil on top of the limestone. The limestone beds are undulating, but the general dip is southerly.

Wherever it outcrops the limestone is uniform in appearance, being extremely fine-grained to dense in texture and very dark blue-grey in colour. Small blebs and veinlets of translucent white calcite are plentiful, and in places, particularly along joint planes, crystals of iron pyrites are to be seen. The bedding is indistinct and the stone has a tendency to break into angular fragments. Samples taken at the tip of Indian Point (No. 23), in the quarry of the Mersey Paper Co. (Nos. 24, 24A, 24B, 24C), from outcrops between the quarry and the railway (No. 24D), and from the property of Zenas Meisner near the far end of the outlier (No. 24E), show that a large tonnage of high-grade limestone is available. Shipping facilities are provided by the Halifax and Southwestern branch of the Canadian National railway, and, in the near future, water shipment also may be possible, though at present there is no wharf extending to deep water 300 feet offshore.

Quarry of Mersey Paper Co., Ltd. This company is quarrying limestone for use in the sulphite pulp mill at Liverpool from what is locally known as the Lordly quarry near the beach at Indian Point. The quarry is 200 feet square and has been worked to a maximum depth of 45 feet. Overburden of gravelly soil containing granite boulders is from 5 to 10 feet in thickness. The stone in the top 40 feet is similar in appearance to that already described. It is in irregular beds from a few inches to 2 feet in thickness, and is free from shale. The dip of the strata is extremely variable but is always seawards, which partially explains why there is no infiltration of sea water into the quarry, though it is located close to the shore and has been worked to a depth well below low-water level. As shown by the analyses of Samples 24 to 24C the content of magnesium carbonate gradually increases with depth until, at a depth of 40 feet, a hard and tough, drab-grey, finely granular, brown-weathering dolomite is encountered. The dolomite, the thickness of which is not yet known, contains fossil shells similar to those found in the high-calcium limestone above, but the interiors are filled with coarsely crystalline white dolomite instead of calcite.

The quarry, from which during the quarrying season about 55 tons of stone per day is removed, is worked by means of jackhammers and a portable air compressor. Broken stone is loaded by hand onto 1½-ton trucks and taken to the railway siding, ¼-mile distant, where it is dumped from a loading platform directly into gondola cars. Waste material is being utilized in the construction of a pier so as to permit of water shipment.

Another outlier of the Windsor series, containing a deposit of limestone similar to that just described, occurs ¼ mile east of the Halifax and Southwestern railway at a point 3 miles by rail northeast of East River station.

PLATE XIV

A. Carboniferous limestone boulders, Gaetz Cove, Lunenburg County, N.S.

B. Heavily bedded, Carboniferous limestone, Churchville, Pictou County, N.S.

Frail Cove

On the east shore of Goat Lake—a small body of brackish water at the head of Frail Cove in Mahone Bay, 2 miles east of East Chester—is an outlier of high-calcium limestone. The deposit is small but could be easily quarried as it takes the form of a ridge that on the shore of the lake is 200 feet wide and 15 feet high and it increases in height inland at right angles to the shore of the lake. Outcrops are visible for 200 feet back from the shore, and the deposit may extend another 200 feet before it is in contact with the granite on which it rests. Granite outcrops are also to be seen a short distance north of the ridge. To the south the land is low.

The limestone is quite like that at East River in appearance and composition, being a very fine-grained high-calcium stone that contains many crystals of secondary calcite, but it is slightly lighter in colour. It is much fractured and readily breaks into small angular fragments. Bedding is not clearly defined. On the north edge of the ridge, the surface stone contains many small cavities filled with yellow ochre. Sample 25 is representative of the 15-foot face on the shore of Goat Lake, exclusive of the ochreous portion.

A small amount of quarrying was at one time done on the shore of Goat Lake to obtain stone for making lime for building and agricultural purposes. At high tide there is sufficient water to float small scows in the narrow channel connecting with the head of the bay. The Halifax and Southwestern railway passes within $\frac{1}{4}$ mile of the deposit.

Gaetz Cove

At Gaetz Cove, just north of the village of Upper Blandford on the east shore of Mahone Bay, many large boulders of light grey calcium limestone are strewn over the land adjacent to the beach, and indicate the presence of a bedded deposit of limestone. The boulders have a peculiar contorted structure as shown in Plate XIV A, page 93. Sample 26, taken from numerous boulders, reveals on analysis that the stone is only fairly pure.

Analyses of Lunenburg County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Totals	S	CaO	MgO	Ratio of CaO to MgO
23.....	0·62	0·45	0·25	0·02	97·63	1·00	99·97	tr.	54·68	0·47	116 : 1
24.....	0·56	0·40	0·18	0·02	97·87	0·74	99·77	0·06	54·82	0·35	156 : 1
24A.....	0·32	0·41	0·16	0·02	97·81	1·22	99·94	0·08	54·78	0·58	94 : 1
24B.....	1·15	0·63	0·24	0·02	95·64	2·01	99·69	0·08	53·56	0·96	56 : 1
24C.....	1·20	1·90	1·30	0·02	55·53	40·60	100·55	0·07	31·11	19·17	1·62 : 1
24D.....	1·72	0·46	0·35	0·03	95·68	1·15	99·39	tr.	53·58	0·55	95 : 1
24E.....	0·88	0·42	0·46	0·02	96·07	1·75	99·60	tr.	53·80	0·84	64 : 1
25.....	0·48	0·49	0·09	0·04	97·71	1·09	99·90	nil	54·75	0·52	105 : 1
26.....	5·26	0·62	1·40	0·02	91·13	0·23	98·66	0·07	51·04	0·11	464 : 1

23. East River. Ten feet of strata at tip of Indian Point.
24. " Mersey Paper Co. quarry, top 10 feet of face.
24A. " " " next 12 " "
24B. " " " " 12 " "
24C. " " " dolomite in quarry floor.
24D. " Outcrops between Mersey Paper Co. quarry and railway.
24E. " Outcrops on land of Zenas Meisner.
25. Frail Cove. Fifteen feet of strata on east shore of Goat Lake.
26. Gaetz Cove. Numerous limestone boulders near beach.

Pictou County

The principal area underlain by rocks of the Windsor series lies south of Westville and Stellarton and extends up the valley of the East River as far as Sunnybrae. Many deposits of limestone occur in this area particularly in the valley of the East River where they were quarried on a considerable scale for flux during the years 1891 to 1904 when the blast furnace of the Nova Scotia Steel and Coal Company was in operation at Ferrona. All the deposits are of the high-calcium or calcium type—none of the samples containing over 3 per cent magnesium carbonate—but all contain a considerable amount of argillaceous matter. The deposits at Springville, Iron Rock, and Sunnybrae are 40 feet thick, and that on the Dunbar property at Lorne even exceeds this thickness. A number of small limestone outcrops associated with gypsum occur south of Thorburn along the course of McLean Brook. Other deposits occur in outliers of the Windsor formation at Limerock and at Lovat, a short distance west of the main area of Windsor strata, and also in an outlier between Avondale and Knoydart in the northeastern part of the county. In this latter area, however, the deposits, in addition to being far from rail transportation, are apparently of limited extent and of poor quality. Several bands of calcareous sandstone were seen along the south shore of Merigomish Harbour and also between the harbour and New Glasgow.

Within recent years the only use that has been made of the limestones of Pictou County has been for agricultural purposes, and since the closing, in 1930, of the agricultural limestone plant erected by the Nova Scotia Government at Iron Rock, no production at all has been recorded.

Limerock

At Limerock village, $\frac{3}{4}$ mile south of the highway between Truro and New Glasgow, but 8 miles from the nearest railway, is a deposit of Carboniferous limestone that at one time supplied stone for lime-burning to the towns of Pictou and New Glasgow and to much of the surrounding territory. It was the practice to haul the stone from the quarry and burn it where required. Until quite recently a quarry was worked here by Messrs. McKay and Munro, the product of which was ground for local agricultural use in a Jeffrey No. 2 Limepulver.

The limestone occurs along the southeast edge of a small outlier of the Windsor series in a deposit about 25 feet thick that is underlain by sandstone. The top beds are thin and rubbly but the main part of the deposit consists of heavy, solid beds up to 3 feet thick. The stone is fine-grained, blue in colour, and hard. Outcrops are visible at intervals from the quarry, which is south of the junction of the roads to Salt Springs and Lovat, for over $\frac{1}{4}$ mile northwards, principally in the valley of a small brook. In the quarry the dip of the strata is to the west at an angle of 25 degrees. Sample 65 represents the 10-foot quarry face.

Lovat

Three-quarters of a mile east of Lovat, and $1\frac{1}{2}$ miles almost due south of the deposit at Limerock, a deposit of high-calcium limestone of good

quality occurs on a level hill-top on the land of the late Robt. McCunn, where it was formerly quarried and pulverized for agricultural use. The limestone is light pinkish brown in colour, hard, dense and brittle, and dips southerly at an angle of 35 degrees. In the small quarry a thickness of 8 feet of this limestone is exposed beneath 4 feet of hard, purple shale and 2 to 3 feet of soil. Sample 66 was obtained from the 8-foot section. No other exposures of limestone were seen in the vicinity and the extent of the deposit is unknown.

Hopewell

Slightly over a mile west of Hopewell station on the Canadian National railway a number of small quarries were worked many years ago along a ridge extending north for $\frac{3}{4}$ mile from the junction of the Whitehill and Marshdale roads. The pits are now filled in with debris and but little of the solid limestone is to be seen. The stone quarried was a dense, blue calcium limestone containing veins of white, secondary calcite. It is apparently of only a fair degree of purity, but the opportunities for quarrying are good.

Lorne

On the land of John A. Dunbar, 1 mile northwest of Lorne, a large deposit of calcium and high-calcium limestone occurs on the crest of a hill where it is in an excellent position for quarrying. The stone is dense-textured, hard, and in heavy beds that dip north at an angle of 75 degrees. The exposures show the deposit to be over 40 feet thick and it may be considerably more, for in no place was a contact with another type of stone seen. Overburden is light and the limestone can be traced by outcrops for several hundred feet east and west along the crest of the hill. Strata composing the north or upper half of the deposit are mostly blue-grey in colour and are sparingly veined with white calcite. Toward the north edge the stone becomes rather impure. The strata composing the south half, or lower part, of the deposit are mostly brown and reddish brown in colour, and calcite veins are more numerous. Sample 67 was taken across 20 feet of strata composing the north half of the deposit, and No. 67A from the 20 feet of strata composing the south half. Shallow quarries were worked here many years ago, principally to obtain stone for making lime. The main line of the Canadian National railway is $\frac{3}{4}$ mile west of the deposit.

One-half mile south of Lorne post office a very impure, blue, shaly limestone outcrops in the valley of Big Brook just east of the road bridge.

Centredale

One mile northeast of Centredale school, on the land of Daniel A. Campbell, a dense, dark blue calcium limestone underlain by sandy shale is exposed in a small quarry. The beds are flat and in a good position for quarrying but, as shown by the analysis of Sample 68 obtained from the 10 feet of strata in the quarry, the stone is only of a fair degree of purity.

Riverton to Sunnybrae

Along the valley of the East River between Riverton and Sunnybrae, which district is served by a branch line of the Canadian National railway, deposits of limestone are numerous. From 1891 to 1904 many of the deposits were quarried for flux, and in recent years two quarries were worked for the production of pulverized limestone for agricultural purposes.

Riverton

On the east side of the East River, opposite Riverton flag station, are several abandoned quarries from which limestone for flux was obtained. The largest of these, known as Fishpools quarry, was opened in a 20-foot band of hard, dense, heavily bedded, dark blue high-calcium limestone that dips at an angle of 75 degrees in a southwesterly direction and in which thin veins of white, secondary calcite are plentiful. The deposit is overlain by red shale and underlain by blue shale. It extends across the river and Sample 69 was obtained on the west side of the river near the railway. Faulting of the strata in this vicinity renders doubtful the amount of limestone available. Just north of Riverton station an impure, shaly limestone is exposed in the bed of a small brook.

Churchville

Between Eureka and Churchville, about 1 mile west of the latter village, a deposit of heavily bedded, dark blue, fine-grained limestone extends northeasterly from the road running westerly from Churchville. Owing to its dark colour and heavy bedding it has attracted some attention as being a possible source of black marble. A small quarry for agricultural limestone was recently worked in this deposit by Alex. McIntosh of New Glasgow, a Jeffrey No. 1 Limepulver being used to pulverize the stone. The outcrop at the quarry shows beds 5, $3\frac{1}{2}$, and 3 feet thick. (Plate XIV B, page 93.) The top 5-foot bed contains very thin, shaly streaks but the other beds are nearly free from shale. The deposit is gently domed, but the maximum angle of dip does not exceed 12 degrees. Sample 70 includes the $11\frac{1}{2}$ feet of strata. Another outcrop of the same type of stone occurs $\frac{1}{4}$ mile to the east, along the road to Churchville.

Springville

A large quarry, from which limestone for flux was obtained, was worked here by the Nova Scotia Steel and Coal Company about 30 years ago and the stone shipped by rail to Ferrona. The quarry was opened for a length of 300 feet in a deposit of limestone 40 feet thick that forms the west face of a high hill and dips down hill at an angle of 25 degrees. At the north end the overburden is 20 feet thick, but at the south end it is not excessive. The limestone is in heavy but much shattered beds and is dense-textured, hard, brittle, dark blue in colour, and contains veinlets of white, secondary calcite. In the bottom 2 feet of the deposit are angular fragments of other varieties of rocks. Some veins and masses of medium-grained, brownish white, rusty-weathering dolomite are to be seen in the limestone

particularly at the south end of the quarry. Sample 71 taken at the south end of the quarry shows the composition of the stone exclusive of the dolomite veins.

About $\frac{3}{4}$ mile northwest of the above quarry, a belt of pure, heavily bedded, high-calcium limestone, tinted purple and green, is exposed. It has been quarried to a small extent, but owing to its dipping into a hillside at an angle of 10 degrees there is but little available without recourse to mining methods. Sample 72 taken here across 6 feet of strata shows that this is the purest stone examined in the district.

At the forks of the road, $\frac{1}{4}$ mile farther north, is a small quarry in stone similar in appearance but somewhat less pure than that from which Sample 72 was obtained.

Iron Rock

A plant for the production of agricultural limestone was established at Iron Rock in 1924 by the Nova Scotia Department of Agriculture, and was in operation until 1930 when it was closed down. The limestone deposit quarried to supply this plant occurs along the base of the steep hillside of igneous rock on the north side of the East River. The beds, all much fractured, rest on the igneous rock and dip steeply down hill at about the same angle as does the surface of the igneous rock. Though the limestone apparently extends for several hundred feet along the base of the hill in both directions from the quarry it does not extend up the hillside for more than 60 feet above the level of the highway which passes between the quarry and the river. There is a maximum thickness of about 40 feet of soft, fine-grained, rather impure, drab calcium limestone in broken beds, and this is covered by what appears to be an ancient talus of soft, shaly, yellow-brown calcium limestone, in turn covered by about 3 feet of soil. Sample 73 was taken across the 40 feet of bedded limestone, none of the talus being included.

The quarry was opened at the road level by digging a trench through the soil and talus into the bedded stone and then was extended along the hillside in both directions in the bedded stone—the soil and talus on the upturned edges of the strata first being removed. The stone was trammed across the highway to the pulverizing plant which was located alongside the railroad and consisted of a Jeffrey No. 4 Limepulver operated by a steam engine. Forty tons of pulverized limestone per day was the average output.

One-quarter mile east of the Iron Rock quarry and on the same side of the East River is a worked-out quarry in a deposit of dense, hard, blue calcium limestone that apparently occupies a small depression in the igneous rock composing the hillside. This quarry was worked for flux.

Sunnybrae

A 40-foot cliff of fine-grained, light grey and purplish grey limestone forms the south bank of the East River for 200 feet upstream from the road bridge, and outcrops of similar limestone occur in the fields a short distance southeast of this cliff. Along the river the strata are very thick and nearly horizontal, but in the fields to the southeast they appear to dip steeply. As revealed by the analysis of Sample 74, which was taken from

the cliff face, the stone is rather impure. This deposit occurs at the eastern extremity of the long tongue of the Windsor series that extends up the valley of the East River.

Analyses of Pictou County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
65.....	3·56	0·81	1·05	0·02	93·28	1·01	99·73	0·17	52·23	0·48	108: 1
66.....	2·18	0·66	1·11	0·07	93·64	0·86	98·52	nil	52·48	0·41	128 : 1
67.....	4·52	0·52	1·28	0·02	90·32	2·83	99·49	0·02	50·60	1·35	38 : 1
67A.....	3·10	0·82	0·66	0·01	94·10	1·28	99·97	tr	52·70	0·61	86 : 1
68.....	3·08	1·01	1·55	0·11	90·32	2·86	98·93	0·33	50·60	1·36	37 : 1
69.....	2·10	0·75	0·83	0·07	92·82	2·02	98·59	tr	52·02	0·96	54 : 1
70.....	3·98	0·68	1·34	0·04	90·41	2·00	98·45	0·32	50·65	0·95	53 : 1
71.....	2·32	0·57	0·77	0·04	94·46	2·03	100·19	0·09	52·92	0·96	55 : 1
72.....	1·70	0·61	0·07	0·04	96·21	1·24	99·87	nil	53·90	0·59	90 : 1
73.....	6·36	0·78	1·88	0·07	89·60	0·94	99·63	0·14	50·17	40·5	112 : 1
74.....	7·10	0·77	2·11	0·07	89·30	1·30	100·65	0·24	50·05	0·62	81 : 1

65. Limerock. Ten feet of strata exposed in quarry face.
66. Lovat. Eight feet of limestone in bottom of quarry.
67. Lorne. Dunbar property, 20 feet of strata on north side of band.
67A. " " " 20 feet " on south side of band.
68. Centredale. D. A. Campbell property, 10 feet of blue limestone.
69. Riverton. Twenty-foot band of limestone across the East River, from the Fishpools quarry.
70. Churchville. Eleven and one-half feet of strata in quarry of Alex. McIntosh.
71. Springville. Forty feet of strata at south end of quarry formerly worked by Nova Scotia Steel and Coal Company.
72. " Six feet of strata in small quarry ¼ mile northwest of the above quarry.
73. Iron Rock. Forty feet of strata in quarry worked for agricultural limestone.
74. Sunnybrae. Forty feet of strata in cliff on south bank of East River, just above the bridge at the village.

Richmond County

All known limestone deposits in this county occur in the Windsor series—principally in the basal strata—and nearly all have an exceptionally low content of magnesium carbonate. A few beds and small masses of dolomite, apparently of secondary origin, occur in some of the calcium limestone deposits in the vicinity of St. Peters but in no place is it in quarriable amount. The largest deposits are found along the east shore of St. Peters Inlet and the east shore of Bras d'Or Lake. Smaller deposits occur on Ile Madame, and also in a number of outliers of the Windsor series extending in a line from Lower L'Ardoise on the Atlantic coast northerly to beyond Loch Lomond. Small quantities of limestone for agricultural use have been obtained from a quarry near Grand River. In the western end of the county the only known deposits are near Dundee and along the southeast shore of West Bay.

A number of small quarries were worked in years gone by to obtain stone for making into lime for structural and agricultural purposes, for foundation stone, and, unsuccessfully, for marble. A considerable trade was at one time developed in supplying limestone to Prince Edward Island, where it was burned chiefly for agricultural use. The only

PLATE XV

A. Calcite veins cutting Carboniferous limestone, Dundee, Richmond County, N.S.

B. Thinly bedded, vertically dipping Carboniferous limestone, Cameron quarry, Robinson Cove, Richmond County, N.S.

quarrying of any account in recent years has been at Robinson Cove, Bras d'Or Lake, from where stone has been shipped to Prince Edward Island.

Dundee

A short distance west of the village, a few outcrops of impure, brownish grey, calcium limestone are seen south of the road to West Bay.

One mile south of Dundee, where the road going due south from the Dundee-West Bay road crosses a small brook that flows easterly, a deposit of limestone can be traced along the north side of a hill of Precambrian igneous rock and down the brook for nearly a mile. The limestone overlies the igneous rock to a depth of 25 feet, and dips northerly and westerly into the hillside north of the brook. It is brownish grey, fine-grained, high-calcium limestone thickly dotted with small masses of white calcite. The beds are irregular and rarely exceed 8 inches in thickness and are crossed by veins of white calcite and by a few veins of barite. (Plate XVA, page 100.) Pebbles of igneous rock occur in the bottom bed. Analysis of Sample 89, representative of 20 feet of limestone strata, shows that it is quite pure. Owing to the angle of dip into the hill, however, it is probable that no large quantity could be obtained without extensive stripping.

The Points, West Bay.

On the property of Robert Ross, ½ mile inland from McLeod Point on the southeast shore of West Bay, Bras d'Or Lake, a rather porous, fine-grained, thin-bedded, grey calcium limestone rests on the igneous rock of Sporting Mountain. It outcrops in a knoll from which it could easily be quarried, but the total amount available is uncertain. Sample 90 was taken from the outcrops.

Ile Madame

Fifty years ago a number of shallow quarries were worked at Lennox Ferry to obtain stone for shipment to Prince Edward Island where it was made into lime. The stone quarried was a blue, fine-grained calcium limestone containing fossils and blebs of white calcite and occurring in lenticular areas, in some instances 400 feet by 300 feet in area and possibly 20 feet thick, that are separated by drab and reddish, impure, shaly limestone. The dip is shoreward at a low angle corresponding closely to the slope of the land. At a distance of 200 yards from the water the elevation of the deposit is about 100 feet. The limestone is overlain by from 4 to 6 feet of hardpan and apparently rests on a quartzose conglomerate. Sample 91 is a composite sample from four of the quarries, there being very little stone exposed in any one of them owing to soil having caved in and hidden the faces. The water is deep up to the shore and shipment could be made by vessel, but it is not known how much of the better grade limestone remains in the deposit.

On the eastern outskirts of Arichat, just at the head of the harbour, a band of light grey, rubbly, calcium limestone can be traced from the shore for 1,000 feet in a northwesterly direction over rolling country. Neither the width of the band nor its angle of dip could be determined. The analysis of Sample 92 indicates the quality.

St. Peters

One-quarter mile east of St. Peters Inlet and about an equal distance south of the highway to Sydney a deposit of impure and variable limestone is exposed over an area 300 feet by 125 feet in extent. On the west side is an intrusive mass of igneous rock that has altered the dark blue limestone to a very light grey. The strata dip easterly or away from the igneous intrusion. Most of the limestone is thinly laminated, and along the laminæ are films of rusty-weathering shale that project on the weathered surface. A few thin platy patches of rusty-weathering dolomite occur in some parts of the deposit.

At Peggy Point on the east shore of St. Peters Inlet, 2 miles northeast of St. Peters, a deposit of dark blue, impure, slaty limestone, veined across the beds with white calcite, extends along the shore. At the edge of the bank the strata dip steeply toward the water, but farther back the angle of dip is much less. A few of the top beds consist of fine-grained, grey-blue, rusty-weathering dolomite, and irregularly shaped patches of the same are to be seen in other parts of the deposit. Interbeds and lenses of calcareous shale are also present in the deposit, and, on the whole, although there is a large tonnage available, the limestone is too impure and variable for chemical and metallurgical uses. The same deposit can be traced for more than a mile to the northeast.

North of Lynch Creek, the same type of limestone, associated with sandstone, continues along the shore for over ½ mile to the head of the cove on the south side of Sandy Point, where it is exposed over a large triangular area in which dips and strikes are extremely variable. The limestone is grey, fine-grained, rather soft, and is thinly bedded. No shale or dolomite was observed. Sample 93 taken from many outcrops within the area shows on analysis that the stone contains more than 8 per cent of impurities.

Corbett Cove—Salmon Creek

Some time prior to 1875 an unsuccessful attempt was made to quarry marble from a deposit of very light grey, fine-grained, calcium limestone occurring on the south side of St. Peters Inlet, Bras d'Or Lake, ¼ mile north of Corbett Cove. The deposit, which is 30 feet thick and underlain by a quartzose conglomerate, is folded into a very gentle anticline and forms the crest of a wooded hill trending northwesterly at an elevation of 200 feet above the lake. The limestone is heavily bedded but through all the beds, though more prevalent in some than in others, is a network of films of greenish shale. This shale accounts in large part for the rather high content of impurities as shown by the analysis of Sample 94 which represents the entire thickness of the deposit.

On the north shore of this same promontory a small outcrop of Carboniferous limestone, similar in appearance to and probably of the same composition as that in Sample 93, occurs at the base of the Windsor series, in contact with the underlying Precambrian rock.

Robinson Cove (Barra Head)

An almost vertical band of nearly black, thinly bedded, calcium limestone forms the south shore of Robinson Cove and can be traced from there northeasterly for over 1 mile along the southern edge of the area of Windsor strata to the shore of Soldier Cove. At Robinson Cove the limestone has been quarried on a considerable scale for making lime and for shipment by vessel to other localities. The old quarries extend for 600 feet along the shore in the nearly vertical limestone band, which has a thickness of 50 feet and rises 50 feet above the water. A small quarry is occasionally worked here by James M. Cameron, of Barra Head, who ships the stone to Prince Edward Island. The limestone is very fine-grained and tends to break readily into thin slabs. (Plate XV B, page 100). It is traversed at right angles to the bedding by numerous veins of white calcite containing cubical crystals of pyrite. Sample 95 was taken across the 30 feet of strata exposed in the quarry now being worked. Quarrying is done with hand drills and blasting powder, and the broken stone is trammed over a short trestle and dumped into the hold of a vessel.

Red Islands

At Red Islands a very large deposit of pure, brownish grey, high-calcium, shell limestone that could be cheaply quarried blankets the steep hillside of igneous rock facing Bras d'Or Lake. The Trans-Canada highway passes along the lower slope of the hillside and all exposures of limestone are above the road. Patches of the shell limestone are to be seen near the top of the hill about $\frac{1}{4}$ mile south of Red Islands school, but the main deposit begins 1 mile north of there and extends for $\frac{3}{4}$ mile northerly to the Roman Catholic church. At the widest part, opposite a small island in the lake, the limestone can be traced southeasterly from the highway over the crest of the hill and down the other side to the valley of a small brook—a distance of 400 yards. The hill at this place rises 200 feet above the lake. Where seen in a small quarry by the roadside the limestone is composed almost entirely of shells and is very friable, but on top of the hill it contains a much larger proportion of dense, cementing material, and exhibits no tendency to crumble. Test pits show that the deposit is 20 feet thick on the brow of the hill facing the lake and farther back on the crest it is even thicker than this. Along the small brook on the opposite side of the hill a face of 15 feet of limestone is visible above an equal thickness, or more, of mottled red and green shale that here lies between it and the igneous rock. (Plate XVI A, page 104.) Northwards the shell limestone occupies lower land and, opposite the church, it extends only 400 feet east of the highway. Samples were obtained as follows—No. 96 from the 20 feet of limestone in the test pit midway between the road and the eastern limit of the deposit; No. 96A from the 15-foot face along the brook at the east edge of the deposit; No. 96B from numerous outcrops near the northeastern end of the deposit. Though the limestone in the deposit could easily be quarried, facilities for shipping are not of the best for, though the water is deep close to the shore, the shore is exposed to storms and there is no wharf available at present.

Irish Cove

At Irish Cove, 3 miles northeast of Red Islands, a large deposit of pure, shell limestone occupies a triangular area on the steep hillside of igneous

PLATE XVI

A. Face of shell limestone in valley of small brook on southeast side of hill at Red Islands, Richmond County, N.S.

B. Carboniferous limestone conglomerate on the southeast shore of Boularderie Island, 2½ miles northeast of Big Harbour, Victoria County, N.S.

rock facing Bras d'Or Lake. The base of the triangle extends along the shore of the lake for about ½ mile on either side of Irish Brook, and the apex lies up the valley of the brook, 400 yards from the shore. The largest exposures are to be seen in the immediate valley of the brook where the stream has cut a 25-foot gorge through the soft, brown shell limestone. Outcrops of the limestone are also visible on the sides of the valley to a height of 100 feet above the lake. Three hundred and fifty yards up the brook from the highway bridge, a mottled red and green shale, exactly like that at Red Islands, is to be seen beneath the limestone, and 100 yards farther only the igneous rock of the mountain-side is seen. Sample 97 was taken from the 25-foot cliff along the brook, near the shore, just above where the stream passes under the highway, and No. 97A was taken from numerous outcrops on the higher land on both sides of the valley. One-half mile southwest of the brook, 8 feet of soft, brown limestone, composed almost entirely of fragments of crinoid stems, is exposed beneath 8 to 10 feet of clay for a short distance along the shore of the lake. Sample 97B was obtained from this 8 feet. Northeastward along the shore of the lake a rather shaly shell limestone is visible beneath 25 feet of clay soil for a distance of ¼ mile or more from Irish Brook, and inland on the road to Loch Lomond on high land about ¼ mile northeast of the lake are outcrops of pure, shell limestone of the same type as that in the gorge. The average thickness of the entire deposit may not exceed 20 feet, but a very large tonnage is available. Any large-scale quarry operation would have to rely on water shipment. Though deep water is available a short distance off shore, the shore is exposed and the present wharf is suitable for small boats only. The Trans-Canada highway passes over the deposit.

Analyses of Richmond County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
89.....	1·44	0·68	0·18	0·02	95·92	0·95	99·19	0·15	53·73	0·45	120 : 1
90.....	2·44	0·68	1·02	0·04	94·72	0·48	99·38	0·03	53·04	0·23	231 : 1
91.....	2·22	0·48	0·44	0·07	92·50	3·68	99·39	0·07	51·84	1·17	30 : 1
92.....	4·40	0·68	1·32	0·09	91·42	0·76	98·67	0·11	51·25	0·36	142 : 1
93.....	6·02	0·74	1·34	0·13	90·14	0·71	99·08	0·22	50·50	0·34	149 : 1
94.....	4·62	0·46	1·72	0·09	92·39	0·63	99·91	0·18	51·80	0·30	173 : 1
95.....	4·48	0·78	1·82	0·04	90·14	0·99	98·25	0·38	50·50	0·47	107 : 1
96.....	0·84	0·21	0·25	0·11	97·73	0·56	99·70	nil	54·79	0·27	203 : 1
96A.....	0·42	0·20	0·28	0·11	98·00	0·55	99·56	tr.	54·94	0·26	211 : 1
96B.....	0·38	0·29	0·21	0·07	97·43	0·44	98·82	0·11	54·60	0·21	260 : 1
97.....	0·72	0·68	0·10	0·09	96·70	0·86	99·15	0·05	54·20	0·41	132 : 1
97A.....	0·92	0·34	0·38	0·07	96·58	0·75	99·04	tr.	54·12	0·36	150 : 1
97B.....	0·34	0·24	0·26	0·07	97·77	0·74	99·42	nil	54·79	0·35	157 : 1

89.	Dundee village, southwest of.	Strata in brook northwest of village.
90.	The Points, West Bay.	Outcrops on land of Robt. Ross.
91.	Ile Madame.	Old quarries at Lennox Ferry.
92.	" "	Outcrops east of Arichat town.
93.	St. Peters Inlet.	Head of cove on south side of Sandy Point.
94.	Corbett Cove.	Abandoned marble quarry.
95.	Robinson Cove.	Cameron quarry.
96.	Red Islands.	Twenty feet of stone in test pit.
96A.	"	Fifteen-foot face at east edge of deposit.
96B.	"	Outcrops on northeast end of deposit.
97.	Irish Cove.	Cliffs on Irish Brook.
97A.	" "	Outcrops on both sides of Irish Brook.
97B.	" "	Strata along the shore ½ mile southwest of Irish Brook.

Victoria County

Dolomites and calcium limestone of both Precambrian and Carboniferous ages, and having a wide range of purity, are found in this county.

Precambrian limestones are obtainable 4 miles north of Iona and at New Campbellton, where the deposits consist of interbanded calcium limestone and dolomite and are of value chiefly for the latter, as the bands of calcium limestone seem extremely variable in quality and also contain more dykes of trap and interbeds of slate and quartzite than do the dolomitic bands.

Carboniferous limestones, including both the shell and bedded varieties, are found principally in the southern part of the county, adjacent to the Bras d'Or Lakes. They are also present in many of the detached areas of Windsor strata fringing the Atlantic coast as far north as Aspy Bay. Few of the deposits are of large extent and many, excepting the shell limestones, are only of a fair degree of purity. The most extensive of the Carboniferous deposits examined was the dolomite deposit at Ingonish.

Water transport must be relied upon in most districts, as the only railway in Victoria County is at the extreme south part, where the Canadian National railway crosses the Iona peninsula. Navigation on the Bras d'Or Lakes, however, is possible only from April to December, for in the winter the lakes are frozen.

Small quantities of limestone have been quarried at several places for lime-burning, foundation stone, flux, and for agricultural use, but there are no quarries in operation at the present time.

Estmere

Just north of this village, which is in the extreme southwest corner of Victoria County, a low ridge of brown, earthy, rather impure calcium limestone of Carboniferous age extends for several hundred feet along the north shore of a small cove one-half mile south of the Canadian National railway. The deposit is owned by D. H. Kennedy, Estmere, who states that it was at one time quarried for making lime. On the fresh surface the stone is blue-grey in colour, but it weathers deeply to a drab shade and becomes quite soft. It is in rubbly, broken beds, the dip of which was not determined but, as stone of the same character is exposed 200 feet north of the cove, it is probable that the strata lie nearly flat. Sample 112 represents the stone at the west end of the ridge where it is less weathered than at any other place, and No. 112A is from the more completely weathered portion near the east end of the ridge adjacent to a small quarry. No very large tonnage could be secured but shipping facilities are good.

McKinnon Harbour

At the head of McKinnon Harbour, immediately north of the Canadian National railway, is a badly fractured deposit of very fine-grained, brownish grey, calcium limestone that weathers deeply to an earthy, drab colour. It is probably similar in composition to the limestone in the deposit where Sample 112 was obtained.

East of McKinnon Harbour a deposit of fine-grained, grey-blue calcium limestone, occurring in beds up to 20 inches thick, has been quarried on the land of Roderick Gillis for use in building the local culverts on the Canadian National railway. The deposit strikes northwest-southeast and dips nearly vertically. It is only a narrow band and could not yield a large tonnage. These deposits are both of Carboniferous age.

Gillies Point

One mile from the shore at Gillies Point a high hill of Precambrian rock projects through the Carboniferous strata which form most of the bedrock in this locality. The top of this hill is composed largely of metamorphosed dolomite and calcium limestone of the George River series, the two being interbanded and intermingled in many places, but the major part is dolomite. The deposit appears to strike nearly due east and west and to dip northerly at angles of 45 to 60 degrees. James C. MacNeil owns the eastern part of the deposit and John Nash the western part. Both the calcium limestone and dolomite are much alike in appearance being fine- to medium-grained and bluish to nearly white in colour. Much of the dolomite is traversed in all directions by very thin veins of calcareous material which in weathering more rapidly than the dolomite leaves many narrow, deep scars on the weathered surface, like those illustrated in Plate I A, page 9. On the MacNeil property, Sample 113 was taken from a 50-foot face of dolomite exposed for several hundred feet along the gorge-like valley of a small brook. Some of the stone seen is less pure than this. On the crown of the hill north of this brook is a large exposure of bluish white calcium limestone, and Sample 113A represents the quality across a width of 50 feet. Sample 113B is from a large area of bluish white dolomite along the course of a brook on the Nash property near the east boundary. Calcium limestone was also seen on the Nash property adjacent to the dolomite. The whole hill-top is densely wooded and this makes it difficult to appraise the deposit but there is apparently much dolomite and calcium limestone available as outcrops are plentiful over the greater part of an area $\frac{1}{2}$ mile wide by $\frac{3}{4}$ mile long. There are no nearby wharves for water shipment, and it is a distance of 4 miles by road to Iona station on the Canadian National railway.

Small deposits of Carboniferous calcium limestone were seen on the Iona Peninsula at Washaback Bridge; at South Cove; and at Nineveh. The Nineveh deposit appears to be of better quality than the others, but even it is impure, containing as it does about 8 per cent total impurities.

Nyanza

Pure, high-calcium, shell limestone outcrops north of the highway $\frac{1}{4}$ mile west of the bridge at the head of Indian Bay. The stone is brownish grey in colour and is composed very largely of shells but is not friable. It forms a low ridge extending north from the road for a distance of 500 feet. Near the road a width of 100 feet of the limestone is seen, but farther north the stone is covered with soil. On the west side is a swampy valley, and at its maximum height the ridge rises 20 feet above it. Sample 114 was taken from the 14-foot face of a small quarry in the shell limestone on the land of A. F. McRae, Nyanza.

Valley of Middle River

Strata of the Windsor series underlie the flat broad valley of Middle River for the lower 11 miles of its course, and then leaving the river valley the strata extend northwesterly into Inverness County and join with the area of Windsor strata in the Margaree Valley. Along the lower reaches of Middle River, flat-lying deposits of limestone are very numerous, and several have been quarried on a very small scale to obtain stone for lime-burning and for crushing for agricultural purposes, but most of the deposits seen were impure and in poor position for quarrying, though sufficient stone for local agricultural requirements could be obtained from any one of them.

Baddeck Bridge

A conglomeratic limestone composed very largely of small fragments of dense-textured, brown calcium limestone is exposed on a high ridge along Baddeck River, just southeast of the village of Baddeck Bridge. Interstratified with the better grade conglomerate are thick seams of soft, greenish, shaly grit also holding numerous fragments of older limestone. Cross bedding is noticeable in the upper beds, some of which are 2 feet in thickness. The base of the exposure is a rubbly mass composed of larger fragments of limestone cemented by a greenish shale. Some of the beds are fairly pure but as a whole the deposit is very impure. The dip is to the northwest at an angle of 25 degrees. Sample 115 represents the top 15 feet. Overlying this conglomerate is a soft blue shale, and succeeding the shale is a brown, fine-grained, apparently pure, dolomite, but very little of the latter is exposed and no sample was obtained. Lime was made in this vicinity many years ago from calcium limestone obtained from small outcrops $\frac{1}{4}$ mile west of here, on the north side of the road.

Two miles northeast of where Sample 115 was obtained a deposit of pure, high-calcium, shell limestone is exposed in the valley of Foyle Brook a short distance above its junction with Peter Brook. The shell limestone is 20 feet thick, and is underlain by a dull-lustred, grey-brown limestone devoid of fossils. The shell limestone is composed of relatively large shells, which are well cemented by a brown, dense-textured matrix. Sample 116 represents the shell limestone and 116A the underlying non-fossiliferous limestone. Good opportunities for quarrying exist at this place, but the extent of the deposit could not be determined as everywhere away from the brook the limestone is covered by 3 to 5 feet of soil supporting a dense growth of bushes. The distance to the pier at Baddeck is slightly over 3 miles.

Shell limestone is reported to occur on the peninsula southeast of Baddeck Bay. A small outcrop of shell limestone was also observed on the east side of a small brook that crosses the highway 1 mile west of Bevis Brook, but it is not in a good position for quarrying as the land is low.

Many deposits of Carboniferous limestone are reported along the upper valley of Baddeck River.

Boularderie Island

The structure of this island is that of a long narrow syncline, the axis of which extends the length of the island near its centre. Pennsylvanian strata comprise the main part of the surface rock but along the edges occasional narrow strips of the underlying Windsor strata appear, and these in places consist of limestones. As the strata almost invariably dip inland into rising ground, conditions are not favourable for the occurrence of deposits of limestone workable by open-pit methods. Part of this island is in Cape Breton County and the description of the limestones in that part is given on page 38.

On the southeast shore of the island, 2½ miles northeast of the mouth of Big Harbour, a deposit of shaly limestone conglomerate is exposed near the beach. The conglomerate consists of fragments of blue, tan, and red limestone embedded in a matrix of green calcareous shale. (Plate XVIB, page 104.)

In the base of the cove north of Point Clear, on the eastern side of the island, is a large deposit of impure, grey limestone interbedded with shale at intervals of 3 to 5 inches. The deposit dips inshore at 20 degrees.

A number of limestone deposits were observed along the northwest side of the island, but none of a good degree of purity was seen in a quarriable location.

New Campbellton

Both Precambrian and Carboniferous limestones occur between New Campbellton and Cape Dauphin, on the northwest side of the Great Bras d'Or.

The Precambrian limestone extends northwards in three lenticular bands from the west shore of Kelly Cove to Cape Dauphin. The first of these, i.e. the one outcropping on Kelly Cove, extends about ½ mile inland, and then is overlain by Carboniferous rocks. The Precambrian limestones reappear, however, 1,200 yards farther north and extend for 1,200 yards to form the second lens, which has a maximum width of about 350 feet, and from which white dolomite has been quarried. Three hundred yards north of this a belt of the George River series, consisting largely of limestones, extends for 2¼ miles to the shore just west of Cape Dauphin.

At Kelly Cove a good cross-section of the Precambrian limestone band is to be seen along the road around the shore of the cove. At this place the ridge of limestone, trending north and south and dipping easterly at angles of 55 to 70 degrees, ends abruptly in a precipitous cliff at the shore—there being only sufficient room for a narrow road between the cliff and the water. The steeply dipping Precambrian limestone strata rest on the syenite composing St. Ann Mountain and are overlain at the foot of the ridge by Carboniferous limestone, a cross-section of which is also exposed on the shore. For about 500 feet west of the Carboniferous limestone, soil obscures most of the strata, but occasional exposures show this part of the deposit to consist of interbanded blue dolomite and blue magnesian limestone, and possibly some calcium limestone. The more calcareous stone weathers smoothly and to a blue colour, whereas the dolomite weathers grey and has a very rough, scarred surface. At the bend in the road, just west of the centre of the section, is 90 feet of fine-grained, blue

dolomite without any calcareous bands. Sample 117 represents this zone. On either side is dolomite interbedded with fine-grained, light blue magnesian limestone containing veins of white calcite. Sample 117A shows the composition of these calcareous bands. Westward, toward the base of the deposit, the limestone is coarser in grain, lighter in colour, and very little true dolomite is to be seen, the major portion being either calcium limestone or magnesian limestone in which are numerous tiny crystals of pyrite. Near the contact with the syenite of the mountain-side, several bands of trap and quartzite occur. Owing to the angle of dip it would be difficult to obtain the dolomite from this deposit by other than mining methods.

The Carboniferous limestone, where it is in contact with and overlies the lower slopes of the ridge of George River limestone along the shore of Kelly Cove, is mostly impure and shaly, but northwards, on the land of Mrs. Flora Bain, Carboniferous limestone of a good degree of purity forms a long ridge, 20 to 50 feet high and up to 200 feet in width, between a small brook and the mountain-side. The strata in this ridge have a general dip to the eastward at a steep angle, but a certain amount of faulting appears to have occurred which may complicate the structure. Along the east side of the ridge the limestone is thinly bedded, dark grey in colour, and impure as the analysis of Sample 118, taken along this edge, shows. On the west side, however, the stone is of good quality and is dense-textured and brown in colour. Sample 118A represents a face of 20 feet of the purer stone on the west side of the ridge near Mrs. Bain's house.

The second lens of George River limestone north of Kelly Cove has been quarried to a small extent for dolomite in the bed of a small brook 75 feet or so up the hillside. The strata here are much contorted, and in general dip into the hill at angles of 45 to 60 degrees. The dolomite is pure white, coarse-grained, and is found in a band about 100 feet thick, with blue, fine-grained calcium limestone on either side, in which are also numerous dark bands of slaty and quartzose rock. A band 10 feet wide of mashed, blue calcium limestone occurs in the white dolomite, but it could easily be eliminated in quarrying. Sample 119 represents a thickness of 60 feet of the white dolomite below the 10-foot calcium band, and 119A is from the 35 feet of similar dolomite above this band. The same high-grade dolomite is seen in the valley of the small brook 600 feet south of the quarry, but here it is higher up the hill, indicating that the deposit extends obliquely along the slope. Overburden averages about 7 feet, and the ridge is thickly wooded. The angle at which the belt dips into the hillside would permit only of shallow quarrying operations, but there is a very large amount available by mining methods. Shipment by water could be made from Kelly Cove where deep water is available. The grade of a narrow-gauge tramway to abandoned coal mines farther north passes within $\frac{1}{3}$ mile of the quarry.

No examination was made of the long belt of the George River limestone extending to Cape Dauphin, but reports on this belt on file at the office of the Dominion Steel and Coal Corporation show that it also contains dolomite, calcium limestone, and magnesian limestone, in association similar to that in the belts already examined.

St. Ann Harbour

Large areas of Windsor strata occur at the head of and along the west shore of this harbour, and within these areas limestone deposits are plentiful, but the majority are small and consist of interbedded calcium limestone and dolomite of a low degree of purity. A small deposit of shell limestone outcrops in the valley of North Gut Brook, west of where the road to Ingonish crosses it. It is overlain and underlain by impure limestone and it dips at a very steep angle.

Five hundred feet north of the mouth of this same brook is a deposit of variable and impure limestone, some being dolomitic.

A deposit of shell limestone, which at one time was quarried by the Steel Company for flux, occurs on Mill Brook, 2,000 feet west of the Government wharf. A 25-foot face was worked in a ridge trending north and south on the west side of the brook. Soil 8 to 12 feet deep covers the limestone and most of the quarry face is now covered up; Sample 120 was taken along the face. The limestone is seen for a short distance south of the quarry, but the full extent of the deposit could not be determined. Outcrops of gypsum are to be seen a short distance to the east.

Other deposits of limestone, including shell limestone, are reported to occur along the hillside from one-half to 1 mile back from Seal Cove and Goose Cove.

Skir Dhu

The sloping cliff face, 60 feet high, along the Atlantic coast between the villages of Skir Dhu and North Shore is composed mainly of magnesian limestone dipping seaward at an angle of 50 degrees. Plate XVII A, page 112. Beds of greenish shale alternate with the limestone, some of which, with the exception of the basal strata, is quite pure. At the point of land, just south of the mouth of French River, this limestone band would be found at some distance back from the shore and could be quarried. Sample 121 represents 20 feet of magnesian limestone strata exclusive of the interbeds of green shale. On the south side of this point a band of very pure high-calcium limestone outcrops on the shore, and it too can be traced inshore to a quarriable location on the land of Neil J. McDonald. Sample 121A was taken across the 20-foot thickness of this band where it outcrops on the beach. There is no possibility of shipping from here except in calm weather, as the shore is fully exposed to the Atlantic Ocean.

Ingonish

Along the Atlantic coast immediately west of the town of Ingonish, fine-grained, brown Carboniferous dolomite, in nearly horizontal beds aggregating 20 to 30 feet in thickness, caps the 30-foot cliff along the shore of Bear Cove from Jackson Point northwards for ½ mile. Outcrops are also seen inland for ¼ mile west of the beach, thus the deposit appears extensive. The dolomite is underlain by 2 feet of blue shale, which in turn is underlain by a coarse grit. These rocks are seen at the water level midway along Bear Cove where the dolomite is domed upwards. The west

PLATE XVII

A. Steeply dipping beds of Carboniferous limestone, along the sea coast at Skir Dhu, Victoria County, N.S.

B. Calcareous beds greatly resembling tufa in the deposit of Carboniferous dolomite at Ingonish, Victoria County, N.S.

tip of Ingonish Island, off Jackson Point, is underlain by the same type of dolomite.

On Jackson Point the dolomite has calcium limestone in beds resembling those of tufa deposits interstratified with it. (Plate XVIIB, page 112.) Elsewhere these highly calcareous strata are not conspicuous. Occasional zones of dark brown, shaly dolomite were seen in places, particularly near the contact with the granitic rocks at the north end of the cove, where the strata seem to be faulted. The bedding throughout the dolomite deposit is very rough and uneven.

The following samples were obtained:

122 On Jackson Point, excluding the obviously calcareous layers.
122A Interbeds of calcium limestone, Jackson Point.
122B Thirty-foot face of dolomite at north end of Bear Cove, near the contact with granite, excluding a dark shaly layer.
122C Dark brown, shaly layer in the face at north end of Bear Cove.
122D Thirty-foot face midway along Bear Cove.

Only small vessels can enter the North Harbour at Ingonish, at the entrance to which the deposit is situated, on account of a gravel bar, though probably a deeper channel could be dredged.

On the mountain-side, 4 to 5 miles inland from Ingonish, deposits of Precambrian limestone (George River series) are reported[1] in the valleys of McKinnon, Clyburn, and Power Brooks.

Aspy Bay

The following notes on the Carboniferous limestone at Aspy Bay were obtained from a report on the deposit made for the Steel Company at Sydney.

Limestone is exposed in cliffs along the shore of South Harbour near the entrance, for a distance of 1,200 feet. At the southeast end of the cliff the limestone can be traced 300 feet southerly to the granite hills, and at the northwest end it can be traced back for 600 feet. The deposit is at least 40 feet in maximum thickness. A bar of shifting sand at the entrance to the harbour permits only small vessels to enter. The following analyses of samples taken along the cliff face show the deposit to be of the high-calcium variety.

Silica	Oxides of iron and alumina	Calcium carbonate	Magnesium carbonate	Sulphur
0·64	1·36	97·10	1·52	0·05
1·36	2·00	95·00	1·20	0·07
0·64	1·20	96·49	0·75	0·05
0·88	1·64	96·70	1·00	0·08
0·52	0·84	95·85	2·00	0·10

A large deposit of limestone is also stated to occur near the shore of Middle Harbour, and the same report mentions the occurrence of rather impure limestone at St. Lawrence Bay, at the extreme north end of the island.

[1] Geol. Surv., Canada, Rept. of Progress, 1882-84, p. 36H.

Analyses of Victoria County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
112	2·92	0·64	1·16	0·12	91·86	4·07	100·77	0·07	51·56	1·94	27 : 1
112A	5·62	0·94	2·18	0·07	85·47	5·19	99·47	0·04	47·91	2·48	19 : 1
113	1·46	0·59	0·21	0·04	56·77	40·61	99·68	tr.	31·81	19·42	1·67 : 1
113A	2·54	0·78	0·41	0·07	93·88	2·24	99·92	0·03	52·57	1·07	49 : 1
113B	1·24	0·60	0·20	0·09	58·46	39·46	100·05	tr.	32·95	18·87	1·71 : 1
114	0·60	0·31	0·29	0·07	97·08	0·95	99·30	tr.	54·42	0·45	121 : 1
115	11·06	1·11	1·59	0·09	84·31	1·01	99·17	0·03	47·26	0·48	97 : 1
116	0·22	0·48	0·12	0·02	97·63	0·86	99·33	tr.	54·68	0·41	133 : 1
116A	9·00	0·98	2·86	0·24	83·58	1·89	98·55	0·08	46·98	0·90	52 : 1
117	1·48	0·59	0·59	0·09	55·18	42·74	100·67	tr.	30·95	20·44	1·51 : 1
117A	1·32	0·30	0·52	0·20	83·34	15·06	100·74	tr.	46·77	7·20	6·5 : 1
118	14·40	1·00	2·76	0·11	64·94	16·16	99·37	0·30	36·43	7·73	4·7 : 1
118A	1·50	0·52	0·84	0·04	95·22	1·60	99·72	0·11	53·34	0·76	70 : 1
119	0·64	0·37	0·31	0·09	55·51	44·37	101·29	tr.	31·14	21·22	1·46 : 1
119A	0·62	0·62	0·20	0·09	55·47	44·27	101·27	tr.	31·12	21·17	1·46 : 1
120	1·50	0·36	0·56	0·13	96·33	0·99	99·87	0·04	54·02	0·47	115 : 1
121	2·18	0·57	0·45	0·07	75·27	21·50	100·04	0·11	42·20	10·28	4·1 : 1
121A	0·60	0·20	0·14	0·07	98·29	0·63	99·93	tr.	55·07	0·30	184 : 1
122	1·08	0·83	0·39	0·02	55·32	42·53	100·17	0·11	31·00	20·34	1·52 : 1
122A	0·40	0·49	0·41	0·04	94·57	4·75	100·66	tr.	52·98	2·27	23 : 1
122B	0·88	0·88	0·36	0·15	55·70	41·88	99·85	tr.	31·27	20·03	1·56 : 1
122C	3·44	1·26	1·20	0·04	54·04	40·07	100·05	0·11	30·28	19·26	1·57 : 1
122D	0·50	0·71	0·23	0·02	55·25	43·52	100·23	tr.	30·95	20·81	1·49 : 1

112.	Estmere.	Unweathered Carboniferous limestone on land of D. H. Kennedy.
112A.	"	Weathered Carboniferous limestone on land of D. H. Kennedy.
113.	Gillies Point.	Precambrian dolomite on J. C. MacNeil property.
113A.	" "	Precambrian, calcium limestone on J. C. MacNeil property.
113B.	" "	" dolomite on John Nash property.
114.	Nyanza.	Shell limestone on land of A. F. McRae.
115.	Baddeck Bridge.	Carboniferous limestone conglomerate along Baddeck River southeast of the village.
116.	" "	Shell limestone 2 miles northeast of No. 115.
116A.	" "	Bedded limestone beneath the shell limestone.
117.	New Campbellton.	Blue, Precambrian dolomite on shore of Kelly Cove.
117A.	" "	Precambrian, magnesian limestone adjoining the dolomite.
118.	" "	Carboniferous limestone. Impure strata on east side of ridge on property of Mrs. Flora Bain.
118A.	" "	Strata on west side of same ridge.
119.	" "	Sixty-foot thickness of Precambrian dolomite, east of calcareous band in quarry 1½ miles north of Kelly Cove.
119A.	" "	Thirty-five-foot thickness of dolomite west of calcareous band in the same quarry.
120.	St. Ann Harbour.	Shell limestone deposit in valley of Mill Brook.
121.	Skir Dhu.	Carboniferous, magnesian limestone in cliffs along the sea coast.
121A.	"	High-calcium limestone in cliffs along the sea coast.
122.	Ingonish.	Carboniferous dolomite at Jackson Point, excluding Calcareous interbeds.
122A.	"	Interbeds of calcium limestone at the above locality.
122B.	"	Thirty feet of dolomite at north end of Bear Cove.
122C.	"	Shaly stratum at north end of Bear Cove.
122D.	"	Thirty-foot face midway in Bear Cove.

CHAPTER III

THE LIMESTONES OF NEW BRUNSWICK

DISTRIBUTION AND CHARACTERISTICS

Limestone deposits in New Brunswick occur mostly around the borders of the province. They are especially abundant in the southern part adjacent to the shore of the Bay of Fundy, and are also found in the upper valley of the St. John River, and in the northern part of the province near the shore of Chaleur Bay. Dolomite and magnesian limestone as well as calcium limestone are found in the southern part of the province, but elsewhere only calcium limestone is known. At the present time only the deposits in the vicinity of Saint John are being worked, the limestone requirements of the other parts of the province being supplied either from this district or from quarries in Quebec.

Precambrian Limestones

Limestones are not found throughout the Precambrian system but are characteristic of a series of metamorphosed sediments enfolded in the igneous rocks composing the major part of the system. This series, for which several names have been proposed—including the name Portland series—is composed largely of metamorphosed limestone and quartzite, both of which have been intruded by dykes and sills of trap rock and by masses of granitic rocks. The series is exposed only in the southern part of the province where it occurs in a number of elongated belts and lenses extending in a line from the shore of Mace Bay, northeasterly past the city of Saint John to near the village of Salt Springs in Kings County. Areas of Precambrian igneous rock containing no limestone intervene. In the largest of these belts—north of Saint John—are the principal limestone quarries in the province and the Saint John district is also the centre of the New Brunswick lime industry.

TABLE V

Rock Formations of New Brunswick

Showing the Stratigraphic Position of the Limestones

System	Formation	Types of Rock
Triassic		Shale, sandstone, conglomerate, volcanic rocks.
Carboniferous	Pennsylvanian formations	Shale, sandstone, corglomerate, volcanic rocks, coal.
	Mississippian formations (includes equivalents of Horton and Windsor series of N.S.)	Limestone, gypsum, anhydrite, shale, sandstone, conglomerate, volcanic rocks.
Devonian	Upper Devonian formations	Shale, sandstone, conglomerate
	Middle Devonian formations	Sandstone, shale, conglomerate, granite.
	Lower Devonian formations	Limestone, shale, conglomerate, volcanic rocks.
Silurian	—	Limestone, shale, sandstone, igneous rocks.
Ordovician	—	Limestone, shale, sandstone, igneous rocks.
Cambrian	—	Shale, sandstone, conglomerate.
Precambrian	—	Limestone, quartzite, slate, granite, gneiss, volcanic rocks.

The Precambrian limestones include high-calcium and calcium limestone, dolomite, and magnesian limestone—the magnesian limestone being quite rare. The high-calcium and calcium limestones vary in texture from fine- to coarse-grained, and in colour from nearly white to very dark blue; a blue-and-white striped variety is also very common. Most of the dolomite and magnesian limestone is fine- to medium-grained and of various shades of blue in colour, but the purest dolomite is white and yellowish white. All of the stone is much fractured.

The several varieties of limestone, together with quartzite, may all be present in one belt, generally as steeply dipping, roughly parallel, alternate bands, the average strike of which corresponds with the prevailing trend of the main belt. Usually the dividing line between the different types of limestone is very sharp and distinct (Plate XXIX A, page 171) and, where the width of the band is sufficient, any one type can be quarried without being contaminated by another type. The succession of bands does not follow any regular system though it was noted that a band of dolomite usually, but not invariably, adjoins a quartzite band. The width or thickness of any particular band is rarely constant but usually varies to a great degree and the band may pinch out suddenly. Faulting also may abruptly terminate a wide band of limestone. The best quality limestone is found in relatively narrow zones and lenses within the wider bands. The widest band of high-calcium limestone at present being

worked is somewhat less than 200 feet and the widest band of dolomite is 80 feet. These lenses of pure stone are remarkably uniform in composition, more so than are the zones of pure limestone of the same age in Nova Scotia.

Impurities present in the limestone include stringers of quartz (especially characteristic of the dolomites); pyrite in varying amounts and usually most prevalent in the vicinity of intrusions of trap rock; thin, irregular films of slate; and also siliceous strata containing, in some few deposits, nodules of blue chert. Very tiny flakes of graphite are common in much of the calcium limestone, and occasional blebs of serpentine occur in the dolomite. However, large flakes of graphite and mica, and grains of various silicate minerals, so prominent in the Precambrian limestones of Ontario and Quebec, are rare. The areas of pure limestone, such as are being quarried, are almost completely free from impurities with the exception of minor amounts of pyrite and traces of siliceous and argillaceous matter. The Precambrian limestones have a very low phosphorus content and usually the sulphur content is almost negligible. Dykes and sills of trap rock are much more common in the Precambrian limestones of New Brunswick than in those of Nova Scotia. They intrude pure and impure stone alike but, aside from the expense involved in removing it, the trap rock does not constitute a serious impurity as it is readily recognizable and can be easily sorted out.

Silurian Limestones

Limestones considered by the Geological Survey to be of Silurian age occur in large, irregular, lenticular deposits near the shore of Chaleur Bay in the northwest corner of Gloucester County, and also at L'Etang on the shore of Passamaquoddy Bay, Charlotte County. Near Windsor, Carleton County, are large exposures of limestone formerly regarded as being of Silurian age but now doubtfully regarded as such. In the same doubtful category are the calcareous slates underlying large parts of the northern and western counties, which slates, in places, are sufficiently calcareous to be termed limestones.

Greys and blues are the predominant colours, except where the limestones have been highly metamorphosed, in which case they may be nearly white. All deposits are fine-grained to dense in texture. The content of magnesium carbonate is uniformly low and, excepting some unimportant bands in the highly metamorphosed deposit at L'Etang, no dolomite is known to occur in the Silurian of New Brunswick.

The chief impurity is argillaceous, or clayey, matter, which occurs both as interbeds and also disseminated through much of the limestone. There are, however, large areas of limestone practically free from it as for example at Windsor and L'Etang. The sulphur content is remarkably low, rarely being more than a trace, and the content of calcium phosphate varies from a trace to 0·24 per cent in the samples obtained.

Other than for a small amount used locally for agricultural purposes no present use is being made of the Silurian limestones, chiefly because the best of them are 5 miles or more from a railroad, though at one time the deposits at Windsor and L'Etang were rather extensively utilized for the manufacture of lime.

Carboniferous Limestones

Limestones of this age are found in the southern part of the province in the Counties of Kings, Albert, and Westmorland, and again in an isolated area along the valley of the Tobique River in Victoria County. They occur in strata that are the equivalent of the Windsor series of the Carboniferous system in Nova Scotia and in general they resemble very much the bedded Carboniferous limestones of that province, but no deposits of dolomite nor deposits of shell limestone were observed. The limestone is all fine-grained to dense, and the prevailing colours are browns, greys, and reds with a lesser amount of greenish grey. The deposits occur as a series of lenses, some of which are several miles in diameter and as much as 50 feet in thickness, but rarely more. As a general rule the limestone strata are sharply defined from the shale or sandstone with which they are associated. In New Brunswick folding and faulting are not so pronounced in the Carboniferous strata and consequently a number of the limestone deposits lie in a horizontal or nearly horizontal position, though there are also many that are tilted at various angles, some few being vertical.

Some deposits are shaly and thin-bedded, others are heavily bedded. Some are quite fossiliferous, others are nearly devoid of fossils.

The principal impurities are sand grains and argillaceous matter and there are few deposits with less than a total of 3 per cent of these constituents. Iron oxide expressed as Fe_2O_3 ranges from 0·3 per cent to over 1 per cent, and a few deposits in Kings County contain veins and pockets of manganese oxide. Calcium phosphate is rarely present in quantity over 0·3 per cent and the average is less than 0·1 per cent. The content of sulphur ranges from nil to 0·5 per cent.

No present use is being made of the New Brunswick Carboniferous limestones except for local supplies of agricultural limestone, but at one time they were quarried in several places for the manufacture of lime and attempts have been made to utilize some of the red limestone for decorative purposes.

PRODUCTION AND UTILIZATION OF LIMESTONE IN NEW BRUNSWICK

Statistics on the production of limestone and lime are given in Tables VI and VII and shown graphically in Figures 10 and 11. Data prior to 1921 were obtained from the records of the Mines Branch, and for 1921 and subsequent years from the records of the Dominion Bureau of Statistics.

The chief products from the New Brunswick quarries are stone for lime manufacture; for use in the manufacture of sulphite pulp; and for agricultural purposes. In addition small quantities of poultry grit, crushed stone, and pulverized stone for use in sugar refining are also produced.

Almost the entire production comes from the Precambrian limestone of the Saint John district, where five companies are engaged in quarrying, four of which manufacture lime.

The lime industry has been in existence in New Brunswick since the early days of the settlement of the country, and the white limes from the plants along St. John River and the Bay of Fundy were at one time largely exported to the United States, as well as to Nova Scotia and Prince Edward Island, but at the present time none is exported to the United States. Prior to 1929 all lime was marketed as quicklime packed in wooden casks and barrels. In 1929 the first hydrated lime from this district was put on the market. Formerly a lime industry of local importance was in operation near Windsor, Carleton County; near Demoiselle Creek, Albert County; and at L'Etang, Charlotte County; but the kilns at these places have not been in use for many years.

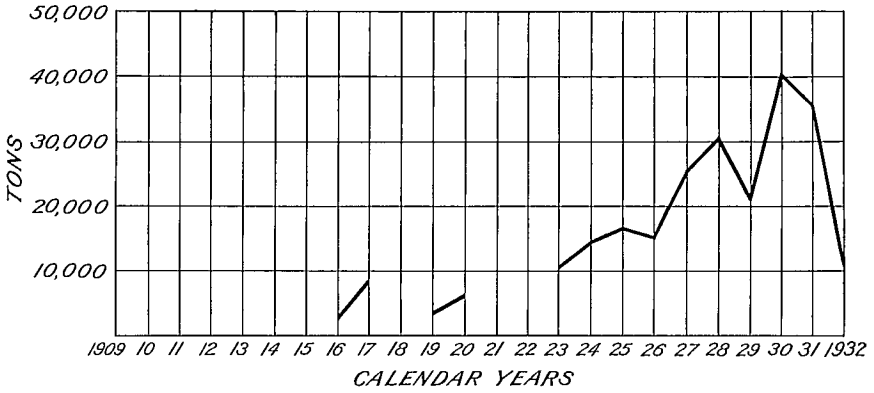


Figure 10. Production of limestone in New Brunswick.

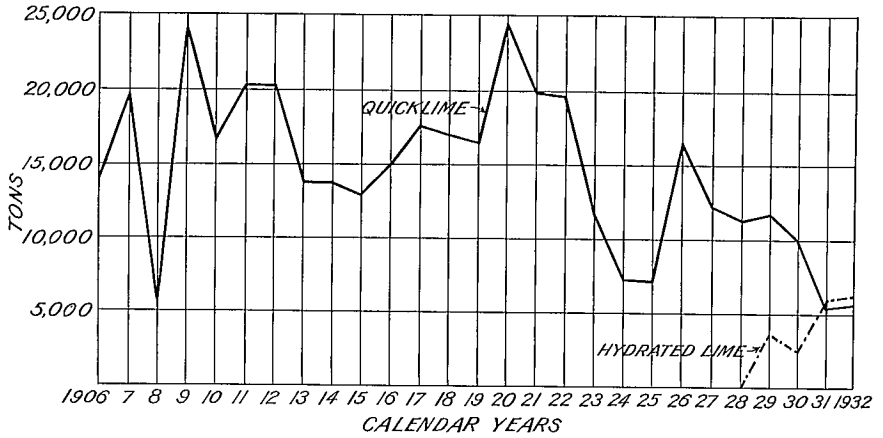


Figure 11. Production of quicklime and hydrated lime in New Brunswick.

TABLE VI

Production of Limestone in New Brunswick

Year	Tons	Value
		$
1909	.....	30
1910	.....	315
1911	.....	110
1912	.....	
1913	.....	
1914	.....	
1915	.....	
1916	2,500[1]	6,900
1917	8,500[1]	22,875
1918	.....	
1919	3,461[2]	9,518
1920	6,081[2]	16,720
1921	.....	
1922	.....	
1923	16,689	21,981
1924	14,308	33,299
1925	16,364	35,612
1926	15,054	30,722
1927	25,124	56,146
1928	30,792	57,650
1929	20,710	33,360
1930	40,262	97,841
1931	35,378	73,398
1932	10,707	31,554

[1] Estimated. [2] For flux only.

TABLE VII

Production of Lime in New Brunswick

	Quicklime			Hydrated Lime		Total Lime	
Year	Bush.	Tons	Value	Tons	Value	Tons	Value
			$		$		$
1906....	405,450	14,191	94,290	.....	.....	14,191	94,290
1907....	554,330	19,403	124,786	.....	.....	19,403	124,786
1908....	155,748	5,451	34,262	.....	.....	5,451	34,262
1909....	697,466	24,411	154,151	.....	.....	24,411	154,151
1910....	470,050	16,452	105,593	.....	.....	16,452	105,593
1911....	613,728	21,500	132,897	.....	.....	21,500	132,897
1912....	616,835	21,589	133,742	.....	.....	21,589	133,742
1913....	392,985	13,754	98,841	.....	.....	13,754	98,841
1914....	391,739	13,711	102,980	.....	.....	13,711	102,980
1915....	369,117	12,919	93,797	.....	.....	12,919	93,797
1916....	424,113	14,844	104,635	.....	.....	14,844	104,635
1917....	532,251	17,530	171,248	.....	.....	17,530	171,248
1918....	482,548	16,898	221,935	.....	.....	16,898	221,935
1919....	468,533	16,399	223,193	.....	.....	16,399	223,193
1920....	701,859	24,565	365,030	.....	.....	24,565	365,030
1921....	562,447	19,686	203,084	.....	.....	19,686	203,084
1922....	560,834	19,623	187,895	.....	.....	19,623	187,895
1923....	329,548	11,534	104,814	.....	.....	11,534	143,814
1924....	208,180	7,286	108,890	.....	.....	7,286	108,890
1925....	202,106	7,194	92,216	.....	.....	7,194	92,216
1926....	477,266	16,704	196,477	.....	.....	16,704	196,477
1927....	343,111	12,009	148,321	.....	.....	12,009	148,321
1928.....	.....	11,236	130,484	25	300	11,261	130,784
1929.....	.....	11,766	135,981	3,752	38,572	15,518	174,553
1930.....	.....	9,947	104,159	2,574	31,145	12,521	135,304
1931.....	.....	5,161	61,729	6,080	65,325	11,241	127,054
1932.....	.....	5,547	59,064	6,025	50,120	11,572	109,184

Pulverized limestone for agricultural use is produced at Indiantown, Brookville, and Torryburn in the Saint John district, and in small quantities for local use at Havelock, Kings County, at Oxbow, Victoria County, and, until recently, at Petit Rocher, Gloucester County. The plant at Brookville, the largest producer of this material, was erected in 1920 by the Government of New Brunswick and is being operated by the Brookville Manufacturing Company. Agricultural limestone produced in the Saint John district is marketed throughout the province of New Brunswick and also in Prince Edward Island and the State of Maine.

Limestone for use in the manufacture of sulphite pulp is produced from Precambrian deposits in the Saint John district, and from this district it has been shipped to pulp mills in the northeastern part of the province, but these mills are at the present time obtaining their limestone requirements from Gaspe Peninsula, Quebec.

Small quantities of building stone suitable for foundations and rock-face construction have been obtained from the Precambrian limestones and to a lesser extent from the Carboniferous limestones, but the former are too much fractured to yield consistently the large rectangular blocks required by the modern cut-stone industry and the Carboniferous and Silurian limestones are usually too hard, too brittle, or too dark in colour to be utilized generally for this purpose.

Attempts have been made to quarry decorative stone or marble from some of the more highly coloured Carboniferous limestones, particularly from the red limestones at Shepody Mountain in Albert County, and at Queenstown in Queens County, but in each case the deposits were found to be too badly fractured to yield in quantity the large blocks demanded by the marble industry, though material suitable for use as terrazzo could be obtained.

NEW BRUNSWICK MINING LAWS RELATING TO LIMESTONE

"In most grants of land issued by the Crown in New Brunswick since about the year 1805, all mines and minerals are reserved to the Crown and are regarded as property separate from the soil. Most of the grants previous to this date reserve only gold, silver, copper, lead, and coal.

"Minerals under the Mining Act 1927, without limiting the scope of the word, include the following: salt, oil, natural gas, infusorial earth, ochres, paints the base of which is found in the soil, fireclay, carbonate of lime, sulphate of lime, gypsum, coal, bituminous shale, albertite, but minerals shall not include building and monumental stones, millstones, grindstones, sand, gravel, pottery clay, mineral waters, soapstone, and peat.

Prospecting Licences

"A prospecting licence is necessary before beginning search for minerals. This licence is issued at a cost of $10 to any person over 18 years of age. It is effective throughout the whole province and applies to all

lands whether they be Crown lands or lands privately owned, with the following exceptions:

(*a*) Any lands which may have been especially reserved from prospecting.
(*b*) Lands already held under mining licence or lease.
(*c*) Lands in a village, town, or city.
(*d*) Lands used for railway or highway purposes.
(*e*) Lands occupied by or surrounding buildings and land under cultivation.

In the cases of (*c*), (*d*), and (*e*) entry may be made with consent of the owner or by order of the Lieutenant-Governor in Council."[1]

There is no royalty on limestone.

More detailed information and copies of the Mining Laws and Regulations for New Brunswick may be had on application to the Deputy Minister, Department of Lands and Mines, Fredericton, N.B.

TABLE VIII

New Brunswick Limestone Quarries

Operator	Location of Quarry	Product
	Kings County	
Geo. Downey, Havelock	Havelock	Agricultural limestone.
	St. John County	
Brookville Mfg. Co., Ltd., Brookville	Brookville	Agricultural limestone.
Purdy & Green Ltd., Saint John	Indiantown	Quicklime, hydrated lime.
Randolph & Baker Ltd., Randolph, Saint John	Randolph	Quicklime, stone for use in manufacture of sulphite pulp.
Saint John Lime Co., Brookville	Brookville	Quicklime, hydrated lime, agricultural limestone, poultry grit.
Snowflake Lime Ltd., Saint John	Indiantown	Quicklime, hydrated lime, agricultural limestone.
	Victoria County	
Charles Hayden, Oxbow	Oxbow	Agricultural limestone.

DISTRIBUTION OF LIMESTONE BY COUNTIES

Albert County

The limestone deposits of Albert County, with possibly one exception, are of Carboniferous age and occur in the strip of Lower Carboniferous rocks that extends northeasterly across the county from the border of Kings County through Elgin and Prosser Brook to Hillsborough. Lime-

[1] "The Mining Laws of Canada," Mines Branch, Dept. of Mines, Canada, Rept. 713, p. 26, (1931).

stone is also found in the Carboniferous strata south of Hillsborough. The limestone possibly not of Carboniferous age, is that a short distance west of Pleasant Vale where numerous angular boulders of greyish white, metamorphosed limestone indicate the presence of limestone of similar character in situ. All limestone seen in the county was of calcium or high-calcium type and none of the samples contains over 4 per cent magnesium carbonate. Most of it is rather impure, particularly in the Hillsborough district, the purest being in the vicinities of Elgin and Curryville. The limestone horizon is easily traced by outcrops but whether the deposits are continuous between the outcrops or whether the outcrops are lenticular was not determined, though it is probable that in some districts, as around Hillsborough, the outcrops are part of an extensive deposit, and in other districts the outcrops are of relatively small lenticular deposits. The greatest thickness of limestone strata observed in any one outcrop was less than 20 feet.

A number of the deposits have been worked in the past to obtain stone for lime and agricultural limestone but there is no production at the present time. Dr. Ells,[1] in referring to an unsuccessful attempt to quarry marble from the red Carboniferous limestone along Robertson Brook on the northeast slope of Shepody Mountain, states,—

"A deposit of reddish impure limestone has been opened up at this place for a marble quarry, but the rock was found to be too much shattered to be of great value. The limestone contains a small quantity of manganese."

Elgin

A small exposure of cavernous, grey, fine-grained high-calcium limestone occurs on the property of Hamilton G. Steeves at the village of Elgin, adjacent to the branch line of the Canadian National railway extending from Petitcodiac to Elgin. The limestone resembles in some respects the Carboniferous shell limestones of Nova Scotia but the shells are not so numerous as in the typical shell limestones. Many small cavities in the stone are partly filled with calcite crystals and with black bituminous matter. The extent of the deposit cannot be definitely determined without trenching, but possibly it underlies the greater part of the low hill on the side of which it is exposed. Sample 51 represents the stone in the outcrop. Within recent years a small amount was quarried and pulverized for agricultural use and many years ago a lime kiln was in operation here.

Below this, a few feet of dense-textured, brownish grey calcium limestone, interbedded with shale, is exposed along the banks of Pollett Brook. The beds are up to 6 inches in thickness and dip northwesterly at 20 degrees. Sample 51A was taken from the outcrops along the brook.

Pleasant Vale

Just west of Pleasant Vale, angular boulders of highly metamorphosed, fine-grained, greyish white calcium limestone containing films of greenish grey shale are very plentiful over a small area on land belonging to the Levi Crandall Estate. It is quite probable that limestone of the same

[1] Geol. Surv., Canada, Ann. Rept. 1885, vol. I, p. 35E.

character will be found in place beneath the soil but the deposit would not be very extensive because outcrops of igneous rock are to be seen at no great distance to the north, east, and south, leaving but a small area wherein limestone could possibly occur. Sample 52 consisted of chips taken from a great many boulders.

It is stated by residents of the locality that boulders and possibly solid ledges of the same type of limestone are plentiful over another small area about 1 mile to the west, but this area is separated from the other by igneous rock.

Prosser Brook

At the village of Prosser Brook a few nearly horizontal beds of dense-textured, grey and reddish grey calcium limestone are exposed along the lower slopes of the hillside above the road and brook. Above them on the same hillside are outcrops of sandstone and sandy shale, so the limestone is not well located for quarrying on any considerable scale. The thickness and true character of the entire deposit of limestone cannot be told without trenching. Sample 53 was obtained from the few ledges visible on the property of J. W. Carter. Along the line of outcrop at this place are the ruins of five small lime kilns, and near each is a small pit, now filled with debris, from which the stone for burning was obtained. The limestone at Prosser Brook is only of local importance for it is about 12 miles from the nearest railway line.

Curryville

On the property of Trueman Smith, north of Curryville, and about $\frac{1}{4}$ mile southwest of the Salisbury and Albert branch of the Canadian National railway, is a limestone deposit that at one time was quarried to provide stone for McHenry's Lime Works which supplied the local demands for lime, but the lime kilns have been in ruins for many years. The limestone, in nearly horizontal beds, is exposed to a height of 15 feet on both sides of the brook in steeply rising hills, which are 30 to 80 feet high, but no rock is exposed on the upper slopes and the full thickness of the limestone cannot be ascertained without trenching. Apparently, however, much overburden would have to be removed before any extensive quarrying could be done. The limestone is fine-grained, grey and reddish grey calcium limestone and occurs in heavy, irregular beds, through some of which is a network of very thin, shaly films, but the total amount of shale present is small. Black bituminous matter is present in small vugs and along joint planes, but the most serious impurity is chert which, in the form of reddish brown nodules, is very prevalent in the limestone on the north side of the brook. On the opposite side, however, the stone is nearly free from chert. Sample 54 was taken along the outcrops on the south side of the brook where the limestone is of the best quality.

Demoiselle

About $1\frac{1}{2}$ miles southwest of the Salisbury and Albert branch of the Canadian National railway, and a short distance south of Wilson Brook, is a large deposit of calcium limestone—in part fairly pure and in part shaly and impure. The deposit is exposed on the land of W. F. Wilson

and Sons in the valleys of two small brooks, about 700 feet apart, flowing northerly into Wilson Brook. In the westernmost of the two brooks (Brook No. 1) a thickness of 15 feet of thin-bedded, grey and brownish grey, calcium limestone is seen resting on red, quartzose conglomerate. Both limestone and conglomerate dip northeasterly at an angle of 7 degrees. Brook No. 2, 700 feet east of No. 1, issues from the limestone deposit and on this brook a thickness of 15 feet of limestone is also exposed but the basal conglomerate is not seen, indicating that these strata are somewhat higher in the deposit than those on Brook No. 1. The dip on Brook No. 2 is to the northeast at an angle of 15 degrees. Much of the stone is heavily bedded, purplish to light grey in colour, and contains much secondary calcite. Current channels of shaly stone are present in the heavy strata and, in places, the entire exposure is of thin-bedded, impure stone, the transition from heavily bedded to thinly bedded stone being very abrupt. The total area in which outcrops are seen is about 1,000 feet, east and west, by 300 feet, north and south, and the deposit apparently forms a blanket on the lower part of the northeastern slope of a high hill of red conglomerate. Part of the land underlain by the deposit is wooded and part is cultivated. The depth of soil varies from almost none to about 10 feet. Sample 55 was taken from a 10-foot face of heavily bedded limestone on Brook No. 2; Sample 55A represents the thin-bedded impure stone adjoining No. 55 on Brook No. 2; and Sample 55B is from 10 feet of thin-bedded stone on Brook No. 1.

Albert Mines

A number of outcrops of impure, laminated, calcium limestone are to be seen at the village of Albert Mines and west thereof. The general dip is easterly and southeasterly at low angles. On the property of Fred Milton, a short distance south of the village, 6 feet of impure, thinly laminated, calcium limestone is exposed in a small disused quarry in a cultivated field about 50 feet west of the Salisbury and Albert branch of the Canadian National railway. The stone is in beds up to 20 inches thick but the tendency is for the strata to split into thin slabs due to the laminated structure. Differential weathering, or etching parallel to the lamination (Plate XVIIIA, page 126), is very noticeable. The dip is easterly at an angle of 10 degrees and this corresponds to the slope of the land surface in the vicinity. The depth of soil over the stone averages about 2 feet. Sample 56 represents the 6 feet of strata in the quarry.

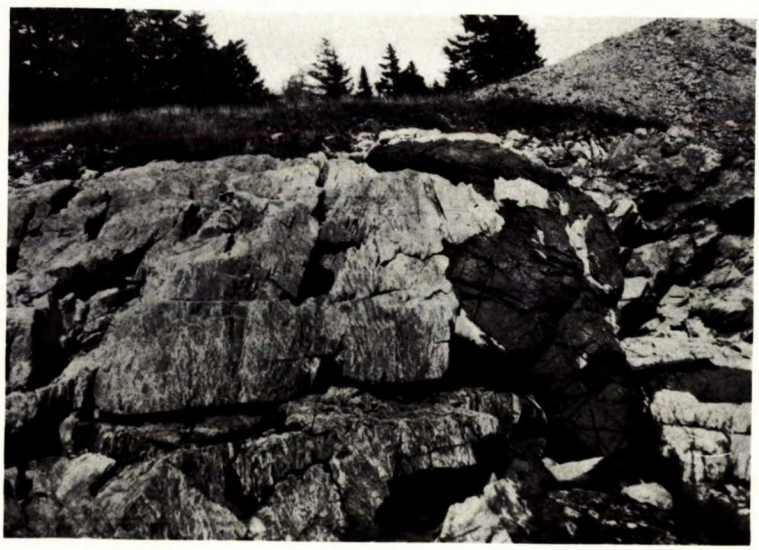
North of Albert Mines station impure limestone of the same character as that just described is exposed at intervals for nearly 2 miles in a narrow strip of country between the gypsum quarries and the Salisbury and Albert railway.

Edgett Landing

Impure, thin-bedded, fine-grained calcium limestone resting on red, siliceous conglomerate is exposed on the steep hillside on the south side of the road leading to the gypsum quarry of the Hillsborough Plaster Quarrying and Manufacturing Company. The dip of both conglomerate and limestone is southerly at an angle of 12 degrees. The limestone

PLATE XVIII

A. Near view of thinly laminated, Carboniferous limestone in quarry on property of Albert Manufacturing Company, Ltd., Hillsborough, Albert County, N.B., showing differential weathering.



B Dyke of trap rock intruded in Silurian limestone at L'Etang, Charlotte County, N.B. Note the fragments of limestone in the dyke.

exposed for 8 feet above the conglomerate is mostly grey and reddish grey —the red colour being more prevalent in the upper part—and for a foot or two above the conglomerate it contains much sand. On top of the 8 feet of limestone is 3 feet of calcareous red shale, and on top of it is 10 feet of rubbly, red limestone, containing many films of red and green shale and in which are numerous vugs and fractures coated with black bituminous matter. No further exposures of rock are seen on the hillside above this. Sample 57 was taken from the top 10 feet of limestone and Sample 57A from the bottom 8 feet.

A number of other outcrops of calcium limestone were observed in the vicinity but all seemed impure.

Hillsborough

Impure, thinly laminated, grey and reddish grey limestone, resting on red siliceous conglomerate, is exposed in a number of places in the vicinity of the gypsum quarries southwest of the village. Wherever seen the limestone has the same general character, and the only sample taken (Sample 58) was from a small disused quarry on the property of the Albert Manufacturing Company where 10 feet of grey and reddish grey, fine-grained calcium limestone is exposed. Plate XVIIIA, page 126, shows the laminated structure and also the differential weathering that takes place on exposure. The dip of the strata in the quarry is southerly at an angle of 10 degrees.

Analyses of Albert County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
51.....	2·46	0·30	0·80	0·02	95·72	0·48	99·78	nil	53·61	0·23	233 : 1
51A.....	3·60	0·31	1·19	0·09	93·34	0·53	99·06	nil	52·31	0·25	209 : 1
52.....	3·18	0·70	0·58	0·07	94·18	1·43	100·14	0·05	52·80	0·68	78 : 1
53.....	2·76	0·33	1·23	0·04	94·27	0·38	99·01	tr.	52·81	0·18	293 : 1
54.....	1·24	0·31	0·35	0·11	97·62	0·40	100·03	nil	54·72	0·19	287 : 1
55.....	3·46	0·67	0·91	0·02	93·68	0·90	99·64	0·06	52·47	0·43	122 : 1
55A.....	7·52	1·08	2·14	0·07	85·39	3·84	100·04	0·08	47·85	1·83	26 : 1
55B.....	8·34	0·74	2·46	0·26	85·73	1·79	99·32	0·17	48·15	0·85	57 : 1
56.....	11·28	2·97	1·23	0·09	81·50	2·69	99·76	tr.	45·69	1·28	36 : 1
57.....	5·94	0·57	2·35	0·11	90·25	0·82	100·04	tr.	50·60	0·39	130 : 1
57A.....	7·30	0·67	2·39	0·04	86·93	1·93	99·26	0·10	48·70	0·92	53 : 1
58.....	4·78	0·61	0·23	0·07	91·89	2·01	99·49	0·51	51·60	0·96	54 : 1

51. Elgin. Cavernous, grey limestone on property of H. G. Steeves.
51A " Dense-textured limestone along Pollett Brook.
52. Pleasant Vale. Boulders of metamorphosed limestone on Levi Crandall Estate.
53. Prosser Brook. Property of J. W. Carter.
54. Curryville. Fine-grained, grey limestone on property of Trueman Smith, formerly quarried for lime-burning.
55. Demoiselle. Heavily bedded limestone near Wilson Brook.
55A. " Thinly bedded limestone adjacent to the above.
55B. " Thinly bedded limestone from outcrop 700 feet west of 55.
56. Albert Mines. Small quarry on property of Fred Milton.
57. Edgett Landing. Top 10 feet in outcrop on road leading to gypsum quarry of Hillsborough Plaster Quarrying & Manufacturing Company.
57A. " " Bottom 8 feet in same outcrop.
58. Hillsborough. Small quarry on property of Albert Manufacturing Company, Ltd.

Carleton County

A large part of Carleton County adjacent to the St. John River is underlain by strata, possibly of Silurian age, consisting largely of slate, which in places is very calcareous. In the valley of the Beccaguimic River between Windsor and Carlisle are extensive exposures of pure, high-calcium limestone that at one time was quarried for lime manufacture, but no lime has been produced for the past 25 years. Recently a small amount of stone has been quarried for the production of agricultural limestone. Though the deposits are large and the stone very pure, remoteness from rail transportation prevents their more extensive exploitation, the nearest railway line being the Canadian Pacific at Hartland, 9 miles to the southwest. Deposits of impure limestone occur near the village of Peel.

Windsor

One-quarter mile east of the village of Windsor are extensive outcrops of fine-grained, grey high-calcium limestone, containing many veins and crystals of pink and white calcite. Owing to fracturing and to the absence of definite parting planes, stratification is not clearly defined, but apparently the deposit strikes[1] nearly north and south and dips very steeply to the west. The width of the exposure is 200 feet and the limestone can be traced to a small brook, 600 feet north of the road going east from Windsor. It is also seen on the hillside north of the brook. The soil cover rarely exceeds 1 foot in this area and a face 50 feet high could be developed above the level of the brook. A small quarry has been opened in the deposit by Arthur Orser for the production of agricultural limestone. The pulverizing plant consists of a small jaw crusher and a set of small rolls. Lime kilns were formerly operated here but no lime has been produced for the past 45 years. Sample 7 was obtained in the Orser quarry, and Sample 7A from the outcrops between the road and the brook.

Carlisle

The same type of pure limestone seen near Windsor is exposed near the northwest base of a high hill 1 mile west of Carlisle, which is 3 miles south of Windsor. As at Windsor, the absence of definite bedding planes renders it difficult to ascertain the strike and dip but the topography is favourable for quarrying. Fracturing of the strata is not so marked as in the limestone at Windsor. Until about 25 years ago this limestone was quarried for lime-burning at a point 600 yards northwest of the old road leading from Lower Windsor to Carlisle; the kilns, two in number, were along the roadside. Sample 8 was taken in and around the old quarries, which are now caved in and grass-grown. East of here, near the north branch of the Beccaguimic River, a similar limestone is exposed in a cliff 50 feet high, but most of the strata are concealed by soil. Between Carlisle and Windsor several other exposures of pure, grey high-calcium limestone were observed and it is possible that the deposit is continuous between these places.

[1] In this report wherever the strike of a stratum of limestone is given, the bearing refers to magnetic north and not to true north. The average magnetic declination in the Maritime Provinces is about 23 degrees west of true north.

Analyses of Carleton County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
7.....	0·32	0·30	0·14	0·11	98·98	0·42	100·35	tr.	55·48	0·20	277 : 1
7A.....	0·90	0·22	0·64	0·07	97·43	0·46	99·72	tr.	54·60	0·22	248 : 1
8.....	0·70	0·26	0·52	0·24	97·9	0·50	100·20	tr.	55·00	0·24	230 : 1

7. Windsor. Orser quarry ½ mile east of the village.
7A. " Outcrops in the vicinity of the quarry.
8. Carlisle. Outcrops 1 mile west of Carlisle.

Charlotte County

Two belts of calcium and high-calcium limestone occur in the southern part of the county adjacent to the shore of the Bay of Fundy, the larger and more easily accessible being at L'Etang, 5 miles south of St. George, and the other 3 miles south of Lepreau village, close to the east shore of Mace Bay. The L'Etang deposit is believed to be of Silurian age and the Lepreau deposit of Precambian age. Impure limestone is reported by Dr. Bailey[1] to occur on Kent Island, off the south coast of Grand Manan Island.

In 1927 a small amount of limestone was quarried at L'Etang and shipped by vessel to Saint John for use in the manufacture of sulphite pulp, for which purpose it was found satisfactory. Previous to that the L'Etang deposit had not been worked for 100 years when it was quarried by the St. George Lime Co. and their successors, for the manufacture of lime, most of which was shipped to the United States. Lime was also made in small quantities many years ago from the deposit south of Lepreau. At the present time there are no limestone quarries in operation within the county.

L'Etang

An extensive deposit of Silurian high-calcium limestone occurs on the southern part of L'Etang Peninsula, about 5 miles south of the town of St. George. It extends across the entire peninsula in a northeast direction—a distance of 4,000 feet—underlying country that is partly wooded and partly cleared and which, on the average, rises to an elevation of 50 feet above sea-level. The general strike of the strata is N. 70° E. and the dip is vertical. On the west shore of the peninsula the limestone belt, including slaty bands and igneous dykes, is 1,500 feet wide and it maintains this width for 2,500 feet northeasterly, but from there on it narrows rapidly and where it outcrops on the east shore of the peninsula it has a width of only 30 feet. All along the southeast side of the deposit is a highly metamorphosed, argillaceous rock, and similar rock extends along most of the northwest side. Both the argillaceous rock and the limestone are surrounded by igneous rock, apparently of volcanic origin.

[1] Bailey, L. W., "The Mineral Resources of the Province of New Brunswick," p. 83, Geol. Surv. Canada. (1898).

All the limestone is very fine-grained to dense-textured, thin-bedded and brittle (Plate XIX A, page 131). Owing to intensive cross-fracturing, the stone in the outcrops breaks readily into small rhombohedral fragments and into thin plates, but deeper in the deposit, as revealed in the quarries, this tendency is not so noticeable and the limestone is much more solid. The greater part is light blue in colour and faintly banded, but in the south-western part much has been metamorphosed to a creamy grey colour or to a grey that is mottled and streaked with light blue. At many places in the deposit are dykes of basic, igneous rock (Plate XVIII B, page 126) a few inches to 20 feet in width, that commonly trend nearly, but rarely exactly, parallel to the bedding planes, though in some instances they cross the deposit diagonally. These dykes are particularly numerous along the sea-shore at the west end of the band but many terminate a short distance inland, and even along the shore there are places where the dykes are 100 feet apart. The dyke rock is always readily distinguishable from the limestone and could be easily sorted out in quarry operations. In addition to the argillaceous rock bordering the limestone, there are two broad belts of particularly slaty limestone within the deposit—one, 85 feet wide, near the southern edge, and the other, varying in width from 100 to 400 feet, near the middle of the deposit. The contact between the zones of slaty stone and the limestone is not sharp and distinct, but rather there is a gradual merging of the two types. The wide central zone of slaty stone is different in appearance from the other bands of argillaceous stone, much of it having a brecciated character as shown in Plate XIX B, page 131, and the strata composing it are much twisted and broken. This breccia includes fragments of purple and green slate, and mauve and pink limestone.

A generalized section across the deposit, starting from the lava at the Government wharf and proceeding northerly along the shore approximately at right angles to the stratification, is as follows:—

180 feet of metamorphosed argillaceous rock in which are many dykes of trap rock.

30 feet in which thin bands of siliceous dolomite alternate with argillaceous rock and blue-and-white striped limestone.

74 feet of pure limestone some of which is white, striped with blue, and some blue, striped with white. Strike N.70°E.; dip 70 degrees to the northwest. Sample 11A was taken across this band.

85 feet of argillacous limestone, dykes of igneous rock, and thin bands of pure limestone some of which is green and some mauve. The strike is N.60°E.

29 feet of yellowish white limestone from which Sample 11B was obtained. Strike N.70°E.; dip vertical.

220 feet of nearly white limestone, some of which contains fine lines and mottlings of dark blue. Six hundred feet distant from the beach this type of stone pinches out entirely. In the southeastern half of this zone are many trap dykes of various thicknesses up to 20 feet, but in the northern half there is none. The strike of the limestone is N.55°E. and the dip is 80 degrees to the northwest. Sample 11C represents this stone, and Plate XIXA, page 131, illustrates its appearance. Stone for use in the making of sulphite pulp was quarried from this portion of the deposit during 1927.

200 feet of contorted impure, slaty limestone in part brecciated and containing fragments of purple and green slate as well as wavy bands of slaty rock (Plate XIXB, page 131). Some of this is dolomitic. Five hundred feet from the shore this band of impure limestone is only 100 feet wide and it maintains this width for several hundred feet northeast to where it is concealed

PLATE XIX

A. Fractured, laminated Silurian limestone, L'Etang, Charlotte County, N.B.

B. Limestone breccia, L'Etang, Charlotte County, N.B.

by soil. Along the beach, however, this zone of impure, slaty limestone has a width of 400 feet and in many places it has a strike at right angles to that of the pure limestone adjoining it a short distance inshore.

60 feet of interbanded, slaty limestone and pure, grey limestone some of which is mottled with blue, and some of which weathers green and appears to be magnesian.

15 feet of pure, yellowish grey limestone striking S.70°E. and dipping nearly vertically. Sample 11D was obtained from this band.

300 feet of grey and blue limestone in which quarries were worked many years ago to supply a lime kiln situated on the beach. Several igneous dykes occur, the general strike of which is N.70°E. The impure, brecciated and contorted limestone above described occupies a wedge-shaped area on the beach in front of this section. Sample 11E was taken across 100 feet of strata in the floor of the largest quarry.

500 feet of blue and grey limestone containing slaty zones and striking in various directions from S. 20° E. to S. 80° W. There are many igneous dykes in this part. Northward the percentage of slate in the limestone steadily increases until the rock becomes a metamorphosed, highly argillaceous rock similar to that on the southeast flank of the deposit.

The northeastern extension of this deposit appears in the cove south of Gosse Head on the east side of L'Etang Peninsula, but here it is only 30 feet wide. The limestone is light blue, dense-textured, and tends to break into very thin, platy fragments and, in general, closely resembles the blue limestone at the other side of the peninsula. In chemical composition also it is very similar, as shown by the analysis of Sample 11F.

Though the area between the two ends of the deposit is largely covered by soil, the few exposures that occur are of limestone of good quality and a large tonnage is indicated. The vertical or nearly vertical attitude of the strata suggests that the deposit may extend to considerable depth.

Along the southeast edge of the deposit, beginning 500 feet from the shore, is a 40-foot band of siliceous, blue dolomite that extends for 500 feet northeasterly along the margin of the high-calcium limestone. Though, as noted below, dolomite is prominent in the southwestern extension of this belt on Frye Island, this is the only occurrence of it noted on the peninsula.

The deposit is owned by J. Sutton Clark of St. George. In 1927 a small amount of white stone was shipped by sailing vessel to a pulp mill at Saint John, but no quarrying has been done since. The deposit was first worked over 100 years ago by the St. George Lime Company to obtain stone for making lime, the blue stone being utilized for this purpose.

Deep water and a sheltered harbour would allow shipment in vessels of large tonnage, but the Government wharf adjacent to the deposit can accommodate only small vessels. The nearest railway shipping point is at St. George on the Canadian Pacific railway, 5 miles to the north by road.

Frye Island

On this island, which lies directly southwest of the L'Etang Peninsula, a vertically dipping belt of limestone and metamorphosed argillaceous rock extends from the shore of Birch Cove on the east side of the island across to Charlie Cove on the opposite side. It is apparently a continuation of the L'Etang deposit, as it is directly in line with the strike

of the latter. On Frye Island, however, the limestone occurs in comparatively narrow bands (none seen exceeded 50 feet in width) separated by metamorphosed argillaceous rock. Much of the limestone contains veins of milky quartz and slaty laminæ and is impure. At Charlie Cove most of the exposures consist of intermingled calcium limestone and dolomite, the latter occurring in veins and masses in the calcium limestone. As at L'Etang, most of the stone is blue in colour but some is white. The ruins of three field kilns are to be seen along the shore of Birch Cove, and one at Charlie Cove. Three samples were obtained—No. 12 from an 18-foot band in Birch Cove where it was quarried for lime-burning, No. 12A from a 12-foot band in Charlie Cove adjacent to an old wharf and lime kiln, and No. 12B represents a vein of white dolomite that occurs in the calcium limestone.

Lepreau

A deposit of Precambrian calcium limestone occurs 4 miles south of Lepreau village at the eastern boundary of Charlotte County and extends easterly into the adjoining County of St. John. It is best exposed along what is known locally as the "County Line Road" and but few outcrops are to be seen in the wooded country on either side, particularly to the west. Along the roadside the following section at right angles to the strike is exposed from the southern edge of the limestone band northward.

115 feet of grey and light blue limestone striking N. 70° E. and dipping to the north at angles of 30 to 40 degrees. It all has a platy structure and much of it tends to break into thin slabs. Slaty laminæ occur parallel to the stratification in parts of the outcrop. Sample 13 was taken across this band at right angles to the strike.

130 feet concealed by gravelly soil.

120 feet of grey and blue limestone, in appearance much like that on the southern side of the deposit but of a higher degree of purity as shown by the analysis of Sample 13A, which represents this stone. The strata composing this part of the deposit strike S. 30° E. and dip southwesterly at an average angle of 40 degrees.

On the south side the limestone is in contact with a yellowish green dolomitic rock containing over 50 per cent silica. No contact with other rock is visible on the north side owing to a covering of soil, but 100 feet north of where the last limestone is seen there are outcrops of dark blue slaty rock striking S. 70° E. and dipping vertically. Further work is necessary to ascertain the extent and structure of this deposit; it may consist of a single band of limestone folded into a syncline or there may be two bands.

A little over $\frac{1}{4}$ mile due south is a small exposure of very similar limestone and nearby are the ruins of a lime kiln.

Analyses of Charlotte County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
11A.....	1·82	0·32	0·56	0·04	96·79	0·53	100·06	nil	54·11	0·25	216 : 1
11B.....	2·38	0·45	0·55	0·04	94·27	2·56	100·25	tr.	52·81	1·22	32 : 1
11C.....	1·16	0·22	0·28	0·07	97·57	0·36	99·66	nil	54·68	0·17	322 : 1
11D.....	1·86	0·37	0·73	0·04	96·23	0·38	99·61	nil	53·91	0·18	300 : 1
11E.....	1·66	0·19	0·59	tr.	96·84	0·25	99·53	nil	54·23	0·12	452 : 1
11F.....	2·74	0·45	0·62	0·62	95·78	0·32	99·93	nil	53·65	0·15	358 : 1
12.....	4·98	0·49	1·03	0·05	91·90	1·46	99·91	tr.	51·49	0·70	74 : 1
12A.....	10·00	0·69	0·49	0·07	85·64	2·86	99·75	0·01	48·00	1·36	35 : 1
12B.....	0·94	0·67	0·27	0·02	55·36	44·19	101·39	nil	30·99	21·12	1·47 : 1
13.....	3·98	0·45	1·33	0·04	92·61	1·51	99·92	tr.	51·88	0·72	72 : 1
13A.....	2·64	0·32	0·62	0·06	94·68	1·46	99·78	tr.	53·02	0·70	76 : 1

11A L'Etang. Blue-and-white striped limestone across a width of 74 feet on southern edge of belt.

11B " Yellowish white limestone 29 feet wide adjoining the south side of the white striped limestone of Sample 11C.

11C " White limestone in a triangular area 220 feet across the base and 600 feet long.

11D " Yellowish grey limestone band 15 feet wide adjoining south side of the blue limestone of Sample 11E.

11E " Blue and grey limestone of the type quarried over 100 years ago for lime-burning. The sample was taken across a width of 100 feet in the floor of the largest quarry.

11F " Blue limestone across a width of 30 feet in the cove south of Gosse Head on the east side of L'Etang Peninsula and representing the eastern extremity of the L'Etang deposit.

12 Frye Island. Birch Cove, 18-foot band of limestone. Formerly quarried for lime-burning.

12A " Charlie Cove, 12-foot band of blue limestone.

12B " Charlie Cove, band of white dolomite in the calcium limestone.

13 Lepreau. Deposit 4 miles south of village. Sample taken along the County Line Road from 115 feet of outcrop at the south edge of the deposit.

13A " Same deposit, 120 feet of outcrop along the north edge.

Gloucester County

Underlying the flat country between Nigadu and Elmtree Rivers, and extending back from the shore of Chaleur Bay for 12 miles, are Silurian rocks comprising partly metamorphosed limestone, slate, and sandstone. The slate and sandstone are commonly calcareous, but enclosed within them are large lenses ranging from 10 to 300 feet in thickness of thin-bedded limestone of varying degrees of purity, but all being low in magnesium carbonate. The lenses of the higher grade limestone seem to be almost continuous along one horizon, and they extend as a band of irregular thickness from Limestone Point southwesterly for at least 4 miles and probably more. The general dip of the strata is nearly vertical. Along the shore between Petit Rocher and Nigadu River, sandstone, slate, and limestone are also exposed, but the limestone is impure and available only in small quantity.

At Petit Rocher a quarry was worked in recent years for agricultural limestone and many years ago lime was made from a deposit near Elmtree village.

PLATE XX

A. Silurian limestone in quarry of Messrs. Godin and Fournier, Petit Rocher, Gloucester County, N.B.

B. Outcrop of Carboniferous limestone, Havelock, Kings County, N.B.

Petit Rocher

The irregular limestone band above referred to as extending southwesterly from Limestone Point, crosses the LaPlante-Petit Rocher road at a point slightly over 2 miles west of Petit Rocher station, and continues for an unknown distance to the southwest. A short distance north of the road the limestone and associated slate, striking N. 50° E. and dipping almost vertically are exposed in a small quarry worked a few years ago by Messrs. Godin and Fournier, of Petit Rocher, for agricultural limestone (Plate XX A, page 135). The limestone is slaty in appearance, blue, fine-grained, and is traversed by thin veins of white calcite, and much of it contains many films of brown-weathering, slaty material. In places the brown-weathering films are so closely spaced that they impart a brown colour to the outcrops. These films, however, are calcareous and do not lower the quality of the limestone as much as might be expected. The quarry is 36 feet wide and has been worked along the strike of the strata. Soil in this area does not usually exceed 1 foot in thickness. Beginning at the slate on the southeast wall the succession of strata is as follows:—

7 feet of slaty, dark blue limestone traversed by veins of white calcite.
1 foot of blue slate.
7 feet of very fine-grained, light grey limestone with films of slate parallel to the stratification.
3 feet of fine-grained, blue, fossiliferous limestone.
3 feet of very slaty limestone.
7 feet of slaty limestone similar to that on the southwest edge of the deposit.
5 feet of blue, fossiliferous limestone.
3 feet of reddish, impure, slaty limestone traversed by thin veins of white calcite.

Two samples were obtained from the quarry. Sample 2 represents all strata in the face exclusive of the slate band and of the reddish limestone on the northwest side. Sample 2A is from the 10 feet of strata immediately north of the slate band and represents the purest limestone in the quarry.

A short distance northeast of the quarry the limestone band has an apparent width of over 300 feet and the stone is of the same general type as that just described.

Elmtree

Three-quarters of a mile west of the railway, along the road leading westerly from Elmtree village, what is probably the same band of limestone as that quarried by Messrs. Godin and Fournier is again exposed in a field between the road and a small brook that parallels the road a short distance to the north. The limestone here has a pink tint due to numerous fragments of pink crinoid stems and is highly metamorphosed. Across a width of 60 feet, near the ruins of a lime kiln, the limestone is nearly free from shaly films and is quite pure as shown by the analysis of Sample 3, which represents the 60 feet of strata. Between the kiln and the brook the limestone is less pure and contains bands of brick-red shale. The total width of the band is about 300 feet and the strata appear to dip vertically.

On the low shore at Limestone Point a much fractured, impure, blue, slaty limestone containing small lenses of purer, pinkish limestone is exposed. The strike and dip of the strata in this outcrop are extremely variable.

Analyses of Gloucester County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
2.....	6·78	0·73	1·51	0·04	89·75	1·20	100·01	tr.	50·28	0·57	88 : 1
2A.....	2·42	0·41	0·47	0·04	95·75	1·03	100·12	tr.	53·64	0·49	109 : 1
3.....	2·18	0·27	0·45	0·17	96·66	0·63	100·36	tr.	54·22	0·30	180 : 1

2. Petit Rocher. Average of strata in Godin and Fournier quarry.
2A. " " Best stone available in the quarry.
3. Elmtree. Sixty feet of strata in outcrop ¾ mile west of the railway.

Kings County

Many large and easily quarriable deposits of dolomite, calcium and high-calcium limestone occur in this county but, aside from a small occasional production for agricultural use, none is being quarried at the present time. Both Precambrian and Carboniferous limestones are available.

Precambrian limestones—including dolomitic and calcium varieties—are found in long, narrow and generally steeply dipping bands in the area southwest of and between Rothesay and Hampton. The Precambrian rocks of this area form the northeast end of the great belt of rocks of this age that extends across St. John County, and the limestones are in most respects similar to those of the Saint John area but they are less intruded by dykes of trap rock.

Lower Carboniferous rocks underlie the greater part of the central and eastern parts of the county and they include an important formation of calcium limestone. The limestone is visible in many places along the southern margin of the Carboniferous area, notably between Quispamsis and Waterford, where it commonly rests directly on a floor of igneous rock. In the central and northern parts of the area the limestone is exposed at a number of places, particularly at or near Norton, Apohaqui, Millstream, and Havelock. The deposits at Havelock in particular are large, are of uniform composition, and could be cheaply quarried. All the Carboniferous limestone in this county has a very low content of magnesium carbonate—usually less than 1 per cent—and some is of a high degree of purity. The majority of the deposits lie nearly flat. Whether they are continuous under the undisturbed parts of the Carboniferous area or whether they are a series of lenses was not determined. Core-drilling proved the deposit at Havelock to be 57 feet thick in one part. This thickness is not known to be exceeded in any of the other deposits.

Rothesay to Hampton

Ridges of Precambrian dolomite and calcium limestone occur in a long, narrow belt roughly parallel to and ½ to 2 miles southeast of the Canadian National railway between Rothesay and Hampton. The limestone belt begins about 2 miles northeast of Rothesay and extends to within 3 miles of Hampton, having in all a length of 8 miles. Whether the

limestone is continuous throughout this distance was not ascertained as the entire length of the belt was not traversed, but the limestones were examined along to the five roads crossing the belt between Quispamsis and Nauwigewauk stations. At each of these places the limestone is in steeply dipping bands, the average strike of which corresponds to the trend of the main belt, though there are local variations. The following data relate to the limestone exposed along the five roads mentioned.

Quispamsis. The nearest road to the southern end of the limestone belt is that crossing from between Quispamsis and Otty Grove, nearly 3 miles from the southern tip. On this road the first limestone seen is 2,000 yards from the railway where light blue, fine-grained dolomite is exposed across a width of several hundred feet in a series of ledges on the southeast slope of a ridge. The strike of the ledges is northeast-southwest. The dolomite is nearly free from siliceous impurities but it contains a number of films of white calcite and these increase the calcium carbonate content of the deposit to slightly more than that present in a typical dolomite, as is shown by the analysis of Sample 39 which was taken from a number of the outcrops. The sample however cannot be considered entirely representative of the deposit because the stone in the concealed intervals between the ledges was not included in the sample. Southeast of and parallel to this ridge and separated from it by a narrow valley is a higher ridge of igneous rock overlain by dark red, fine-grained, Carboniferous calcium limestone. The red limestone is seen for 800 feet along the road after which it is hidden by gravelly soil. Sample 39A represents many outcrops of this limestone.

Otty Grove. On the second road crossing the limestone belt from a short distance northeast of Otty Grove, the first outcrops of limestone are seen in a field east of the road and slightly more than $\frac{1}{2}$ mile from the railway. They form part of a band of calcium limestone over 200 feet wide, which at this place strikes N. 15° E. and dips steeply to the east. The west edge of the limestone is hidden by soil but what is probably the eastern edge of the band is marked by a few outcrops of white quartzite and trap rock, beyond which very little limestone is to be seen. The limestone in this part of the band is nearly white and is medium-grained. Sample 40 was taken across the strike of a number of exposures. Three hundred and fifty yards farther along the road—which at this place runs N. 21° E., or nearly parallel to the limestone band—a finely granular, light blue dolomite is seen adjoining the calcium limestone to the west. The dolomite contains veins and blebs of white calcite but is very pure as shown by the analysis of Sample 40A taken from a number of outcrops in a field on the west side of the road. Around the bend in the road, some 350 yards farther south, a steeply dipping band of laminated, light blue, calcium limestone, over 150 feet wide, and striking N. 60° E. crosses the road. It contains a dyke of trap rock 6 feet wide. Sample 40B was taken across a width of 150 feet of the calcium stone. Beyond this no more limestone is exposed. All of the deposits along this road are favourably situated for quarry operations.

On the well-travelled road crossing the limestone belt from just east of Otty Grove, white calcium limestone and blue dolomite, similar to that just described, occur in high ridges where they could be easily quarried.

French Village Road. Along the French Village road, which crosses the belt just north of and parallel to the Hammond River, is a high cliff of medium-grained, white and bluish white, calcium limestone with trap rock on either side. This is a little more than 1 mile southeast of the main highway between Saint John and Sussex. Sample 41 was taken along the face of the cliff.

On the north bank of Hammond River, farther to the southeast, are outcrops of very impure calcium limestone containing many thin interbeds of slate—the whole being much mashed and contorted. Across the river limestone is also seen.

Nauwigewauk. The cross-road from Nauwigewauk station to Smithville passes over the northeast end of the limestone belt. Along this road the only limestone seen is on the land of Messrs. Albert and Manzer Smith, 3 miles southeast of the Saint John-Sussex highway, where medium-grained, white limestone outcrops along the top of a ridge that is flanked on either side by red sandstone conglomerate. The limestone strikes N. 23° E. and dips northwesterly at 20 degrees. The entire width exposed is about 100 feet and of this the 50 feet on the northwest side is rather impure due to the presence of thin interbeds of slate. The southeastern half, however, is of better quality and contains only a few films of red, slaty material. Sample 42 represents the better grade limestone.

Salt Springs Station

A small exposure of white, medium-grained, calcium limestone occurs at Salt Springs station, $\frac{3}{4}$ mile north of the St. Martin's branch of the Canadian National railway and west of the road to Hampton. No sample was obtained.

Hillsdale

Beginning 1 mile northeast of Hillsdale post office a large deposit of Carboniferous, high-calcium limestone is exposed for 2 miles along Hammond River, principally on the south side, where it rests on a floor of igneous rock sloping gently toward the river. Ledges of limestone outcrop along the hillside for 800 feet back from the river and to a height of 75 feet and more above the water, indicating a deposit over 50 feet in thickness when allowance is made for the low dip to the northwest. The stone is fine-grained, brownish and reddish grey, and is in heavy beds. A few films of red shale are present in some of the strata and the weathered surfaces of such have a rather rubbly appearance, but there is not sufficient shale to lower the purity appreciably. Sample 43 was taken from many ledges on the property of George Devine and shows the stone to be very pure, but it is possible that limestone of lesser purity may occur in some of the covered intervals between the ledges. The gravelly overburden is light in most places and the stone could be quarried

easily and cheaply but it is 7 miles to the nearest railway shipping point. Lime for local use has been made in small field kilns at several places along the line of outcrop.

This deposit is part of the limestone horizon that extends, either continuously or in a series of lenses, from near Quispamsis easterly through Markhamville, Waterford, Elgin, and Prosser Brook to Hillsborough. The so-called "Ice Caves" at Waterford are in this limestone formation. In a number of places it contains veins and pockets of manganese and has been worked for that mineral, but generally the manganiferous limestone is quite siliceous.

Norton

A large deposit of calcium limestone containing less than 4 per cent total impurities occurs on the hillside immediately south of California Brook, a little over 1 mile northwest of Norton, and only a few hundred feet west of both the Springfield-Norton road and the track of the New Brunswick Coal and Railway Company. The limestone is fine-grained, brownish grey, and irregularly bedded. Many films of calcareous shale are distributed in a network through the stone and give it a rubbly or nodular appearance on the weathered surface. There are also a few tiny calcite veins containing crystals of galena and manganese. Exposures extend along the brook for 800 feet and the limestone apparently underlies the hillside for several hundred feet back from the brook and possibly much farther, as could easily be proved by trenching. The strata dip down hill or to the northwest at an angle of 30 degrees, and the deposit is over 20 feet thick. Sample 44 represents a thickness of 18 feet. Many years ago this limestone was quarried and hauled to farms within a 10-mile radius where it was burned to lime for agricultural use.

Midland

Carboniferous limestones are also exposed near Midland where, on the Walter Gamblin property, there is a deposit of grey and reddish grey, impure calcium limestone, the basal strata of which contain pebbles of quartzite and other rocks. Sample 45 was obtained here. Fifty years ago this limestone was quarried by farmers and made into lime for agricultural use.

Apohaqui

On the property of Michael Guilfoyle, north of the highway and 2¼ miles west of Sussex, is a deposit of impure, fine-grained, brownish grey, Carboniferous limestone resting on red, siliceous conglomerate and overlain by gypsum and possibly by shale. The limestone is in laminated beds that dip northerly at an angle of 54 degrees and can be traced along the strike for about 1 mile. Fifteen feet of strata is visible in a small quarry and from here Sample 46 was obtained.

Havelock

A large deposit of Carboniferous calcium limestone underlies the whole of the summit of a low, broad ridge, known as Butternut Ridge, on

top of which is situated the village of Havelock. A large part of the deposit is owned by the Canada Cement Company, Montreal. The limestone dips northerly at an angle of 7 degrees and is exposed almost continuously in an escarpment 6 to 20 feet in height for a distance of 5 miles along the southeast side of the ridge, and is also seen in occasional outcrops across a width of 600 yards on top of the ridge. (Plate XX B, page 135). Transportation facilities are provided by the Havelock branch of the Canadian National railway, which parallels the southeast side of the ridge for some distance and then crosses it to reach Havelock. The deposit is also well served by roads—one of the secondary highways of the province extending the length of the ridge on top of the limestone. The limestone is dense-textured, rather brittle and heavily bedded, and the prevailing colour is grey with smaller quantities of reddish grey. Aside from a few sandy patches of small extent the limestone in the outcrops is of uniformly good quality. Core-drilling conducted by the Canada Cement Co. showed the deposit to have a maximum thickness of 56 feet 10 inches and to be underlain by red grit or conglomerate. The company kindly supplied the following series of analyses of 3-foot sections of core taken from the hole drilled in the thickest part of the deposit on their property.

Depth in feet	SiO_2	Fe_2O_3 and Al_2O_3	CaO	MgO	Loss on ignition
0- 3	2·30	1·00	53·49	0·60	42·34
3- 6	1·94	0·92	53·76	0·68	42·70
6- 9	0·80	0·40	55·00	0·47	42·94
9-12	1·02	0·54	54·69	0·43	43·22
12-15	1·34	0·60	54·55	0·28	43·16
15-18	1·08	0·40	54·97	0·34	43·18
18-21	1·32	0·42	54·62	0·54	43·10
21-24	0·92	0·54	54·97	0·47	43·00
24-27	1·28	0·80	54·69	0·43	42·76
27-30	1·42	0·66	53·58	0·59	42·86
30-33	4·20	1·86	52·16	0·69	40·80
33-36	3·42	1·32	52·93	0·63	41·37
36-39	3·88	1·54	52·23	0·58	41·00
39-42	7·12	2·46	49·70	0·77	39·06
42-45	10·48	3·84	46·74	0·88	37·32
45-48	2·36	0·88	54·09	0·33	42·48
48-51	2·28	0·90	53·81	0·56	42·36
51-53	1·52	0·76	54·13	0·34	43·00

In this hole no core for analysis was obtained from the 4 feet of limestone that overlies the red conglomerate, but analyses of the cores of the basal 4 to 6 feet of limestone obtained from other holes show it to be very siliceous and argillaceous. The magnesia content is uniformly low from top to bottom of the deposit.

The following samples were taken by the writer from surface showings: Sample 47 was taken from the 9-foot escarpment on the east side of the highway, 350 yards southwest of the cross-roads at Havelock. Sample 47A was taken from the 9-foot face of a small quarry at Havelock worked occasionally by George Downey to obtain stone for making agri-

cultural limestone. The pulverizing plant consists of a Jeffrey No. 1 Limepulver. Sample 47B was taken from a 12-foot face of limestone at the northeast end of the ridge 3 miles northeast of Havelock and near the ruins of a lime kiln, 700 feet south of the road. This part of the deposit is in Westmorland County (see page 176).

Springhill

At Springhill, 4 miles by road northwest of Havelock, a Carboniferous limestone very similar to that at Havelock caps a high hill where it is in a good position for quarrying, but it is 4 miles from a railway. The lower beds of this deposit contain pebbles of quartz, slate, granite, and schist, but the upper part is free from pebbles. Some of the upper beds, however, contain thin, irregular seams of red, calcareous shale which impart a nodular appearance to the weathered surface, but the films are not sufficiently numerous to lower the grade noticeably. This deposit underlies an area about 1 mile (east and west) by $\frac{1}{4}$ mile (north and south), mostly on the properties of Messrs. Clark, McMacklin, and McFarlane. Sample 48 was taken from a 12-foot face on the line between the McMacklin and McFarlane properties.

Samphill

About $1\frac{1}{4}$ miles south of the Springhill deposit a ridge composed of Carboniferous, olive-grey high-calcium limestone, very much like that at Springhill and Havelock, extends for $1\frac{1}{4}$ miles in a southwesterly direction along the north side of the road between Springhill and Perry Settlement. In the northeast end of the ridge the limestone strikes N. 72° E. and dips southerly at an angle of 60 degrees. Toward the southwestern end the angle of dip gradually lessens and in the westernmost exposures it is only 15 degrees. In places the north edge of the ridge rises as a cliff 20 to 30 feet high on which there is almost no overburden, and the stone could easily be quarried, but it is over 4 miles from the railway. The limestone in this ridge is thinner bedded than that in the other deposits nearby and irregular partings of red, calcareous shale occur at intervals of 2 to 6 inches. Sample 49 was taken across a thickness of 25 feet of strata near the northeastern end of the ridge, but does not include any interbeds of shale.

Analyses of Kings County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
39.....	0·80	0·24	0·54	0·04	59·31	39·32	100·25	nil	33·23	18·80	1·76 : 1
39A.....	6·56	0·68	1·98	0·22	84·36	7·66	101·46	nil	47·36	3·66	13 : 1
40.....	3·28	0·42	0·88	0·02	93·84	0·88	99·32	tr.	52·56	0·42	125 : 1
40A.....	0·98	0·26	0·41	0·05	59·31	39·75	100·76	nil	33·23	19·01	1·75 : 1
40B.....	2·48	0·31	0·89	0·07	94·30	1·85	99·90	nil	52·85	0·88	60 : 1
41.....	2·98	0·42	0·98	0·02	92·93	2·48	99·81	nil	52·06	1·18	44 : 1
42.....	3·68	0·33	0·51	0·07	94·55	1·28	100·42	tr.	52·99	0·61	87 : 1
43.....	1·42	0·28	0·36	0·15	97·29	0·29	99·79	0·03	54·57	0·14	390 : 1
44.....	2·72	0·42	0·62	0·04	93·89	0·86	98·55	0·17	52·60	0·41	128 : 1
45.....	6·72	0·69	1·17	0·07	89·68	0·76	99·09	nil	50·26	0·36	140 : 1
46.....	6·06	0·56	2·00	0·13	86·95	3·32	99·02	0·12	48·76	1·58	31 : 1
47.....	2·24	0·43	1·47	0·04	95·07	0·65	99·90	0·05	53·26	0·31	172 : 1
47A.....	2·56	0·33	0·79	0·02	95·59	0·61	99·90	0·03	53·34	0·29	185 : 1
47B.....	1·62	0·18	0·14	0·02	97·91	0·25	100·12	tr.	54·84	0·12	457 : 1
48.....	1·70	0·42	0·30	0·02	96·75	0·90	100·09	tr.	54·20	0·43	126 : 1
49.....	1·30	0·45	0·05	0·02	97·63	0·61	100·06	tr.	54·68	0·29	189 : 1

39	Quispamsis.	Precambrian dolomite on road going southeast from between Quispamsis and Otty Grove, 2,000 yards from the railway.
39A	"	Red Carboniferous limestone overlying the above.
40	Otty Grove.	Precambrian white calcium limestone on road going southeast from Otty Grove, ½ mile from the railway.
40A	"	Precambrian dolomite adjoining the above.
40B	"	Precambrian blue calcium limestone 350 yards south of where Sample 40A was taken.
41	French Village road.	Precambrian, calcium limestone 1 mile southeast of the Saint John-Sussex highway.
42	Nauwigewauk.	Precambrian limestone on road going southeast from Nauwigewauk, 3 miles from the Saint John-Sussex highway.
43	Hillsdale.	Carboniferous limestone along Hammond River northeast of village.
44	Norton.	Carboniferous limestone at California Brook 1 mile northwest of the village.
45	Midland.	Carboniferous limestone on Gamblin property.
46	Apohaqui.	Carboniferous limestone on property of M. Guilfoyle, 2¼ miles west of Sussex.
47	Havelock.	Carboniferous limestone deposit at point 350 yards southwest of Havelock cross-roads.
47A	"	Small quarry at Havelock village.
47B	"	Northeast end of same deposit 3 miles from Havelock.
48	Springhill.	Carboniferous limestone on the McMacklin and McFarlane properties.
49	Samphill.	Carboniferous limestone along road between Springhill and Perry Settlement.

Madawaska County

This county is largely underlain by calcareous slates interbedded with which, in some areas, are thin beds of impure limestone. No limestone deposit of commercial value is known, but it is possible that lenticular deposits similar to those in Gloucester and Restigouche Counties may occur. Limestone for use in pulp-making is brought to the mill at Edmundston from the Saint John district.

Queens County

The limestones of Queens County occur in an area of Mississippian rocks (Carboniferous), that extends westerly in a narrow belt across the southern part of the county into the adjoining County of Sunbury. Near the northern edge of this area between McDonald and South Clones, a distance of 18 miles, are a number of exposures of red and of grey calcium limestone most of which may, on detailed examination, prove to be parts of a continuous band. The only place in the county where limestone is known near a railway is at Queenstown, where a red limestone containing about 4 per cent total impurities is exposed adjacent to the Canadian National railway. Attempts were made many years ago to utilize this red limestone for marble but the fractured nature of the deposit and the irregular bedding made it impossible to obtain the stone in large, rectangular blocks. At South Clones, at Carpenter, and at McDonald the limestone was at one time burned in field kilns. No use is being made of the limestone in this county at the present time.

Queenstown

Two miles south of Queenstown a band, 25 feet thick, of brick-red, Carboniferous limestone is exposed in a cutting on the highway. It strikes N. 65° E. and dips northwesterly at angles of 55 to 65 degrees. It overlies a reddish volcanic tuff and in turn is overlain by red and green shale. The limestone is much like the red limestones of the Tobique River in appearance, being dense-textured, brittle, and containing narrow veins and small crystals of calcite. Calcite also fills many fossil cavities. The outcrops are badly fractured. Bedding is not very definite but there are many irregular streaks of red shale in the stone. Sample 9 was taken across the entire width of the band.

Eastward the band can be traced several hundred yards across the Canadian National railway to the St. John River. Between the road and the railway several pits were sunk in an attempt to utilize the stone for marble but the venture was not successful.

Westerly the red limestone is said to extend for several miles through wooded country.

Carpenter

On the east side of the St. John River limestone is exposed near the village of Carpenter. Dr. W. J. Wright, Provincial Geologist, in a personal communication to the writer, describes the deposit as follows:— "Limestone is exposed about 1,000 feet east of the Wickham-Narrows highway opposite the entrance of the byroad to Carpenter's wharf on the St. John River. In former days a small amount of the rock was excavated. The exposure covers an area about 200 feet in diameter but it is difficult to make out the bedding."

McDonald

Dr. Wright also describes a deposit of limestone 1 mile northeast of the Carpenter deposit as follows:—"In this locality massive limestone is exposed in rounded knobs on the western side of a small brook immediately

south of the highway. In former days a lime kiln was operated here. The exposure is about 200 feet in diameter but the structure and thickness of the bed are uncertain. I would judge that the bed strikes approximately east and west and dips northerly at a moderate angle."

South Clones

West of Queenstown, exposures of what may be a continuation of the Queenstown deposit occur at Summer Hill and South Clones. Dr. W. J. Wright has contributed the following note on the South Clones deposit.

In this locality limestone occurs in immense, rounded boulders, which are undoubtedly residual, forming a belt 200 feet wide that extends approximately east and west. The location is along what is known as the "Derby Gallant Road" 1 mile southwest of South Clones village. The stone is light grey, fine-grained, and is veined and spotted with white calcite and certain beds contain thin seams of shaly material. At one time lime for building and for improving the soil was burned in a field kiln at this place, the stone being obtained from boulders and from the face of a 20-foot, westerly facing escarpment. The limestone is so massive that it is difficult to determine the attitude and thickness of the beds.

A burning test and a chemical analysis were made on a sample of this stone submitted by Dr. Wright. The resulting lime was dark grey in colour and where films of shaly material were present these turned to a brownish red on calcination. The chemical analysis is shown as No. 10 in the table below and reveals the stone to be a high-calcium limestone. Shipping facilities are not good, as 2 miles of bush road must be traversed before reaching the Broad Road highway. The nearest railway station is Enniskillen on the Canadian Pacific railway, 11 miles to the southwest.

Analyses of Queens County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
9.....	2·80	0·25	0·75	0·02	95·50	0·59	99·91	tr	53·49	0·28	191 : 1
10.....	1·94	0·27	0·78	0·03	95·97	0·88	99·84	tr	53·75	0·42	128 : 1

9. Queenstown. Red limestone 2 miles south of village.
10. South Clones. Grey limestone, mainly boulders, 1 mile southwest of the village.

Restigouche County

This county is largely underlain by shales that in many places are very calcareous, sometimes sufficiently so to be termed limestones. However, the only known deposit of limestone adjacent to means of transportation is at Black Point on the shore of Chaleur Bay, 5 miles west of Jacquet River, where an impure calcium limestone, probably of Silurian age, is exposed. The stone was utilized for lime-burning during the construction of the Intercolonial railway (now the Canadian National) and it is stated that it yielded a very strong lime approximating natural cement in its characteristics. The railway line passes very close to the outcrops.

Black Point

Thinly bedded limestone, interstratified with shale and sandstone, is exposed for 800 feet along the shore of Chaleur Bay on the east side of Black Point and probably extends inland for some distance on the Ward, Dickie and Carney properties. The limestone is dense-textured, dark blue, impure and occurs in beds 1, 2, and 3 inches thick separated by from ½ to 1 inch of blue shale, as shown in Plate XXIA, page 147. Faulting is in evidence and the strike and dip of the strata vary from place to place but, in general, the strike is east and west and the dip is steep to the north, being vertical in places. This limestone was quarried to a small extent along the beach for making lime for use in constructing culverts and bridges when the Intercolonial railway was being built through this district. Sample 1 consists of chips taken at intervals of 4 feet from the limestone beds along the entire outcrop, but none of the interbeds of shale are included.

At the eastern end of this large outcrop a medium-grained fossiliferous, light blue limestone, blotched with red, is exposed in a low elevation, lightly covered with soil, on the Alex. Dickie property. This stone is apparently lying nearly horizontally and in places is covered with a sandy conglomerate containing pebbles of limestone, shale, and sandstone. Sample 1A was taken from the few beds exposed.

Analyses of Restigouche County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
1.....	14·34	1·29	3·05	0·07	77·96	2·69	99·40	0·12	43·70	1·28	34 : 1
1A.....	6·32	0·48	2·16	0·02	88·32	2·63	99·93	0·02	49·47	1·25	40 : 1

1. Black Point. Thin-bedded, limestone, exclusive of shale interbeds, exposed along the beach.
1A. " " Fossiliferous limestone on Alex. Dickie property.

St. John County

The principal limestone quarries and lime plants in New Brunswick are situated in the belt of Precambrian limestones and associated rocks that extends northeasterly for 15 miles from west of the St. John River to beyond Torryburn. Most of the territory underlain by the limestone is hilly, wooded country, only lightly covered with soil, and conditions are favourable for cheap quarrying. Dolomite, calcium and high-calcium limestone, as well as minor quantities of magnesian limestone, are available and are being quarried and supplied either in the crude form, pulverized form, or as lime, to all parts of the province, and in lesser quantities to Nova Scotia, Prince Edward Island, Quebec, and the State of Maine. All the limestone is highly metamorphosed and generally occurs in wide, steeply dipping bands associated with quartzite, slate, and granitic rocks. Dykes of trap rock penetrate these older rocks and are especially numerous in the western part of the limestone belt. In the areas where quarries are being operated, however,

A. Thinly bedded Silurian limestone with interbeds of dark-coloured shale, Black Point, Restigouche County, N.B.

B. Precambrian dolomite along the sea coast, Lorneville, St. John County, N.B.

the dykes are not sufficiently numerous to interfere seriously with quarrying. The width of the limestone bands varies greatly, some being only a few feet, others thousands of feet wide, but the wider ones consist of interbanded dolomite and calcium limestone. The very wide bands usually contain much impure limestone but within most of them are lenses of pure stone and it is in such lenses that the present quarries are situated. The greatest width of high-calcium limestone being worked is about 200 feet, and of dolomite 80 feet. The term width instead of thickness is used advisedly in referring to the bands because there is considerable evidence that in many of the wider exposures there is repetition of the strata due to the limestone having been compressed laterally into tight folds.

In the central and northeastern parts of the belt the limestones are of greater degree of purity than those in the western end but the strata in these parts are considerably more crumpled and faulted than in the western end. The limestones of the belt yield white limes of good quality, but the hydrated limes, so far produced from either the dolomites or the high-calcium limestones, do not possess quite enough plasticity to enable them to be classed as finishing limes. Four companies are at present engaged in manufacturing lime and one other company is producing pulverized limestone for agricultural purposes. Several of the lime companies also produce pulverized limestone, crude limestone for use in pulp mills, and crushed stone for road metal and concrete aggregate.

Lorneville

A wide belt of Precambrian limestone strikes northeast-southwest across the peninsula between Musquash Harbour and Manawoganish Cove on the Bay of Fundy. Where it is exposed on the shore of Manawoganish Cove, 1 mile north of Lorneville (Plate XXI B, page 147), the belt is 1,000 feet wide and consists of dark blue and light blue dolomite in which are veinlets of white calcite and occasional stringers of milky quartz. Intersecting the dolomite in all directions are dykes of trap rock varying from a few feet to 40 feet in width; though they are quite numerous they are not sufficiently so to condemn the deposit. All the dolomite is very fine-grained, brittle and much fractured, and on quarrying would tend to break into small angular fragments. Certain zones contain laminæ of slaty rock parallel to the strike, but most of the belt is of a good degree of purity and of uniform composition as shown by the analyses of Samples 14, 14A and 14B. The first two of these samples were taken along the shore—No. 14 represents a width of 300 feet across the strike at the southern edge of the belt, and No. 14A the next 300 feet of strata. No sample was obtained from the remaining 400 feet of the belt, but the stone in this part appears exactly similar to that sampled in other places. Sample 14B represents a 200-foot width of the dolomite where exposed on the road at the northern limit of Lorneville. The general strike of the belt in this area is N. 50° E. and the dip is southwesterly at from 30 to 60 degrees, with the steeper dip predominant. The country rises gradually from the water's edge; it is partly cultivated and partly forested. Overburden does not appear to be very thick over large areas of the dolomite.

On the east shore of Musquash Harbour what is apparently the continuation of this belt is composed principally of high-calcium limestone

with only minor areas of dolomite. The limestone is exposed in a nearly vertical cliff along the shore and it was not possible to examine it thoroughly. Most of it is grey, faintly banded with blue, and all is fine-grained. A grab sample (No. 15) only was obtained but it is representative of much of the deposit. The strike and dip closely correspond with those at Lorneville.

The apparent westerly continuation of this belt of limestone is to be seen on the opposite shore of Musquash Harbour and from there it extends southwesterly across a point of land into the sea. Easterly the belt seems to terminate in Manawoganish Cove.

Ketepec Station to South Bay Station

West of the South Bay of St. John River, the belt of limestone and associated rocks is well exposed along the Canadian Pacific railway between Ketepec and South Bay stations, and also along the highway paralleling the railway a short distance to the east. The belt has a width of nearly 2 miles; its general trend is N. 60° E. and the dip is generally to the south at a very steep angle. Geological maps[1] show it to become gradually narrower and to terminate 4 miles to the westward. It is composed of roughly parallel bands of dolomite and calcium limestone of irregular thickness, together with mashed beds of dark quartzite and dykes and sills of trap rock. The trap dykes and sills are so numerous and form such a complicated pattern through the limestone that they would greatly add to the difficulties of quarrying. In the neighbourhood of many of the trap intrusions there is a development of pyrite in the limestone and also, in areas where the trap rock is particularly abundant, some of the calcium limestone has been dolomitized.

The first outcrops of limestone on the north edge of the belt are seen in and near a railway cutting south of a small brook that crosses the track about ½ mile south of Ketepec station. Impure calcium limestone, quartzite, and trap rock in the form of sills and dykes is exposed for 275 feet along the railway. Next to this is a 70-foot band of blue-and-white striped, fine-grained calcium limestone practically free from trap rock, and adjoining it to the south is an equally wide belt of brown weathering, fine-grained, blue-grey and white dolomite followed by impure, dark blue, slaty dolomite. The outcrops of the blue-grey dolomite have deeply scarred surfaces caused by the more rapid weathering of a network of very thin veins of white calcite that occur all through the deposit. These veins, though very thin, are sufficiently numerous to raise the calcium carbonate content of the stone to such an extent that, on the basis of a chemical analysis of a general sample, the deposit could be classed as a magnesian limestone rather than a dolomite. The general strike of these two adjacent bands of limestone is N. 60° E. and the dip is south at a very steep angle. Both are visible on the roadside a short distance to the east, but here the calcium limestone is exposed only as a narrow strip of impure stone much intersected by igneous dykes, whereas the purer dolomite has a width, across the outcrop, of 80 feet. On the bank of the river, about ¼ mile from the railway, the dolomite was at one time quarried and burned in

[1] Geol. Surv., Canada, Map No. 318; Province of New Brunswick Map No. 1 S.E.

several large field kilns, now in ruins. Sample 16 represents the best of the calcium limestone exposed in the railway cutting, and Sample 16A represents the best grade of dolomite outcropping along the highway.

In the railway cutting, $\frac{1}{4}$ mile north of Acamac station, only very impure calcium limestone is seen. The limestone has many laminæ of slate through it and these, standing out in tiny ridges on the weathered outcrops, serve well to show the contorted nature of the beds.

Midway between Acamac and South Bay stations are large exposures of fine-grained, hard, light blue dolomite containing slaty laminæ and also nodules and thin lenses of blue chert. Dykes of trap rock are numerous all through the outcrop. The band extends eastward to beyond the highway and in this direction neither trap dykes nor chert nodules are so numerous. Sample 17 represents a 120-foot width of the dolomite along the roadside.

No outcrops of limestone were observed adjacent to railway or highway in the low land between the last-mentioned outcrop and South Bay village.

At South Bay village light blue, fine-grained dolomite, containing occasional calcareous streaks and also a few nodules and platy masses of chert, is exposed along the highway for a distance of 100 feet. It appears to strike N. 60° E. and dips nearly vertically. The stone is much fractured and breaks readily into small angular fragments but it is comparatively free from dykes of trap rock. The weathered surface is light brown and very rough. Sample 18 was obtained from this belt and, as shown in the table of chemical analyses on page 173, this dolomite is the purest obtainable in the district, but owing to the wide variation in both kind and purity of the limestone exposed in the vicinity it cannot be assumed that there is a large tonnage of dolomite of this quality available.

In the railway cutting a short distance west of where Sample 18 was obtained, very little dolomite is visible and the entire exposure is of blue-and-white striped and nearly white, calcium limestone of fine to medium grain, but, at the best, quite impure, as the analysis of Sample 18A, taken here, indicates. Dykes of trap rock and beds of mashed quartzite are very numerous, and adjacent to some of the igneous dykes the limestone contains much pyrite. The ruins of several lime kilns are to be seen on the shore of the St. John River at this place, indicating that this limestone was at one time burned for lime.

The limestone at South Bay station forms the southern edge of the main belt.

Topography throughout most of the area between Ketepec and South Bay is favourable for quarry operations and the overburden of soil is light. However, in this area the limestone is so variable in both kind and quality and so interrupted by dykes of trap rock and by beds of quartzite that the quarrying on a large scale of limestone of uniform quality would be very difficult. Eastward on Green Head and east of the St. John River the limestone of this belt is of much better quality.

Green Head Island

Precambrian limestones forming part of the main belt extending from west of the St. John River to beyond Torryburn are well exposed on Green Head Island—a wooded, rocky island ¾ mile wide (east and west) and 1 mile long, which separates the main channel of St. John River from the quiet waters of South Bay. The greater part of the island rises over 150 feet above the river. It is separated from the mainland on the south side by a narrow strip of shallow water and marshy land across which a causeway has been built. The road forks at the village of Randolph at the southern end of the island and a branch extends up either side on the high land. Along these roads a number of quarries have been opened, principally by Messrs. Randolph and Baker, Ltd., who manufacture lime at Randolph village and who also ship crude limestone for the manufacture of sulphite pulp.

The limestones, comprising calcium, magnesian and dolomitic varieties, form two steeply dipping, well-defined belts that cross the island in a northeast-southwest direction. The prevailing dip is steep to the southeast, and in places it is vertical. One belt, consisting mainly of calcium limestone, crosses the northwest tip of the island, the other—the main belt, ½ mile wide—crosses the central part, and between the two is a belt of quartzite ⅓ mile in width. Minor beds of quartzite also occur within the limestone belts. The northern half of the main belt consists largely, though not entirely, of dolomite and the southern half consists largely of calcium limestone with lesser quantities of magnesian limestone. There is a wide range in the purity of each type of stone, due principally to the presence of slaty films which occur parallel to the stratification throughout much of the limestone. In each belt, however, are bands, or long lenses, of relatively pure limestone free from slaty films and it is in these that the quarries have been opened. Intruding both limestone and quartzite alike are dykes and sills of trap rock from a few inches to many feet in thickness, but they are not so numerous as in the district between Ketepec and South Bay and they do not greatly interfere with the quarrying of the limestone.

Quarries of Randolph and Baker, Ltd. This company has opened a number of quarries in the main limestone belt, the more important being the "Blue" quarry on the west side of the island, from which calcium limestone and magnesian limestone are obtained, and the "White" quarry on the east side from which dolomite is obtained. The "Blue" quarry is the only one being worked at the present time.

Just north of where the road divides at the village of Randolph a quarry, now abandoned and nearly worked out, was opened in a lens, about 80 feet wide, of striped blue-and-white calcium limestone that strikes N. 45° E. and dips southeasterly at 75 degrees. An analysis of the stone from this quarry made by Professor Cameron of the University of New Brunswick is as follows:—

Insoluble	2·3
Iron oxides and alumina	0·7
Calcium carbonate	89·8
Magnesium carbonate	6·3
	99·1

A. Precambrian calcium limestone in "Blue" quarry of Randolph and Baker, Ltd., Randolph, Green Head Island, St. John County, N.B.

B. Precambrian dolomite in "White" quarry of Randolph and Baker, Ltd., Randolph, Green Head Island, St. John County, N.B.

This quarry is near the southeastern edge of the main limestone belt; south of it is mainly igneous rock with a few narrow bands of calcium limestone, dolomite, and quartzite.

The "Blue" quarry is located along the road that extends up the west side of the island, at a point ¼ mile northwest of Randolph village. It is of the sidehill type and has been extended for 150 feet in a northeasterly direction along the strike of the limestone (N. 50° E.) and has an average width of 60 feet. The face varies from 14 to 20 feet in height exclusive of 1 to 2 feet of soil. The strata dip southeasterly at 80 degrees. Beginning at the southeast wall of the quarry, which is composed of impure, light grey, fine-grained limestone streaked with slaty films, the following types of limestone are exposed—

16 feet of dark blue, fine-grained calcium limestone veined both parallel to and across the stratification with stringers of white calcite. Sample 19 represents this band.

20 feet of alternate lenticular bands of calcium limestone, magnesian limestone and dolomite, all light-coloured and ranging from fine to medium in grain size. The dolomitic zones vary from 2 inches to 4 feet in thickness and are distinguishable by their nearly white colour as contrasted with the bluish tints of the calcium limestone. Sample 19A was taken across the entire width of this zone.

40 feet of light blue and grey, fine-grained calcium limestone striped parallel to the stratification with fine lines of dark blue. Sample 19B represents this stone.

The only trap rock seen in the excavation is in the northwest wall, half way in from the entrance, where there is a mass 20 feet wide at the top of the wall but which pinches out entirely at the bottom and is not visible on the opposite wall of the quarry.

Quarrying is done by means of jackhammers and dynamite, and the products—stone for lime manufacture and for use in the manufacture of sulphite pulp—are transported from the quarry in motor trucks.

To the northeast, in line with the strike of the limestone, the land is fairly level to the opposite side of the island and it is possible that strata of the same character as those being quarried extend continuously across the island, because in a small quarry on the opposite side the same succession of strata is exposed.

The "White" quarry (Plate XXII B, page 152, Plate XXIII A, page 155) is in the high land on the east side of the island about ½ mile north of the fork in the road at Randolph. It has been opened lengthwise of a ridge near the southeastern edge of the broad belt of dolomite that extends across the island. The land is comparatively level inland in the direction in which the quarry will be extended, but it drops away to the south and to the east. The quarry takes the form of a trench-like excavation nearly 900 feet long, 20 to 45 feet wide, and with walls varying from 20 to 50 feet in height. The stone in the quarry faces is a creamy white, pure, fine-grained dolomite that occurs in a zone averaging 40 feet in width in a belt of less pure dolomite that contains slaty laminæ and nodules of bluish chert. The strike of the pure dolomite varies locally to a considerable extent but it averages N. 55° E. and the dip is nearly vertical. Extending lengthwise of the quarry is a faulted dyke of trap rock 10 to 12 feet in width,

as illustrated in Figure 12, which shows the plan of the excavation. The only visible impurities are occasional crystals of pyrite, which are most prevalent in the immediate vicinity of the trap rock. Two samples were obtained—No. 20 across the 30-foot wide face at the southwest end of the quarry, and No. 20A across the floor of the quarry 160 feet northeast of that point and representing a width of 40 feet of stone.

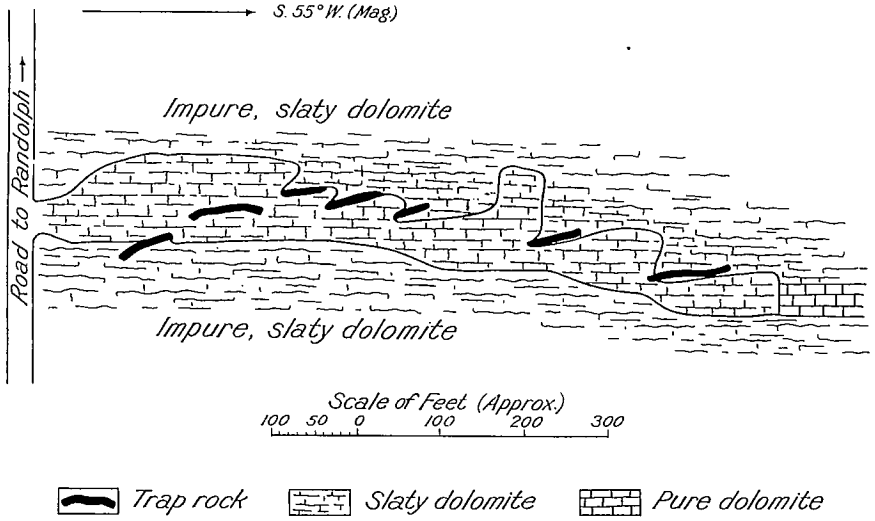


Figure 12. Plan of "White" quarry of Randolph and Baker, Ltd., Randolph, Green Head Island, St. John County, N.B., showing faulted dyke of trap rock.

One hundred feet south of the "White" quarry is the small quarry previously referred to as being in the same type of strata as are being quarried in the "Blue" quarry.

The belt of dolomite in which the "White" quarry is located has a width of about $\frac{1}{4}$ mile on the east side of Green Head Island but this width also includes minor bands of quartzite and calcium limestone. Where the dolomite belt outcrops along the road on the west side of the island, a small quarry (Quarry A) has been opened in it about 350 feet north of the "Blue" quarry. Though the quality of the dolomite is good, as shown by analysis 19C, which is representative of 60 feet of strata, the stone is badly fractured and such a high percentage of spalls was obtained that the quarry was abandoned. Another small opening (Quarry B) was made a short distance northeast of Quarry A, but the dolomite here also is badly fractured and in addition contains about 3 per cent total impurities.

The lime plant operated by Randolph and Baker, Ltd. is at the village of Randolph on the shore of St. John River. It consists of two vertical kilns constructed of stone and lined with firebrick. Only one kiln with a capacity of 10 tons of lime per day is in present use. The distance by road to the Canadian Pacific railway at Fairville is $1\frac{1}{2}$ miles, and it is $3\frac{3}{4}$ miles to the Canadian National railway at Saint John.

PLATE XXIII

A. "White" quarry of Randolph and Baker, Ltd., Green Head Island, St. John County, N.B. The vertical band of dark rock in the centre of the illustration is a dyke of trap rock.

B. Green Head quarry and old lime kilns, Green Head Island, St. John County, N.B.

Green Head Quarry. On the shore of a cove at the northwest end of Green Head Island are the now abandoned workings known as the Green Head quarry. The quarry is large and of irregular shape and has been worked back from the shore into the hillside, which rises steeply to a height of more than 100 feet above the water. On the shore of the cove are several lime kilns, two of which are still in a fair state of preservation. (Plate XXIII B, page 155.) When the quarry and lime plant were in operation the products were shipped by water. The stone in the quarry floor and faces is a rather soft, fine- to medium-grained, grey-blue high-calcium limestone. On close inspection much of it is seen to be composed of alternate layers, $\frac{1}{32}$ to $\frac{1}{8}$ inch thick, of white and of dark blue limestone, the colour of the blue streaks being due to minute flakes of graphite. Despite the marked banding, parallel to which cleavage is developed, the stone is quite massive and has no undue tendency to break into small fragments. The strike of the strata varies from N. 30° E. to N. 85° E. and the dip is vertical. A number of thin dykes of trap rock cut through the limestone, particularly in the east end of the quarry, and for an inch or two on either side of the narrowest of these dykes the limestone has been altered to a nearly white colour, and also in the immediate vicinity of these dykes there is a small development of pyrite. Otherwise the limestone is free from visible impurities. Two samples were obtained—No. 21 across 50 feet of strata adjacent to the shore in the northeast end of the quarry and No. 21A across 75 feet of strata farther inland at the same end of the quarry. The analyses of these samples show that the limestone is of very uniform quality.

A short distance beyond either end of the quarry the limestone is cut off by large masses of trap rock and quartzite but to the west a very similar limestone forms the promontory of Green Head and extends inshore for at least 400 feet and possibly much farther.

East Shore of St. John River

Limestone is well exposed in the cliffs along the east shore of St. John River between Indiantown and Pokiok and also at the narrows just below the Reversing Falls. The latter exposures are part of a narrow belt of Precambrian limestone south of, but parallel to, the main belt which passes north of the city of Saint John. The only sample (No. 22) of the limestone in the southern belt was obtained across 40 feet of strata in the cutting for the Canadian Pacific railway a short distance east of the railway bridge over St. John River, where an impure, very fine-grained, dark blue, slaty calcium limestone is exposed. Some of the stone is streaked with white. On the north side of the belt are many dykes of trap rock, and the stone in that part is even more impure than that which was sampled. The same band extends eastward into the city but seems to become more impure and also more magnesian in that direction.

From Indiantown to Pokiok the Precambrian limestones of the main belt are well exposed for a distance of 700 yards, both on the river bank and along the road that follows the river. The first limestone seen along the road is a little over $\frac{1}{4}$ mile northwest of the creek that empties into

the St. John River at Indiantown where, in contact with the granitic rocks to the south, there is a 30-foot band of impure, blue calcium limestone striking N. 60° E. and dipping northwesterly at an angle of 80 degrees. It is adjoined on the north side by a band of white and light blue dolomite about 400 feet wide, which trends in the same general direction as the calcium limestone, and which is apparently quite pure but it contains a few veins of white calcite. A quarry was at one time started in this dolomite belt between the road and the shore. From here to a short distance beyond where it turns sharply to the north opposite Robertson Point, the road passes over alternate parallel bands of blue calcium limestone and white and light blue dolomite. Just at the turn in the road, opposite Robertson Point, is a vertically dipping band of dolomite, 600 feet thick, much of which is of a high degree of purity, as shown by the analysis of Sample 23 taken across 100 feet of strata just north of the bend in the road. The stone is fine- to medium-grained and nearly white in colour with, in places, faint tints of blue, yellow, purple, and rose. The weathered surfaces are all very dark grey and deeply scarred. In common with all the dolomites of this area it is quite brittle and tends to break into rather small angular fragments. A few dykes of trap rock intersect the deposit and some stringers of white quartz were observed in places, but not in the zone that was sampled.

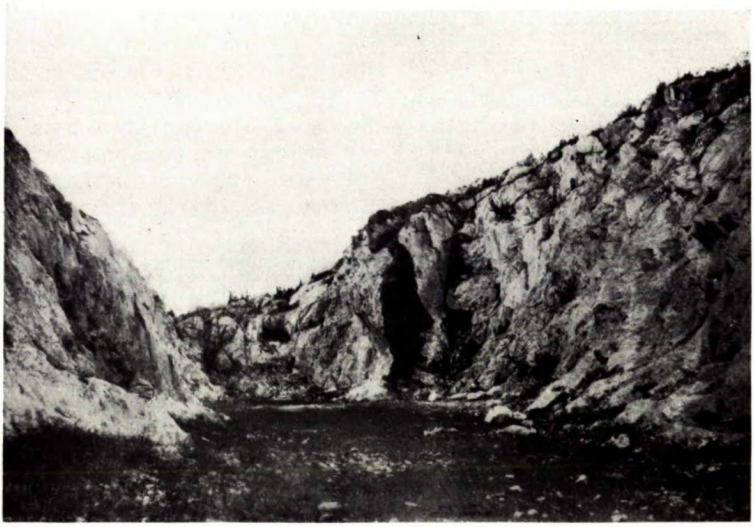
Miller Quarry. Close to the shore of the St. John River at Robertson Point, a large quarry not now being worked, known as the Miller quarry, is located in a wide band of calcium limestone that occurs immediately south of the white dolomite just described. The quarry was worked for about 35 years but operations ceased in 1919. All the stone visible in the quarry is light blue in colour and fine- to medium-grained, but there is a considerable variation in quality and also in the strike of the strata, though the dip is almost everywhere vertical. Much of the limestone contains slaty films and is otherwise impure but through it are lenticular zones of pure high-calcium limestone. In the neighbourhood of trap intrusions the limestone is quite ferruginous. The pure stone has been quarried and the impure stone has been left standing, in projecting masses, resulting in a very irregularly shaped excavation, the walls of which vary from 25 to 50 feet in height, depending on the surface topography. A lime kiln located on the shore was operated in conjunction with the quarry and all products were shipped by water.

Northwards for over ½ mile from the deposit where Sample 23 was obtained, most of the rock exposures along the shore road are of quartzite with only minor bands of calcium limestone and dolomite. Opposite the north end of Green Head Island, however, is a wide belt of blue, calcium limestone in which the Glen Cove quarries were at one time worked.

Glen Cove Quarries. These are two in number and each has been worked back from the shore of the St. John River into the cliffs of blue, calcium limestone that rise abruptly to a height of well over 100 feet. In the south quarry the limestone is fine-grained, very dark blue, and contains some tiny crystals of pyrite, particularly in the neighbourhood of the dykes of trap rock. The stone in the north quarry is coarser grained and lighter in colour, being largely composed of parallel laminæ of nearly

PLATE XXIV

A. Face of Precambrian limestone, 100 feet in height, Green Head quarry, Green Head Island, St. John County, N.B.



B. "White" quarry of Snowflake Lime, Ltd., at Indiantown, Saint John, N.B.

white and of light blue limestone, in places it also contains transverse veins of white calcite. The average strike of the strata in both quarries is N. 45° E. and the dip is 80 degrees to the southeast. Sample No. 24 was obtained across 50 feet of strata in the north quarry. Neither quarry has been worked for many years.

A short distance north of the Glen Cove quarries the Precambrian rocks are overlain by rocks of Carboniferous age and are not seen again between there and Ragged Point, 1¼ miles to the north, where an impure calcium limestone much intruded by trap rock, is exposed.

Indiantown

Precambrian limestones forming part of the broad belt of metamorphosed sediments extending from west of South Bay to northeast of Torryburn, are well exposed in the hilly country north of Indiantown across a strip of country 1,200 yards wide. The full width of the belt is not visible, as to the north it is overlain by Carboniferous strata. In the vicinity of the road to Milledgeville the belt is composed largely of dolomite, but ¼ mile northeast of this road, calcium limestone predominates. Three quarries are being worked in this area—two by Snowflake Lime, Ltd., and one by Purdy and Green, Ltd.

Quarries of Snowflake Lime, Ltd., Saint John. Snowflake Lime, Ltd. operates two quarries and a lime plant and produces both high-calcium and dolomitic quicklimes and hydrated limes, and also agricultural limestone. The lime plant is situated on the shore of the St. John River at Indiantown, just north of the creek; the "White" quarry is in a dolomite deposit ½ mile northeast of the lime plant; and the "Blue" quarry is in a deposit of high-calcium limestone 1 mile northeast of the "White" quarry.

The "White" quarry has a length of 300 feet parallel to the stratification, is from 60 to 80 feet wide and has been worked to a maximum depth of 40 feet. It is located in a wide band of dolomite that strikes N. 45° E. along the southeast slope of a ridge and dips northwest at angles varying from 65 degrees to nearly vertical. Within the limits of the quarry the dolomite is bluish white and yellowish white in colour and is medium- to fine-grained. The only visible impurities are occasional tiny blebs of serpentine. Sample 25 was taken across the 70 feet of strata in the working-face, and No. 25A and No. 25B from the white and the bluish white stone respectively. The high totals obtained when the calcium and magnesium are reported as carbonates, indicate that small percentages of calcium and magnesium exist in some form other than carbonate. Only two dykes of trap rock are encountered in the quarry. These are nearly vertical and of irregular thickness, being 2 feet thick in places and 10 feet in others. One of them is to be seen in Plate XXIV B, page 158. On either side of the quarried zone, particularly on the northwest side, the dolomite is darker blue in colour and contains films and narrow veins of white calcite and also more than 3·5 per cent of silica. Weathered outcrops both of the pure and impure varieties are dark in colour and deeply scarred.

Quarries of Snowflake Lime, Ltd. and Purdy and Green, Ltd., in Precambrian limestone, Indiantown, Saint John, N.B.

Quarrying is done with jackhammers and dynamite. Owing to the brittle nature of the dolomite and to its fractured state, a considerable proportion of spalls is obtained, these are pulverized and sold for agricultural use, but the major part of the stone quarried is utilized in the lime plant, to which it is transported by motor truck.

The main dolomite band, consisting mostly of blue limestone, extends in varying width for some distance southwest and northeast of the quarry. Toward the northeast it can be traced for more than ½ mile to where it suddenly terminates in the side of a narrow, swampy valley on the opposite side of which is calcium limestone having approximately the same strike as the dolomite. It is probable that the valley marks a fault plane.

The "Blue" quarry (Plate XXV) is in a deposit of high-calcium limestone nearly 1 mile northeast of the "White" quarry. It is opened in the southeast face of a high hill and has a length of 450 feet parallel to the strike of the strata, i.e. N. 70° E., has a width of 225 feet, and the walls are from 50 to 120 feet in height, depending on the topography. The entrance to the quarry is a narrow cutting driven northwesterly from the road, and this also provides a drainage channel for surface water. The stone quarried is a blue-and-white striped, medium-grained, high-calcium limestone in which the only visible impurities are a few grains of pyrite. It occurs in heavy, fractured beds dipping to the southeast at angles of from 30 to 60 degrees, but the fracture planes are not so closely spaced as to cause undue waste in quarrying. Sample 28 is representative of the stone being quarried. The sloping wall of the quarry opposite the entrance, i.e. the northwest wall, coincides with the northwest edge of the pure limestone and beyond it the limestone becomes increasingly impure, due to the presence of numerous slaty films parallel to the stratification. The southwest end of the quarry adjoins that of Purdy and Green, Ltd., only a narrow wall of limestone separating the two. The northeast face of the quarry is in pure limestone and the quarry can be extended for some distance in that direction in limestone of good quality. At present, however, the quarry is being deepened, and conditions are such that the floor can be lowered at least 25 feet without losing the advantage of natural drainage.

Jackhammers and dynamite are used in quarrying and motor trucks are used to transport the stone to the lime plant, 1½ miles distant.

The lime plant consists of four vertical kilns, constructed of stone, and one Schulthess, continuous hydrator. Each kiln has a capacity of 11 tons of lime per 24 hours, and wood is used for fuel. The hydrator has a capacity of 4,000 to 4,500 pounds of hydrated lime per hour. Many years ago all shipments of lime were made by vessel direct from the plant, but at the present time shipments are made mostly by rail, motor trucks being used to carry the products to the railway—the nearest loading point on the Canadian Pacific railway being 1¼ miles from the plant, and that on the Canadian National railway 1½ miles.

Quarry of Purdy and Green, Ltd., Saint John. This quarry (Plate XXV, page 160, Plate XXVI A, page 162) worked for stone for the making of lime, adjoins the southwestern end of the "Blue" quarry of Snow-

A. Quarry of Purdy and Green, Ltd., in Precambrian limestone, Indiantown, Saint John, N.B.

B. Lime plant of Purdy and Green, Ltd., Indiantown, Saint John, N.B. The wood in the foreground is fuel for the kilns.

flake Lime, Ltd., just described, and the same type of blue-and-white striped, medium-grained high-calcium limestone is obtained in both quarries. In the Purdy and Green quarry the average strike of the beds is N. 30° E. and the dip is mostly to the southeast at an angle of 30 degrees. Due, however, to faulting and folding of the strata there are rather wide local variations. The property of the company lies at the western end of a high, wooded ridge composed mostly of high-calcium limestone and includes what was formerly the Morrow quarry at the extreme west tip of the ridge. Overburden is very light on the slopes of the ridge and quarries of the sidehill type have been extended in an irregular fashion over a large area. The quarry developed by Purdy and Green, Ltd., however, has been opened for 400 feet along the strike of the beds, or N. 30° E., and has a width of 200 feet across the strike. Along the hillside a face of 100 feet of limestone is exposed, but the quarry is being deepened in stages and the maximum height of face worked at any one time does not exceed 35 feet. The limestone on the hillside back of the quarry is less pure than that within the quarry limits, but much pure limestone is still obtainable by further deepening the quarry. Several dykes of trap rock cut across the strata, some nearly parallel to the bedding, others almost at right angles, and a few are vertical. They are not, however, sufficiently numerous to seriously interfere with quarry operations. The uniformity of composition of the limestone being quarried is shown by the analysis of Sample 29 which is practically a channel sample taken across the 250 feet of strata exposed in the excavation.

Steam drills are used in quarrying, and the quarried stone is loaded by hand onto horse-drawn dump carts for transportation to the kilns.

The kilns, two in number, are situated at the quarry. They are of the vertical type (Plate XXVI B, page 162) and are constructed of limestone blocks and lined with firebrick. The capacity of each, with wood used as fuel, is 10 tons of lime per 24 hours. The distance from the kilns to either the Canadian National or the Canadian Pacific railway at Saint John is approximately 2 miles.

The hydrate plant operated by Purdy and Green, Ltd. is situated at 323 Main Street in the city of Saint John and the hydrating unit is a Kuntz hydrator having a capacity of 2 tons per hour.

Other Deposits near Indiantown. The band of dolomite in which the "White" quarry of Snowflake Lime, Ltd. is situated (page 159) extends for over ½ mile northeasterly to the foot of the ridge of high-calcium limestone in which are the Purdy and Green quarry and the "Blue" quarry of Snowflake Lime, Ltd., and here it ends abruptly in a narrow, swampy valley across which only calcium and high-calcium limestone is exposed. The widest part of the band is where the road to Milledgeville crosses it and here it has an exposed width of 1,000 yards, the eastern half of which consists entirely of dolomite and the western half mostly of dolomite but includes also lenses and bands of calcium limestone up to 100 feet in width. In different places near this road the strike of the strata varies from N. 15° E. to N. 80° E., and the dip from vertical to 45 degrees. As may be expected, in view of the variable strike of the strata, the width of the band also varies greatly at different places. Most of the dolomite

is blue but some is white. All is much fractured, fine-grained, and has a rough, scarred weathered surface, and, in places, veinlets of white calcite are plentiful. In a few localities stringers of milky quartz occur in the dolomite. The following samples were obtained from the better grade stone. Sample 26 was taken in a small quarry opened in light blue dolomite on the northeast side of the Milledgeville road, just opposite where the road from Pokiok joins it. Sample 26A is a grab sample from blue dolomite on the southwest side of the Milledgeville road near the northwestern edge of the dolomite band. Sample 27 is from a small quarry across the swampy valley from the Purdy and Green quarry. The dolomite in this quarry is very light blue to white in colour and is in thin, broken beds the average strike of which is N. 5° E. and the dip is westerly at an angle of 55 degrees.

North of the Purdy and Green quarry and the Snowflake Lime "Blue" quarry, calcium limestone containing thin, wavy bands of slate is to be seen for 500 yards along the trail to Howe Lake. Adjoining this is a band of quartzite, 200 yards wide, and then another band of slaty, blue, calcium limestone, 200 yards wide, followed by more quartzite. On top of the ridge above the quarries the limestone beds strike N. 50° W. but a little farther on the prevailing strike of both limestone and quartzite is N. 60° E. A narrow zone of dolomite was observed at each contact between limestone and quartzite.

Sand Point Road

Where the road going north from Saint John to Sand Point on Kennebecasis Bay crosses the limestone belt, many good exposures of the Precambrian limestone are to be seen. Just east of the road and south of Mayflower Lake, or Dark Lake as it is often called, is a triangular area of greyish blue calcium limestone most of which is rather impure. On the road the limestone band is only 40 feet wide but it rapidly increases in width until just south of the lake it has a width of 500 yards or more. Sample 30 was taken from many outcrops.

About $\frac{3}{4}$ mile farther north along the road, just south of where the road branches off towards Starrs Island, is a narrow band of dolomite and also a band of calcium limestone. Along the Starrs Island road a very siliceous, blue dolomite, in which all fractures and joints have been filled with milky quartz, is exposed about 200 feet from where this road leaves the Sand Point road. Three-quarters of a mile farther northwest, just at the brow of the hill above Kennebecasis Bay, a band of white dolomite and a band of grey high-calcium limestone are exposed. The two adjoin each other and the width of both is about 50 feet; the apparent strike is N. 50° E. On the hillside above the beach opposite Starrs Island a few ledges of slaty, impure, blue-and-white calcium limestone are exposed.

On the Sand Point road, $\frac{1}{4}$ mile north of the church at Sandy Point, calcium limestone is to be seen southeast of the road and on the opposite side is blue dolomite interbanded with calcium limestone. The limestone bands trend northeasterly, or nearly parallel to the road at this place, and the dip is steep. The calcium stone on the southeast side is

pure for a distance of 400 feet from the road, after which only impure slaty limestone was observed.

On the *property of Simon Crowley,* between Sand Point and Ashburn Lake, are many outcrops of calcium limestone and at least two of blue dolomite. The dolomite is seen on the road south of the house, and again on the brow of the hill above Kennebecasis Bay about ⅓ mile northeast of the house, but the amount available in each place seems limited. The calcium limestone occupies a large area between the dolomite and Ashburn Lake, ½ mile to the south. Most of the calcium limestone is fine- to medium-grained, blue and bluish white in colour, and some of it contains irregular films of slate. Two samples—No. 31 and No. 31A—were obtained from many outcrops between the house and the lake. They each represent the same types of stone but were taken on traverses 500 feet apart.

At *Ashburn Lake* calcium limestone is largely exposed on the hills to the north and east, but to the south, blue dolomite interbanded with calcium limestone is exposed nearly continuously for ¾ mile from the lake along the trail to Coldbrook station. Between the calcium limestone and the dolomite is a zone of slate and trap rock several hundred feet across. This is seen along the south and southeast shores of the lake.

Brookville

Quarry of Brookville Manufacturing Company, Ltd., Brookville. The Brookville Manufacturing Company is engaged in the production of agricultural limestone and operates the plant built in 1920 by the Government of New Brunswick to provide agricultural limestone to farmers in all parts of the province served by railway lines. The plant and adjacent quarry are situated on the east side of the Canadian National railway a short distance north of Brookville station. The quarry, formerly known as Lawlor's quarry, is of the sidehill type and is opened on the west side of a wooded ridge of calcium limestone about 80 feet high and on which overburden is very light. At this point the ridge trends north and south but most of the limestone strata composing it strike N. 50° E., though there are wide local variations, and the prevailing dip is to the southeast, or into the ridge, at an angle of 50 degrees. Quarrying operations are mostly confined to a band about 60 feet thick of soft, fine-grained, blue-and-white striped calcium limestone. This has been followed for 300 feet along the strike and a working-face having a maximum height of 75 feet has been developed (Plate XXVII A, page 166). Overlying the blue-and-white limestone is a band, or possibly a lens, of greenish grey, siliceous limestone about 15 feet thick that weathers to a rusty colour. It is exposed on the southeast wall of the quarry. Siliceous limestone also underlies the pure stone. A mashed dyke of trap rock, from which thin tongues project for 6 to 8 feet into the limestone on either side, extends along the northwestern wall of the quarry for a short distance near the entrance and then cuts across the stratification to the opposite wall. In the immediate vicinity of the trap rock considerable pyrite is noticeable in the limestone. Sample 32 was taken across the 60-foot thickness of blue-and-white striped limestone, and Sample 32A from

A. Quarry of Brookville Manufacturing Co., Ltd., Brookville, St. John County, N.B. Precambrian limestone.

B. Quarry of Provincial Lime Co., Ltd., Brookville, St. John County, N.B. Precambrian limestone.

the greenish grey, siliceous limestone exposed in the southeastern wall of the quarry. The band of limestone being quarried extends northeasterly beyond the present limits of the quarry for an unknown distance.

Jackhammers are used in quarrying. The broken stone is loaded by hand into small steel cars which are pushed by hand along a narrow-gauge track to the pulverizing plant, which consists of a 14- by 18-inch jaw crusher and a No. 1½ Sturtevant ring-roll mill together with the necessary screens. It is operated by electric energy and the output is 7 tons per hour of material pulverized to such fineness that all will pass a 10-mesh screen. Shipments are made by rail.

Saint John Lime Company, Brookville. The Saint John Lime Company, which is a company wholly owned by H. G. S. Adams of Brookville, commenced operations in 1933 and is manufacturing dolomitic and high-calcium quicklime and hydrated lime, pulverized magnesian limestone for agricultural use, poultry grit, and limestone gravel. The following information was supplied by Mr. Adams. The property, over 40 acres in extent, is ½ mile north of Brookville station and on the east side of the Canadian National railway. Both dolomite and high-calcium Precambrian limestone are available on the property in a ridge adjacent to the railway and rising to a height of about 90 feet above the track level. The dolomite is exposed on the side of the ridge nearest the railway and immediately beyond it is the high-calcium limestone. Two quarries each having a face of 30 feet, that will increase to 60 feet as the quarries are worked farther into the ridge, have been opened, one in the dolomite and the other in the high-calcium limestone, and the layout is such that stone can be trammed by gravity to the top of the kiln from either quarry.

The following analyses made by H. I. Knowles, Chemist, Atlantic Sugar Refineries, Ltd., Saint John, are from samples obtained at intervals of about 75 feet across that part of the deposit within 600 feet of the plant.

	1	2	3	4	5	6	7	8
Insoluble	1·27	0·3	3·2	1·3	1·44	1·97	1·51	0·93
Fe_2O_3 & Al_2O_3	2·02	0·2	0·5	0·3	0·68	0·33	0·51	0·33
CaO	30·15	30·5	29·4	30·6	30·46	54·28	53·25	54·62
MgO	19·17	21·8	21·0	21·1	20·87	0·87	0·83	0·62
Loss on ignition	46·72	not det.	not det.	not det.	not det.	42·65	42·93	43·31

The lime plant and the mill wherein the pulverized limestone is prepared are situated at the foot of the ridge alongside the railway track and are served by a siding. The lime plant consists of one vertical kiln having a capacity of 12 tons of lime per 24 hours, and a Kuntz hydrator having a capacity of 2 tons of hydrated lime per hour. A Jeffrey hammer-mill having a capacity of 4 tons per hour is used for pulverizing the limestone.

Drury Cove. Precambrian limestone is exposed along both shores of Drury Cove which is about ½ mile west of Brookville. Quarries were at one time worked on both shores of the cove to obtain stone for the making of lime, and several lime kilns are still standing at the head of the cove. The

principal quarry is in a wooded ridge of limestone on the northeast shore near the head of the cove. The ridge trends northerly from the shore but the strike of the limestone beds is extremely variable, though the dip is always at a steep angle. The quarry is opened at the base of the ridge along the shore of the cove and is 200 feet long parallel to the water, and has been worked 150 feet into the hillside. A face of 50 feet is developed but a face of 100 feet can be obtained above the water level by extending the quarry farther into the ridge. Most of the stone is medium to coarse in grain, and blue in colour, though in the northeast face of the quarry is a large, horizontal lenticular mass, 125 feet long by 35 feet thick, of nearly white calcium limestone in the centre of which is a small lens of blue calcium limestone. Visible impurities consist of a few crystals of pyrite, principally in the blue stone. The stone is indistinctly bedded as shown in Plate XXVIII A, page 169. A branching dyke of trap rock is visible in the eastern end of the face but otherwise the quarry is free from intrusive rock. Sample 33 was taken from the north face.

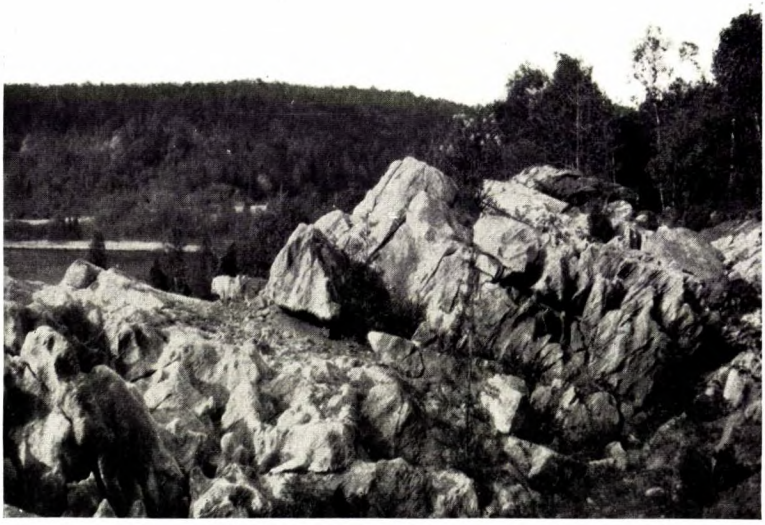
On the west shore exposures of rather slaty, blue calcium limestone are seen near the head of the cove, but a short distance to the north a band of blue dolomite striking northeast-southwest is exposed for 200 yards along the shore. This is succeeded farther north by calcium limestone of varied degrees of purity and which also contains dykes of trap rock and narrow lenses of dolomite. On the opposite shore the only dolomite observed in line with the strike of that on the southwest shore is a band 75 feet thick of light blue, pure dolomite striking N. 55° E.

Southeast of the cove, along the road to Brookville, calcium limestone, dolomite, and magnesian limestone—all rather impure—are exposed. Several dykes of trap rock are also seen in this area. Sample 34 was taken from an exposure of the magnesian limestone.

Quarry of Provincial Lime Company, Ltd., Saint John. The quarry and lime plant of this company, situated ¾ mile north of Brookville station, have not been operated since 1929. The quarry is in the northwest face of a wooded ridge of limestone bordering the Saint John-Sussex highway, and the lime plant is on the opposite side of the highway next to the Canadian National railway. At the point where it has been quarried the limestone ridge rises over 100 feet above the highway and trends northeasterly. Wide variations are noticeable in the strike and dip of the limestone beds but the prevailing strike is N. 75° E. and the dip is northeasterly or into the face of the ridge. The quarry has been opened from the side of the highway and at the same level (Plate XXVII B, page 166). It has been worked for 300 feet along the side of the ridge and into it for 150 feet. At the back of the quarry a face of 90 feet of limestone is exposed and this would be increased by another 20 feet or so if the quarry were worked back to the crest of the ridge. There is practically no overburden. Most of the stone visible in the quarry is blue, medium-grained, high-calcium limestone, but half way up the face is a band, 25 feet thick, of white, coarse-grained limestone that weathers to a brownish colour. Sample 35 was taken from the blue stone in the upper part of the face, No. 35A, from the 25-foot band of white limestone and No. 35B from the blue limestone at the base. Several thin dykes of trap rock occur in the northeastern end of the quarry but not elsewhere. The full extent of the deposit of high-

PLATE XXVIII

A. Drury Cove quarry, Drury Cove, St. John County, N.B., showing the irregular jointing characteristic of most of the Precambrian limestones of the district.



B. Weathered outcrop of steeply dipping beds of Precambrian limestone, Drury Cove, St. John County, N.B.

grade stone could not be determined on account of the covering of soil, but on top of the ridge several outcrops of impure calcium limestone and also of dolomite were observed.

The lime plant consists of two vertical, steel kilns each having a capacity of 10 tons of lime per 24 hours. When the plant was in operation stone was brought from the quarry in 1-ton, side-dump cars pulled by a gasoline locomotive. In addition to lime this company also produced crushed stone and agricultural limestone.

Midway between the quarries of the Provincial Lime Co. and the Brookville Manufacturing Co., east of the railway and just north of a small brook, interbedded dolomite, calcium limestone, and quartzite, striking N. 75° E. and dipping at an angle of 75 degrees to the southeast, are exposed in a ridge. One of the bands of blue calcium limestone, 50 feet thick, has been quarried in a long excavation 15 feet wide and 15 feet deep.

Torryburn

Quarry of Saint John Lime Company, Brookville. (See also page 167). Until 1933, when it was purchased by the present owners, this quarry was owned by C. H. Peters Sons, Ltd., who manufactured lime and agricultural limestone and also shipped crude limestone for use in the manufacture of sulphite pulp. At the present time this property is not being worked. The quarry is of the sidehill type and is opened in a ridge of calcium limestone on the southeast side of the Saint John-Sussex highway directly opposite the station of the Canadian National railway at Torryburn. Considerable crumpling and faulting has occurred in the limestone at this place but the prevailing strike of the beds is N. 70° E., corresponding to the trend of the ridge, and the prevailing dip is southeasterly into the hillside at an angle of 40 degrees. The quarry has been extended along the side of the ridge parallel to the strike for over 300 feet and into the side of the ridge for 100 feet throughout most of its length, and for 200 feet at the northeast end, at which place the quarry face is 75 feet in height. There is considerable variation in the appearance and quality of the stone exposed in the quarry. Some are white, some are blue, and some are white, streaked and stained with red. The grain varies from medium to coarse and some is obviously siliceous. Each type does not occur in regular bands but rather in lenses. The reddish stone yields a reddish lime and some of the dark blue stone yields a lime that has a tendency to crumble, and when the lime plant was in operation these types of stone were cobbed out from the kiln charge. Several thin dykes of trap rock cut through the limestone. Sample 36 is a general sample including all types of limestone in the quarry face exclusive of the trap rock. Sample 36A represents the light blue, medium- to coarse-grained stone in the lower 8 feet of the face.

The lime plant consists of one vertical kiln constructed of stone blocks and lined with firebrick. It has a capacity of 5 tons of lime per 24 hours.

On top of the ridge and about 500 feet back of the quarry are exposures of light blue, medium-grained dolomite and magnesian limestone, the latter being nearest to the quarry. Sample 36B was taken from several of the outcrops of dolomite.

PLATE XXIX

A. Outcrop of Precambrian limestone at Torryburn, St. John County, N.B., showing the sharp line of contact between dolomite (top) and high-calcium limestone, and illustrating the difference in appearance between the scarred, weathered surface of the dolomite and the smooth surface of the high-calcium limestone.

B. Irregularly bedded Carboniferous limestone with interbeds of shale, Oxbow, Victoria County, N.B.

74471—13

Beyond this again and to the south is an abandoned quarry 30 feet wide and 400 feet long opened in a narrow band of coarse-grained, blue-and-white striped limestone striking N. 80° E. and dipping southerly at an angle of 45 degrees. Sample 37 is representative of the stone quarried. The country in the vicinity is wooded and the soil is 4 to 8 feet in depth. The full thickness of the band is not exposed but apparently it does not much exceed the width of the quarry. On the north wall a very impure limestone containing thin beds of slate is visible. A dyke of trap rock forms part of the south wall, and several narrow tongues of trap are to be seen in places on the north side.

About ½ mile east of Torryburn station a band of dolomite 500 feet thick, containing lenses of high-calcium limestone and argillite and also a number of dykes of trap rock, is exposed at the south end of a high, wooded ridge trending northeasterly. The band extends to the northeast along the side of the ridge, but the following description refers only to the exposures adjacent to the farm road passing the south end of the ridge. At this place the southeastern slopes of the ridge are underlain by igneous rock and argillite, but the whole of the northwestern slope down to the cultivated field at the base is underlain by fine-grained, light blue dolomite and coarse-grained, white and blue-and-white striped, high-calcium limestone, the dolomite greatly predominating. The high-calcium limestone is mostly on the lower slope of the ridge and is in long narrow lenses the largest of which has a thickness of 100 feet. In one place a lens of argillite up to 40 feet thick occurs between the dolomite and high-calcium limestone. The strike of the limestone strata varies somewhat from place to place but, in general, it is parallel to the trend of the hill, or northeast-southwest, and the dip varies from 75 degrees to the southeast to vertical. In all places the line of contact between the high-calcium limestone and the dolomite is very sharp and distinct, as shown in Plate XXIX A, page 171, and, as is also shown in this illustration, the two types are easily distinguishable by their weathered surfaces—the weathered surface of the high-calcium limestone being smooth and light-coloured, whereas that of the dolomite is darker and is deeply scarred. Sample 38 was taken across 200 feet of dolomite outcrops and No. 38A across a width of 60 feet of the high-calcium limestone.

Analyses of St. John County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
14	1·80	0·58	0·16	0·02	55·95	40·99	99·50	nil	31·34	19·60	1·59 : 1
14A	1·98	0·52	0·22	0·09	55·18	42·32	100·31	nil	30·95	20·24	1·52 : 1
14B	1·80	0·53	0·13	0·04	56·39	40·99	99·88	nil	31·60	19·60	1·61 : 1
15	2·00	0·49	0·21	0·02	96·16	0·74	99·62	nil	53·86	0·35	154 : 1
16	1·38	0·45	0·51	0·04	92·77	5·04	100·19	nil	51·97	2·41	26 : 1
16A	4·30	0·52	0·56	0·09	57·59	37·19	100·25	nil	32·30	17·78	1·81 : 1
17	4·36	0·39	0·45	0·09	54·71	40·55	100·55	nil	30·68	19·39	1·58 : 1
18	1·30	0·28	0·38	0·07	59·16	39·75	100·94	nil	33·17	19·01	1·74 : 1
18A	11·20	0·66	1·96	0·20	79·32	4·85	98·19	0·11	44·53	2·32	19 : 1
19	2·07	0·30	0·32	0·07	92·21	3·96	98·93	0·04	51·68	1·89	27 : 1
19A	5·64	0·39	0·19	0·04	67·07	26·52	99·85	0·02	37·58	12·68	2·8 : 1
19B	3·00	0·40	0·62	0·09	87·16	8·29	99·56	0·09	48·85	3·95	12 : 1
19C	0·48	0·26	0·04	0·07	55·66	43·88	100·39	nil	31·21	20·98	1·48 : 1
20	0·42	0·24	0·12	0·04	55·45	44·79	101·26	nil	31·07	21·42	1·45 : 1
20A	0·42	0·43	0·21	0·20	56·31	42·45	100·02	tr.	31·64	20·30	1·55 : 1
21	2·28	0·43	0·33	0·13	95·83	0·86	99·86	0·03	53·74	0·41	131 : 1
21A	1·44	0·26	0·38	0·02	97·21	0·38	99·69	nil	54·45	0·18	303 : 1
22	4·50	0·73	1·03	0·07	89·19	4·85	100·37	0·04	49·99	2·32	22 : 1
23	0·52	0·44	tr	0·07	56·62	43·23	100·88	nil	31·75	20·67	1·53 : 1
24	1·48	0·34	0·66	0·04	95·38	2·18	100·08	nil	53·43	1·04	52 : 1
25	1·31	0·78	0·54	0·13	57·02	42·75	102·53	0·03	32·01	20·44	1·56 : 1
25A	1·30	0·73	0·51	0·17	55·90	43·76	102·37	0·03	31·40	20·93	1·56 : 1
25B	1·30	0·58	0·51	0·19	58·20	42·01	102·79	0·04	32·70	20·10	1·62 : 1
26	3·66	0·37	0·17	0·04	55·79	40·95	100·98	0·02	31·26	19·59	1·59 : 1
26A	1·94	0·36	0·30	0·11	55·94	41·49	100·14	nil	31·39	19·83	1·58 : 1
27	1·08	0·40	0·48	0·07	56·20	42·68	100·91	0·09	31·51	20·41	1·54 : 1
28	0·64	0·17	0·15	0·02	97·20	1·39	99·57	tr.	54·43	0·67	81 : 1
29	0·52	0·16	0·12	0·02	97·89	1·47	100·18	tr.	54·83	0·70	78 : 1
30	6·00	0·58	0·94	0·11	90·68	1·51	99·82	nil	50·84	0·72	71 : 1
31	4·88	0·57	0·85	0·11	90·36	3·28	100·05	0·01	50·66	1·56	32 : 1
31A	3·90	0·54	0·56	0·09	89·93	4·89	99·91	nil	50·41	2·34	22 : 1
32	2·98	0·48	0·48	0·15	93·92	2·16	100·17	0·11	52·68	1·03	51 : 1
32A	11·88	0·73	1·17	0·15	83·84	2·63	100·40	0·12	47·04	1·25	38 : 1
33	2·80	0·34	0·42	0·09	94·96	1·16	99·77	0·03	53·22	0·55	97 : 1
34	9·22	0·69	1·47	0·22	77·07	12·32	100·99	0·14	43·29	5·89	7 : 1
35	0·88	0·18	0·28	0·04	97·36	1·60	100·34	nil	54·56	0·76	72 : 1
35A	1·80	0·53	0·63	0·07	95·35	1·91	100·29	nil	53·43	0·91	59 : 1
35B	2·04	0·33	0·49	0·04	95·75	0·76	99·41	0·09	53·64	0·36	149 : 1
36	3·40	0·41	0·93	0·04	91·52	3·11	99·41	0·04	51·27	1·48	35 : 1
36A	1·06	0·17	0·37	0·04	94·89	3·68	100·21	0·03	53·16	1·75	30 : 1
36B	2·13	0·68	0·41	0·04	56·39	40·55	100·20	0·01	31·60	19·39	1·63 : 1
37	3·22	0·32	0·76	0·04	94·50	1·55	100·39	0·13	52·94	0·74	72 : 1
38	2·20	0·70	0·36	0·04	55·91	41·56	100·77	0·04	31·33	19·87	1·57 : 1
38A	2·32	0·22	0·36	0·04	96·14	0·62	99·70	tr.	53·86	0·30	180 : 1

14 Lorneville. Three hundred feet of dolomite forming the southeastern part of the wide belt exposed on the shore of Manawoganish Cove.

14A " Three hundred feet of dolomite from the centre of the above band.

14B " Two hundred feet of dolomite exposed at the northern outskirts of the village.

15 Musquash Harbour. East shore of the harbour.

16 Ketepec Station. Calcium limestone in railway cutting ½ mile south of the station.

16A " Dolomite containing veins of calcite where exposed along the highway a short distance east of the above.

17 Acamac. Dolomite exposed along the highway midway between Acamac and South Bay village.

18	South Bay.	Dolomite exposed along the highway in the village.
18A	"	Calcium limestone in railway cutting at western edge of the village.
19	Green Head Island.	Blue quarry of Randolph and Baker, Ltd.; 16 feet of dark blue calcium limestone on southeast side.
19A	"	Same quarry, 20 feet of interbedded calcium limestone, magnesian limestone, and dolomite near centre of quarry.
19B	"	Same quarry; 40 feet of light blue calcium limestone on northwest side.
19C	"	Dolomite in abandoned quarry 350 feet north of the Blue quarry.
20	"	Dolomite in face at southwest end of "White" quarry operated by Randolph and Baker, Ltd.
20A	"	Sample taken across the floor of the "White" quarry.
21	"	Green Head quarry. Sample from northeast wall near the water's edge.
21A	"	Green Head quarry. Sample from northeast wall near the back of the quarry.
22	Saint John.	Calcium limestone in railway cutting on east side of bridge over St. John River.
23	Indiantown.	Dolomite exposed along the road parallel to the St. John River, northwest of Indiantown.
24	Glen Cove.	Calcium limestone in the now abandoned quarry known as the Glen Cove quarry.
25	Indiantown.	General sample from the "White" quarry operated by Snowflake Lime, Ltd., including both white and bluish white dolomite.
25A	"	Separate sample of white dolomite from the "White" quarry operated by Snowflake Lime, Ltd.
25B	"	Separate sample of bluish white dolomite from the "White" quarry operated by Snowflake Lime, Ltd.
26	"	Dolomite in small abandoned quarry on northeast side of Milledgeville road, opposite the junction with the road from Pokiok.
26A	"	Grab sample of dolomite on southwest side of Milledgeville road a short distance north of where No. 26 was obtained.
27	"	Dolomite from small abandoned quarry on the opposite, or west, side of a narrow valley from the "Blue" quarry of Purdy and Green, Ltd.
28	"	"Blue" quarry of Snowflake Lime, Ltd. General sample.
29	"	Quarry of Purdy and Green, Ltd. General sample.
30	Sand Point Road.	Calcium limestone exposed south and west of Mayflower Lake.
31	Sand Point.	Calcium limestone on property of Simon Crowley.
31A	"	Sample from another place in the above deposit.
32	Brookville.	Blue-and-white striped limestone in quarry of Brookville Manufacturing Co.
32A	"	Greenish grey limestone in same quarry.
33	Drury Cove.	North face of abandoned quarry on east side of the cove.
34	"	Magnesian limestone a short distance southeast of the head of the cove, on the road to Brookville.
35	Brookville.	Provincial Lime Co. quarry. Blue limestone in upper part of the face.
35A	"	Provincial Lime Company quarry. White limestone in centre of face.
35B	"	Provincial Lime Company quarry. Blue limestone in lower part of face.
36	Torryburn.	Saint John Lime Company quarry. General sample from face.
36A	"	Saint John Lime Company quarry. Lower 8 feet of face.
36B	"	Dolomite on ridge 500 feet south of the quarry of Saint John Lime Company.
37	"	Sample from abandoned quarry south of the Saint John Lime Company quarry.
38	"	Sample across 200 feet of dolomite exposed in ridge ½ mile southeast of Torryburn station.
38A	"	High-calcium limestone from same locality as No. 38.

Sunbury County

No deposits of limestone are known in this county but as rocks of Lower Carboniferous (Mississippian) age, which usually contain deposits of limestone, occur in the southern part of the county it is possible that limestone may be found in quarriable locations within that area.

Victoria County

A number of outcrops of red, green, and mottled red and green, calcium limestone occur within an area of Carboniferous strata, 12 miles wide by 28 miles long, that centres on the village of Plaster Rock in the valley of Tobique River. None of the deposits are of a high degree of purity—the chief impurities being tiny sand grains and shaly material. The sand grains are present in most of the deposits, particularly in certain beds, and the shaly material occurs in irregular films through the strata and also as interbeds between the strata. Both impurities are more prevalent in the green limestone than in the red. At Oxbow a small quantity of agricultural limestone is produced for local demand. This is the only use being made of the limestone in this county.

Plaster Rock

At the northern limits of the town of Plaster Rock, in a field owned by Donald Fraser, exposures of fine-grained, hard, brittle, greenish grey and red-and-green mottled limestone occur as stepped, horizontal ledges in the side of a hill, throughout a vertical distance of 15 feet. The limestone, however, contains much fine sand and also clayey streaks. It is underlain by red shale and possibly shale occurs in the concealed intervals between the ledges. The analysis of Sample 4 shows the chemical composition of the outcrops.

Wapske

Very fine-grained, red calcium limestone in a deposit at least 25 feet thick occurs a few hundred feet north of the Canadian National railway, 2 miles east of the village, on land owned by John Day of Plaster Rock. The stone is in horizontal beds 4 to 8 feet in individual thickness, some of which have a rubbly appearance on the weathered surface owing to a network of greenish shale films, but others are free from shaly streaks. The country in the vicinity of the deposit is thickly wooded, but the actual depth of soil is not great. A quarry face could easily be developed as the deposit is exposed in a low cliff. Sample 5 was obtained from all exposed strata.

Oxbow

On the property of David Alton, red and green, dense-textured, brittle calcium limestone lightly covered by soil is quarried on a small scale by Charles Hayden for local agricultural use. The quarry is opened near the base of a gentle slope facing a small lake north of Tobique River and a 10-foot face has been developed. Most of the limestone exposed is red and has small crystals of colourless calcite in it, but at the base of the quarry

is a greenish, sandy limestone. Thin beds of calcareous red shale are present between many of the limestone beds, which are of variable thicknesses up to 1½ feet. All the stone is much cracked (Plate XXIX B, page 171), Sample 6 represents all strata in the quarry face except the shale and the green sandy limestone at the base. The pulverizing plant at this quarry consists of a 10-inch by 4-inch jaw crusher and a Jeffrey No. 1 Limepulver. The nearest railway station is at Plaster Rock, 10 miles to the south.

Analyses of Victoria County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
4.....	17·94	0·67	2·83	0·24	76·13	1·39	99·20	tr.	42·76	0·66	65 : 1
5.....	4·80	0·60	1·96	0·15	90·73	1·13	99·37	tr.	50·89	0·54	94 : 1
6.....	9·08	0·75	2·59	0·09	85·04	1·51	99·06	tr.	47·67	0·72	66 · 1

4. Plaster Rock. Outcrops on land owned by Donald Fraser.
5. Wapske. Twenty feet of red limestone on property of John Day.
6. Oxbow. Nine feet of red limestone in quarry on land owned by David Aiton.

Westmorland County

Rocks of Lower Carboniferous age, in which limestones commonly occur, are exposed north and west of Moncton and also on both sides of the Memramcook River southeast of Moncton, but within these areas only three limestone deposits, all of the calcium variety, were observed near railway lines. These were near the villages of Killam, Petitcodiac and Upper Dorchester. In the past they were all quarried on a small scale for stone for making lime but there is no production at the present time.

On page 383 of the Report of Progress for 1876-77 of the Geological Survey the following mention is made of limestone occurrences in the vicinity of Dorchester:—

On the eastern side of the Petitcodiac River, the only points at which we have observed any limestones are in the upper part of the Beliveau settlement, near the road leading thence to Dover, in Taylorville, and on the eastern side of the Memramcook road, about three miles above Dorchester. At each of these localities they occur in connection with the red, sandy, and shaly beds of Division 4, but while those of Beliveau are red and massive, and like the corresponding beds in Hillsboro, contain bands and nodules of chert and chalcedony, those near Dorchester are dark-grey, flaggy and bituminous. These latter are also peculiar in lying but a short distance to the southward of the Albert shales, and in having, like the latter, a nearly vertical attitude.

Killam

The large deposit of limestone capping Butternut Ridge, and already described in the Kings County section under the heading "Havelock" (page 140), extends into Westmorland County to within 1½ miles northwest of Killam station on the Havelock branch of the Canadian National railway, where it ends in an escarpment 20 feet in height. Sample 47B was

taken from 12 feet of limestone exposed at the top of this escarpment on the property of Benjamin Keith where formerly limestone was quarried on a very small scale for the making of lime.

Petitcodiac

Two and one-quarter miles west of Petitcodiac station on the Canadian National railway, a prominent ridge of Carboniferous limestone can be traced through wooded country for more than a mile southwesterly from the farm of J. A. Hughes. The limestone strikes S. 60° W., and dips at an angle of 65 degrees to the northwest. Two hundred feet to the southeast, across a swampy valley, is a ridge of gypsum. In places the southeast side of the limestone ridge rises steeply to a height of 50 feet above the valley but on the northwest side the slope is very gradual. Until recently a small quarry was worked on the Hughes property to obtain stone for making lime, and in this quarry the following section is exposed—

10 feet of nodular, red and blue-grey limestone containing crystals of white calcite and seams of red and blue shale.
18 feet of pure, brown-grey limestone.
10 feet of brownish grey limestone with sandy seams along the bedding planes.
8 feet of sandy, grey limestone underlain by coarse-grained sandstone.

All the limestone is brittle, dense-textured and thin-bedded. Sample 50 represents the 18-foot band of pure limestone. Sample 50A was taken from the same band of pure stone about 400 yards to the southwest, but here the band is only 15 feet thick.

Upper Dorchester

A deposit of fine-grained, grey, mostly impure, Carboniferous limestone occurs on the McEwan farm just east of the highway about 1 mile south of Upper Dorchester. The strike is N. 80° E. and the dip is southerly at an angle of 40 degrees. The limestone can be traced for 400 yards easterly from the road over rising ground to the McEwan farmhouse. Near the road a small quarry was at one time worked to supply a lime kiln. The limestone in the quarry is dark grey in colour, contains considerable iron pyrites and also has thick shale seams between the beds. A coarse-grained sandstone containing veins and nodular masses of barite overlies it. Midway between the quarry and the farmhouse the exposures consist of light grey limestone through which are many veins and small masses of barite. Analyses made at the Mines Branch of two channel samples taken at this place by Dr. W. J. Wright, Provincial Geologist, are as follows:—

—		1	2
Insoluble	Silica	2·12	2·00
	Alumina and oxides of iron	0·40	0·46
	Barium sulphate	29·56	22·78
	Undetermined	1·54	0·22
Soluble alumina and oxides of iron		0·36	0·48
Calcium carbonate		63·00	71·36
Magnesium carbonate		0·36	0·53
		97·34	97·83

No. 1 represents the northern half of the exposure and No. 2 the southern half.

In the easternmost exposures of all, near the farmhouse, the limestone is of better quality than elsewhere and is apparently free from barite. Sample 59 was taken from these outcrops.

Analyses of Westmorland County Limestones

Sample	SiO_2	Fe_2O_3	Al_2O_3	$Ca_3(PO_4)_2$	$CaCO_3$	$MgCO_3$	Total	S	CaO	MgO	Ratio of CaO to MgO
47B.....	1·62	0·18	0·14	0·02	97·91	0·25	100·12	tr.	54·20	0·43	126 : 1
50.....	1·20	0·36	0·36	tr.	96·51	0·90	99·33	tr.	54·04	0·43	126 : 1
50A.....	1·84	0·22	0·74	0·04	96·91	0·40	100·15	tr.	54·29	0·19	286 : 1
59.....	2·02	1·00	0·98	0·09	94·45	1·11	99·65	0·20	52·94	0·53	100 : 1

47B. Killam. Northeast end of ridge 1½ miles northwest of Killam station.
50. Petitcodiac. Quarry on land of J. A. Hughes, 2½ miles northwest of the village.
50A. " Four hundred yards southwest of No. 50 on the same deposit.
59. Upper Dorchester. Best grade of limestone on the McEwan farm, 1 mile north of the village.

York County

The following references are made in reports of the Geological Survey to limestone occurrences in this county.

Where exposed on the railway south of Canterbury station they (the limestones) are of considerable thickness and quite impure from admixture of sandy and micaceous material, but at a point about one and a half miles south of Dorrington Hill, they are much purer, and of sufficient extent to induce their removal for calcination. They may here be clearly seen to form a part of the micaceous series, alternating with dark grey micaceous sandstones—or with beds of true hornblende schist; all the strata being much disturbed and the dip irregular, though usually to the northwest 70-80°.[1] . . . . .

In the settlement west of Negro Brook they (the slates) include a workable bed of limestone, in character not unlike that of Dorrington Hill and Canterbury.[2]

Highly metamorphosed limestones of probable Silurian age are reported at Waterville[3] in the parish of Southampton. A small quarry in what is said to be pure high-calcium limestone was at one time worked in this vicinity which is 6 miles from Pinder Station on the Canadian Pacific railway.

1 Geol. Surv., Canada, Rept. of Progress, 1882-84, p. 14G.
2 Geol. Surv., Canada, Rept. of Progress, 1882-84, p. 19G.
3 Geol. Surv., Canada, Ann. Rept., vol. XII, p. 160A. (1899).

CHAPTER IV

THE LIMESTONES OF PRINCE EDWARD ISLAND

The surface rocks on Prince Edward Island are sandstones, shales, and conglomerates, and, aside from a few thin, irregular beds, no limestone is known to occur. However, off the northwest shore of the island, near Little Miminegash Pond, a bed of grey calcium limestone is visible at low tide on occasions when the overlying sand has been removed by storms. Dr. Ells[1] states it "has been locally quarried both for lime-burning and for building stone, the church at Tignish being built from this stone." More recently a small portable crusher was operated here for the production of small quantities of agricultural limestone, the stone used for this purpose being mostly limestone blocks that had been cast up on the beach. The size of the deposit could not be estimated but in any case its location is such that it cannot be profitably quarried.

[1] Geol. Surv., Canada, Ann. Rept., vol. XV, p. 374A (1902).

INDEX

Canada
Department of Mines

HON. W. A. GORDON, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH
JOHN McLEISH, Director
1934

MAP OF NOVA SCOTIA SHOWING LIMESTONE RESOURCES

Scale of Miles
10 5 0 10 20 30

LEGEND
- 64 Sample number
- Outcrop or inactive quarry
- Operating quarry
- Commercial lime plant
- Lime plant operated in connection with another industry
- Calcium and high calcium limestone
- Dolomite
- Magnesian limestone
- Windsor series
- George River series

Canada
Department of Mines

HON. W. A. GORDON, MINISTER. CHARLES CAMSELL, DEPUTY MINISTER.

MINES BRANCH
JOHN McLEISH, Director
1934

MAP OF NEW BRUNSWICK SHOWING LIMESTONE RESOURCES

Scale of Miles
10 5 0 10 20 30

LEGEND

- 52 Sample number
- Outcrop or inactive quarry
- Operating quarry
- Commercial lime plant
- Lime plant operated in connection with another industry
- Calcium and high calcium limestone
- Dolomite
- Magnesian limestone
- Lower carboniferous formations
- Precambrian limestone series

ST JOHN AREA
~ Roads
Scale of Miles
0 1 2 3

741