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LABELLE-L'ANNONCIATION MAP-AREA

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PROVINCE OF QUEBEC, CANADA

BUREAU OF MINES

Honourable J. E. PERRAULT, Minister of Mines
J. L. BOULANGER, Deputy-Minister A. O. DUFRESNE, Director

ANNUAL REPORT

OF THE

QUEBEC BUREAU OF MINES

FOR THE CALENDAR YEAR

1934

JOHN A. DRESSER, Directing Geologist

PART E

Labelle-L'Annonciation Map-Area
by F. Fitz Osborne

QUEBEC
PRINTED BY R. PARADIS
PRINTER TO HIS MAJESTY THE KING

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TABLE OF CONTENTS

MAPS AND ILLUSTRATIONS

PLATES
(after page 50)

LABELLE-L'ANNONCIATION MAP-AREA

by F. Fitz Osborne

INTRODUCTION

Location of Area

The Labelle-L'Annonciation map-area is between latitudes 46° 15′ and 46° 31′ and longitudes 74° 35′ and 75° 00′, and has an area of about 383 square miles. Almost the whole of it is included within the northwest quarter of the Ste. Agathe sheet (31 J/7) of the Topographical Survey of Canada. The Mont Laurier line of the Canadian Pacific railway enters the area near the middle of its south boundary and leaves near the middle of the west side, at Belle Rive station. The river Rouge crosses the region from north to south but is too interrupted by rapids to afford an easy canoe route through the area.

Towns and Lakes

Labelle and L'Annonciation, 100 and 113 miles by railway from Montreal, are the two largest villages in the map-area, their population being respectively 685 and 658. Belle Rive, La Minerve, Sainte-Véronique, and La Macaza are other villages. The country lying west of a north and south line passing through Labelle is accessible by roads serving scattered farming communities as well as the towns and villages named. East of this line, roads and settlers are few, and much of the area is covered with hardwood forest. Part of this unsettled area lies within Montagne-Tremblante Park.

Lakes are numerous. The largest are Chaud lake, with an area of three square miles, Nominingue lake, and Montagne-Tremblante lake, but of these only the first-named lies entirely within the map-area. Nominingue lake derives its name from

the Iroquois for "place of red paint", deposits of ochre being found in the sand deposits nearby (1). Montagne-Tremblante lake borders the mountain, which was so named, by the Iroquois, on account of supposed earth tremors. Logan (2) believed the tremblings to be due to slippage in the rock, but Roy (3) has suggested that they are simply the rumblings of numerous streams that tumble down the mountain side into the lake at certain seasons.

Relief

The area is one of considerable relief. The elevations of the main rivers and the larger lakes are between 700 and 850 feet, but hills rise to considerable heights above the streams. One peak of Montagne Tremblante has an elevation of about 3,400 feet. This is the highest point in the Laurentian plateau in this district.

Acknowledgments

The writer is indebted to many residents of the district for helpful information. He is especially obligated to Messrs. F. H. Peters, Director, and A. M. Narraway, Chief Aerial Surveys Engineer, of the Topographical Survey of Canada, for the loan of a stereoscope and the aeroplane photographs from which the topographical base-map was prepared. These assisted very considerably in the geological work and made possible some investigations that could not have been undertaken without them. The structural lines shown on the special sheet accompanying this report were determined from the photographs.

Jean Morency gave efficient service as field assistant.

Previous Geological Work

The geological map accompanying this report was prepared on a base supplied by the Topographical Survey of Canada, with additions and corrections by the writer. The limits of formations

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(1) Roy, Pierre Georges, *Noms Géographiques de la Province de Québec;* Levis, 1906, p. 289.
(2) Logan, Wm., Geol. Surv. Can., Rept. of Progress, 1858, p. 34.
(3) *Op. cit.*, p. 277.

on the western side of the sheet are much more accurately shown than those on the east side. Some of the boundaries were inferred from the topography as seen on the aeroplane photographs.

The geology shown on the map is entirely the work of the writer. Logan (1), in 1858, traversed the river Rouge as far north as Labelle, then known as Iroquois Chute. Observations were later made along Chaud lake and the Cachée river. Unfortunately, a misconception of the nature of the rocks renders his work practically valueless insofar as the present map-area is concerned. F. D. Adams (2) made a study of the geology of an area abutting the present map-sheet on the east and was the first to show the true relationship of the Anorthosite (Morin) series to the other formations in the Laurentian.

Problems and Summary of Results

The Labelle-L'Annonciation map-area was chosen for geological examination for several reasons. It was believed to be a typical Laurentian area and to be without the extensive development of the Anorthosite series that complicates the geology of the country to the east. The area has supplied a variety of non-metallic minerals to the market and was known to have an extensive development of rocks of the Grenville series, which may contain non-metallic 'industrial' minerals not yet exploited, or deposits of metals, such as the zinc deposit that has been worked at the Tétreault mine near Notre-Dame-des-Anges-de-Montauban.

The projected provincial highway to Abitibi will be the continuation of the highway which crosses this area, and thus will pass from the Laurentian to the Temiscamian terrain. It is important to have an accurate knowledge of the Laurentian in order that the transition between these two geological provinces may be traced in the new area for prospecting that will be opened by the new road. The Laurentian province in Quebec has yielded relatively little gold, and part of the work of the season was directed toward finding some reason for this situation.

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(1) *Op. cit.*
(2) Adams, F. D., *The Geology of the Area lying North of the Island of Montreal;* Geol. Surv. Can., Ann. Rept., 1895, Pt. J.

Considerable time was spent in the study of the aeroplane photographs, especially in correlating the features seen in them with the topographical and structural features seen on the ground, with a view to making the photographs more useful in geological reconnaissance, particularly for delimiting areas favourable for prospecting.

Deposits of magnesian limestone, garnet, graphite, and ochre that had been worked were mapped in detail, and the mode of occurrence studied. In addition, some occurrences of other minerals, notably quartz, were found and studied, and the possibility of quarrying building and monument stone was examined. The areal geology was mapped, and the results so obtained are of value not only in the area under consideration but also in correlating the geology with that of other areas in the Laurentian.

It was found that the most important mineral deposits are in the rocks of the Grenville series. This accords with our knowledge of the series gained elsewhere and suggests that these rocks are of great potential value for mineral deposits. The areas of Grenville were accordingly examined with greater care than those occupied by igneous rocks. However, enough work was done to recognize the occurrence of five or more series of plutonic igneous rocks. A stock of quartz syenite and one of alkaline syenite deserve mention. The first because it is the plutonic representative of a rock-type found in Abitibi in close association with the gold deposits, and the other because it includes nepheline-bearing rocks, which lead one to look for possible corundum-rich varieties and pegmatite dykes rich in nepheline. The latter mineral is finding use in the chemical industries on account of its high content of alumina and soda. This is the first discovery of nepheline rocks in the main Laurentian area of Quebec, though similar rocks, with a high content of corundum, have long been known in the Haliburton-Bancroft district in Ontario, where for a number of years corundum mining was successfully carried on.

The trellis drainage-pattern of the smaller streams of the area is due to the control by foliation and joints, but the course of the Rouge river appears to be superimposed.

Ice Movement, Glacial Geology, and Weathering

The map-area was glaciated by ice that moved east of south. Even in the valleys, the striæ tend to be in this direction, indicating a considerable pressure of ice, probably due to its thickness. Despite fiord-like deepening of certain of the longitudinal valleys, such as shown in Plate I-A, some places appear to have escaped the scouring of the last ice sheet. This is true of part of the stock of quartz syenite south of Nomininguc lake. Exposures of syenite that is sufficiently decomposed by weathering to crumble in the fingers are found along the road one mile northeast of Petit Lac Nomininguc. The weathered rock is overlain by a thin mantle of glacial till, and the topography nearby suggests that part of the adjacent area also is underlain by similar material. The exposures are found on the floor of a basin that is surrounded by a rim of hills of rock not so susceptible to weathering, and it is probably the rim of hills that protected the weathered syenite from erosion by the ice.

Confirmation of the east-of-south direction of ice movement was obtained from a study of the distribution of the loose blocks in the drift, the axis of the fan of erratics having almost invariably this trend. It was the occurrence of boulders of a rare type of alkaline syenite (pulaskite) in such glacial drift that led to the discovery of a body of that rock five miles north of Nomininguc lake, beyond the limits of the present map-sheet. The method of boulder-prospecting has been used successfully in the heavily-glaciated Scandinavian countries to locate ore-bodies in territory covered with drift. On account of the possibility of utilizing this method in Canada, rather a detailed description is given here.

Boulders of pulaskite were first noticed near Nomininguc lake (see Figure 1). Examination of all the boulders in the vicinity of the railway track showed that boulders of pulaskite are both less numerous and smaller as one goes east and west of the bay at the southeast end of the lake; also that, at a distance of five miles to the south, there are but few and small boulders of the pulaskite, whereas five miles north of the railway they are in greater abundance and, moreover, are larger and more angular than those along the railway. Here, also, the boulders do not

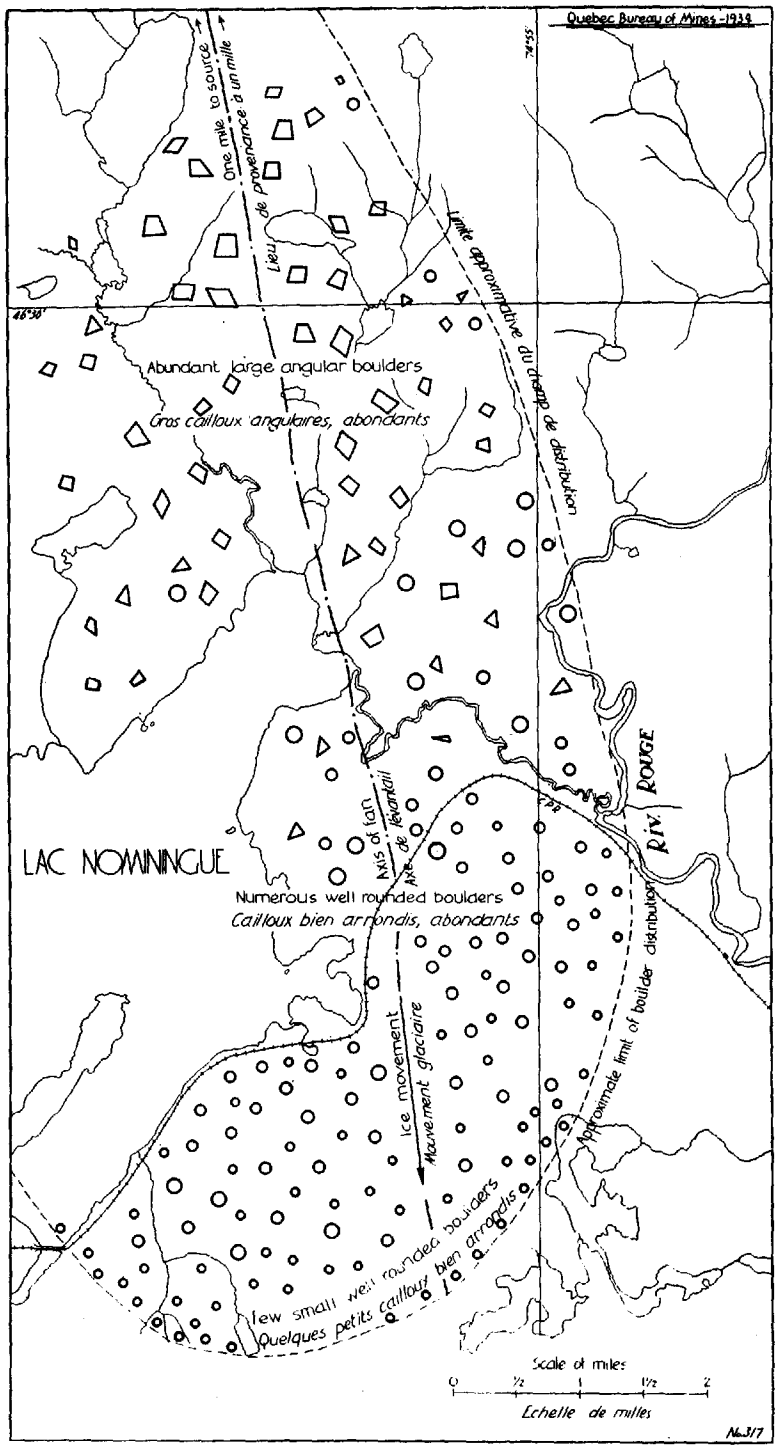

Figure 1.—Diagrammatic plan of distribution of pulaskite boulders by ice from source north of map.

extend so far to east and west as they do in the railway section. The direction of ice movement was obtained from ice scratches on bedrock (see Plate I-B). With these data, it was possible to outline a fan, with a median line indicating the largest boulders in each traverse. The median line coincides with the direction of the ice movement and was projected back on the map to the probable source of the boulders. This was put to the test in the field and outcrops of pulaskite were found north of Truite lake, within a short distance of the position indicated by boulder distribution.

Unsorted glacial débris, known as *till,* mantles the slopes of most of the hills and underlies some of the valleys. Sand and gravel are found along the flood-plains of the streams and such deposits are very extensive along the river Rouge north of L'Annonciation. Terraces also are found along some of the larger streams and near some lakes. The soil developed on the sand is considerably lighter than that on the till, although without the boulders. In places, the sand soil is so light that it will not stand continued cultivation or even pasturage. In almost all parts of the map-area, adequate sand and gravel for road-making is available. In many places, meandering ridges of sand and gravel, known as eskers, rise above the surrounding sand-plain. They contain well-sorted gravel, and along the summits of many of them roads have been built.

Course of the River Rouge

Inasmuch as the Rouge is one of the principal tributaries of the Ottawa and drains a considerable area, the origin of its valley-way is of particular interest. The structural sheet accompanying this report gives considerable data on the structures along the Rouge and enables one to say that it is a superimposed stream insofar as its channel in this area is concerned. The Rouge does not follow any direction of foliation or jointing in the bedrock. This is evidence that its course was determined on some formation not now represented in the area. Palæozoic sedimentary rocks probably covered the area at one time, and the course of the river may have been developed on them or on the sediments that accu-

mulated along a pre-existing river in the very old stage of its development. One topographical feature suggests superimposition by peneplanation as the origin of the course of the Rouge. This is the occurrence on the hills of flat-topped facets that extend outward toward the valley and stand a considerable height above the present level of the river. One such flat is shown on the panorama taken above Labelle (see Plate II). Such facets are found in several places along the Rouge, commonly on south-facing slopes, where they have been protected from glacial erosion. If this hypothesis is correct, the area on the east side of the map would be a monadnock which resisted erosion due to the superior durability of the abundant igneous rocks that underlie it.

Probably the pre-glacial drainage had a normal dendritic pattern, indicated now by the distribution of some of the valleys, but its course cannot be satisfactorily determined without an accurately-contoured map. It is certain that glaciation deepened the channels and modified the pattern greatly.

The edge of the sand-plains along the river is shown by a dashed line on the structural sheet. The irregularities of this boundary indicate the subordinate influence of local structures in determining the main direction of the valley. In general, the softer formations are embayed, but in most places in a direction inclined to the main channelway. The absence of prominent joints parallel to the river is noteworthy, for bedrock forms rapids in a number of places and any such joints would be clearly visible.

The valleys of other streams and lakes have been determined by joints. Examples of some of these will be cited in the section on structural geology.

BEDROCK GEOLOGY

Structural Geology

The Structural Map:

A clear notion of the structure of the Labelle-L'Annonciation map-area may be gained by superimposing the structural map (No. 316A), on transparent paper, on the geological map. The information plotted on the structural sheet was taken from

aeroplane photographs. Such features as the dip and strike of foliation, joints, and shear-zones, and the direction of ice movement, are indicated on the geological map. The aeroplane photographs, especially when examined under the stereoscope, show certain topographic features due to bedrock structures much more clearly than they can be determined on the ground. Straight, steep-walled valleys, prominent scarps, such as may be seen in Plates III-A and III-B, and other features due to bedrock, were outlined on the photographs, and their position and direction transferred to the structural map, on which they are indicated by heavy lines. The boundaries of prominent sand-plains are also outlined, because they help to show the limits of the valley.

LENTICULAR STRUCTURES:

If any generalization can be made concerning the structure of the area, it is that lenticular forms are prevalent. Most of the igneous formations outcrop as bands that taper at both ends, and many of the bodies of Grenville rocks have a similar habit. Presumably, the same lenticular character would be evident in the vertical section, if this were open to observation. The lenticle is the structural unit of the larger massifs and is repeated on a progressively smaller scale in all the rocks of the area. Inclusions of Grenville rocks in igneous rocks and of pods of granite gneiss in the Grenville all tend to be lenticular in plan. Also, crystals in the igneous rocks have been reduced to lenticles by shearing.

The lenticularity of the formations may be assumed to be due to the effects of stresses that acted in a constant direction from the time of the first folding of the Grenville until the intrusion of the Labelle series. The stresses acted in such a direction that formations, as well as the individual parts of them, were elongated (stretched) in a north and south direction. Most of the igneous rocks were stretched while they were still partly liquid. Only a few formations escaped the influence of this stress.

STRUCTURAL AND PHYSIOGRAPHIC DIVISIONS:

The map-area may be divided into two structural and physiographic divisions. The eastern tract, which lies east of a line

trending north and south and passing through Labelle and Chaud lake, has the higher hills of the region and is characterized by a rugged topography with elongated lakes occupying fiord-like trenches. The hill-slopes are mantled with till, with small areas of sand and gravel at lower levels. Igneous rocks that crop out as bands narrowing at both ends are the rule. Grenville rocks occur principally as remnants between the massifs of igneous rock. The western side of the map-area, on the other hand, has lower relief, and the hills are not so high as those to the east. Here, the country is underlain mainly by rocks of the Grenville series, which, however, are intruded by a stock of quartz syenite and a body of grey orthogneiss. The wide sand-plains along the Rouge are particularly noteworthy, and less extensive plains are found along some of the other large streams and lakes.

JOINTS AND SHEAR-ZONES:

Several bedrock features have controlled the development of the (probably post-glacial) valleys. In some places, these valleys lie along the contacts between formations. The elongation of scarps and minor valleys may coincide with the strike of the foliation, but where soft rocks of the Grenville series are associated with igneous rocks, the Grenville is likely to be the more eroded, so it underlies the valleys. This is one of the reasons for the farms being worked on the valleys, for, as long ago observed by Logan, the best agricultural land is underlain by Grenville. Besides valleys where boundaries or trends are fixed by edges of formations and by foliation, joints and shear-planes also have topographic expression. No faults of large displacement were observed in the area, and most of the fractures may be classified as joints.

Zones along which the formations have been reduced to a micro-breccia by shearing are not rare and are found in most of the rock series. Such zones are as much as 25 feet thick, and, where exposures are inadequate, they may be mistaken for fine gneisses with a flat foliation. In places, quartz syenite belonging to one of the younger series has been reduced from a coarse to a medium or fine granularity by shearing. No consistent direction

of shear-planes could be determined, but ordinarily their dip is less than 20°, and in this flat attitude they resemble the intrusions of the Guenette formation (1).

A set of fractures or joints strike nearly north and south, and being thus approximately parallel to the strike of the Grenville series and of the foliation in the orthogneisses, it is difficult to distinguish features due to irregularities in the rocks from those due to fracturing. One prominent series of joints which are more inclined to the strike of the rocks than is commonly the case, traverse Montagne-Tremblante lake, so that a band of Grenville rocks crosses the lake obliquely. Comparable situations were observed on other major lakes, especially where the strike of the joints approximates to the direction of ice movement.

The origin of these joints is uncertain: in part they may have resulted from stresses originating during the intrusion of the large massif of anorthosite and related rocks to the east. It is certain, however, that neither they nor the shear-zones represent faults of large displacement, for no formation is appreciably offset by them.

The regional tension-joints are easily recognized from the fact that they cut almost at right angles across the strikes of the formations, *i.e.*, they strike east and west. Although they may not have been developed simultaneously, they tend to have a common strike and cut all the formations of the area. Their presence may be taken to indicate the continuance of the non-rotational stress acting in the east and west direction that brought about the north and south stretching of the rocks of the several series.

Rivière du Diable Arch:

One feature of the structure remains to be mentioned. It is the western bow or flexure of the outcrops of the formations on the east side of the area. There is a tendency for the formations to form concave-convex lunes with the convexity to the west. Adams (2) has shown the same bowing in formations to the east

(1) Osborne, F. F., Que. Bur. Mines, Ann. Rept., 1932, Pt. E, p. 41.
(2) *Op. cit.*, and G. S. C. Map No 590.

of this, and it coincides with the western extension of the northwest corner of the Morin anorthosite and gabbro. Either the gabbro brought about the bending of the formations or else the gabbro's shape was determined by the same stresses that brought about the bowing on the Labelle-L'Annonciation sheet. The writer favours the former hypothesis.

Summary of Bedrock Geology

The area is noteworthy for the number of mappable units within it. Practically all of them present distinctive lithological characters. Mutual relationships have been obliterated by deformation, or contacts occur in valleys where cover is heavy. The several formations have been arranged in a possible order of age from older to younger, as follows: Grenville series, pyroxene granulite, rose granite-gneisses, Lacoste series, Labelle series (grey to brown gneisses and syenite), Rolland granite, Guenette granite-aplite, Loranger series (syenite and quartz syenite), alkaline syenite and pulaskite, and gabbro. It must be emphasized that some of the data on which the sequence is established are uncertain. Not all the formations are shown separately on the map.

Although all these formations, from oldest to youngest, appear to have been stressed in such a fashion that they tended to elongate in a north and south direction, the stress evidently abated somewhat as time went on, for later intrusions of the Loranger series, and of the alkaline syenite and gabbro, are but slightly, if at all, controlled by the stress. They are, however, cut by the regional tension-joints, showing that the stress was still acting, although somewhat abated, at the time they were intruded.

For lack of evidence to the contrary, it is assumed that all the bedrock formations are of pre-Cambrian age.

The Grenville is the oldest, and is the only meta-sedimentary, series represented in the area. The pyroxene granulite was recognized in an adjacent area by Adams as the oldest of the intrusive rocks. The rose granite-gneisses are intimately associated with the Grenville and have been reduced in granularity owing to repeated deformation in a constant direction. Offshoots of the Lacoste series cut rose gneisses but do not partake so intimately

of the regional structure as the latter. The Labelle series is believed to be related to the anorthosites to the east and was introduced at the culmination of the deforming stress. Protoclastic and cataclastic effects are characteristic. Dykes of the Guenette formation and the Rolland granite may be related to one another, but they escaped the pronounced deformation of the older series. The relative ages of the three remaining series is uncertain; they, also, are not much deformed.

Grenville Series

In 1858, Logan traced the Grenville series from the type locality near the Ottawa river as far north as Labelle. Unfortunately, he included within the Grenville, which is a meta-sedimentary series, a considerable number of igneous rocks, thus giving an exaggerated notion of the importance of the series as a whole. The work of this season shows that the Grenville exists largely as remnants between the younger intrusions of igneous rocks.

In the area examined, the Grenville consists mainly of amphibolite and garnet gneisses (see Plates IV-A, IV-B, V-A). The apparently thick limestone members such as are found along the Lièvre river south of Mont Laurier, and about la Conception, which is south of Labelle, are lacking, as are also the very thick quartzite members. Crystalline limestone and quartzite occur, but they do not have the tremendous development found in some other places. However, they may have a greater economic significance here, for in some places they have undergone changes that have produced economic minerals in them.

The Grenville rocks were originally shales, impure limestone, dolomite, impure sandstone, and probably volcanic rocks. They were metamorphosed before the first plutonic rocks invaded them, for wherever found in the igneous rocks they are invariably regionally metamorphosed phases. The records of the old changes have been in a large measure obliterated, and it is probable that the Grenville has been metamorphosed not once only, but many times.

The structure of the Grenville reflects the complexity of the

metamorphism to which it has been subjected: folds are drawn out, twisted, and broken (see Plate IV-A). The rocks have behaved as if they had had a high degree of plasticity. Observations of strike have little more significance than those of dip: both change in comparatively short distances. The Grenville has exerted some degree of control over the structures of the igneous rocks, but the latter have exerted a greater influence on the Grenville, and parallel structures in the two are the rule.

The igneous rocks appear to have been able to incorporate large amounts of the Grenville rocks in themselves, in very varying degree, depending on the character of the Grenville beds concerned. Quartzites were not susceptible to incorporation and lenticles of quartzite of large and small size are found in the igneous rocks, some of them far from the contacts. In places, the quartzite has even protected blocks of other members of the series and these form inclusions with the quartzite. It was commonly observed near inclusions of other rocks than quartzite that the igneous rocks are characterized by garnet, which is either absent or present in small amount only in the uncontaminated rocks. The syenites seem to have been particularly impotent insofar as the assimilation of quartzite is concerned. A number of screens of quartzite occur within the Loranger stock and in many places the margins of the mass are against quartzite. Such inclusions and marginal bodies have economic significance as sources of silica, for the metamorphism induced recrystallization and apparently some leaching of impurities from them.

Although all the rocks of the Grenville series have gone to a high grade of metamorphism, the remnants near the igneous rocks in the eastern half of the area appear to have been more affected than those on the west. Some even have the appearance of having been partially fused. This is a natural consequence of the small size of the bodies and of the fact that most of them may be considered screens between, or inclusions in, the igneous intrusions. The silication of impure carbonate bands is noteworthy; rocks consisting almost wholly of diopside have been formed, which has necessitated the expulsion of the entire content of carbon dioxide. Such is the country rock of the graphite deposit near Castor lake.

ECONOMIC SIGNIFICANCE OF THE GRENVILLE SERIES:

The Grenville series is the most important potential source of economic minerals in the district. It now yields three non-metallic products—magnesian limestone, garnet, and graphite. In adjacent regions where similar geological conditions obtain, it has yielded others. Among these may be mentioned the magnesitic dolomite at Kilmar, the kaolin and quartzite at Saint-Rémi, and quartzite elsewhere, as well as talc, chrysotile asbestos, and the ores of certain metals, as lead, zinc, and iron. The deposits actually examined in this area are described in the section on economic geology.

PYROXENE GRANULITE

In mapping an area to the east of this, F. D. Adams found a series which he described as pyroxene granulites. He determined them as the oldest rocks intrusive into the Grenville. Rocks which belong to this series were found in several places in the present map-area. They have only small outcrops and are not given a separate colour on the geological map. An outcrop is found a mile west of the village of La Macaza, another between Chaud lake and Lantier lake, and there are several bodies in the Grenville a mile south of McGill lake. The rocks of this series are medium grained and of a greenish colour on the fresh surface, weathering brown. The composition varies between pyroxene syenite and gabbro.

Insofar as known, the rocks have no economic significance in this area.

ROSE GRANITE-GNEISSES

The rose granite-gneisses appear as moderate-sized geological units or as pods in the Grenville, into which they seem to grade in places. The apparent gradation is due to the fact that bands or lentils of granite gneiss occur in the Grenville, and inclusions of Grenville are common in the granite gneiss. The fixing of the contacts between the two series is difficult, but the difficulty is understandable when one considers that the two series have been deformed together.

As indicated by the name, the gneisses are rose or pink, and they are fine grained. They are quite resistant to weathering and crop out as ridges where they are interbanded with the Grenville. The principal dark mineral is biotite, and the other main constituents are microcline-microperthite, albite, and quartz. The microcline is clouded with alteration products, and this and the absence of allanite helps to distinguish the rock from the Guenette formation, which it resembles in colour and granularity. The granulated structure indicates a movement after the rock was solid, and the absence of the elongated quartz is in contrast with the texture of the protoclastic gneisses.

No mineral deposits are known to be associated with the gneisses.

Lacoste Series

The Lacoste series, so named from the extensive development about Lacoste lake, is prominent in the western part of the area. All the rocks of the series are orthogneisses, and they show considerable variation in composition from place to place. Some are pyroxenites, others diorites, quartz diorites, and granites. The gneissic structure is due to deformation at the time of intrusion and consolidation, *i.e.*, it is protoclastic. The quartz, which was the last mineral to consolidate, is drawn out into vein-like bodies, and the micas have been brought into parallel alignment in the plane of the foliation. The strike of the foliation swings in broad curves and tends to be independent of the direction of regional foliation. The large, type mass of the series is probably a phacolith, but in places it transgresses the strike of the containing rocks, particularly the Grenville. In a few places, local shear-zones have cut the rock and induced a foliation inclined to the direction of magmatic flowage.

It is not certain that the pyroxenites are members of this series, but they are found close to its edges. The microscope shows that the pyroxenes have been altered to amphibole, except for cores of crystals. Some feldspathic pyroxenites contain large crystals of biotite in ophi-mottled spots. In places, some of the gabbros have an imperfect orbicular structure, and they also contain biotite.

The dioritic facies are much more prevalent than either the pyroxenite or gabbro; they contain green hornblende. Commoner than any of these is granite, a biotite variety, with oligoclase and microcline in about equal amount. Epidote is found in some parts of the massif and is apparently secondary, for it replaces biotite.

The Lacoste series is younger than the rose granite-gneisses and appears to be older than the Labelle series and the Loranger stock.

Economic Significance of the Lacoste Series:

In general appearance, structural relationships, and the presence of epidote, the Lacoste series resembles the blue-grey granite of Rivière-à-Pierre (1), which is quarried for building and monument stone. At Rivière-à-Pierre it is the more mafic varieties of the granite that are quarried. A body of similar grey orthogneiss occurs near the Tétreault zinc deposit at Notre-Dame-des-Anges-de-Montauban, although it is not certain that the ore deposit is genetically related to it. Parts of the Lacoste series might provide a low-grade building stone, and—if the Tétreault deposit is in fact related to the grey gneisses—the contacts of the Lacoste series with the Grenville would be well worth prospecting for similar zinc-lead deposits.

Labelle Series

The Labelle series consists of rocks ranging from diorite to granite. They are most abundant on the eastern side of the Rouge river, where they form elongated lentils in the older rock and conform to the regional structure. They appear to have been subjected to regional stresses at the time of their intrusion, but in places small parts of the formation have escaped some of the marked effects of these stresses.

In hand specimen, the rocks have a brownish or greyish cast and most of them tend to weather to a light grey surface that renders hills formed from them particularly distinctive in appearance (see Plate V-B). The rock is susceptible to weather-

(1) Osborne, F. F., *Op. cit.*, p. 15

ing; the general grey colour of the outcrop was mentioned, but below the surface the rock is likely to be stained brown for as much as half an inch.

Interior contacts between different parts of the same body are common; also, in places, narrow screens of Grenville rock now separate narrow masses of lithologically similar rocks of the Labelle series. The form suggests that the latter rocks were intruded as lentils in the same fashion as plastic material might be forced into the openings, or potential openings, that might be developed in a thick pile of heavy writing paper that is held at the sides and bent.

Much of the formation is porphyritic, and a protoclastic texture is the rule. The phenocrysts of feldspar lie in the plane of foliation, with the long axes approximately horizontal. In parts of the rock, the phenocrysts retain the rectangularly bounded sections, but in other places they are lentils and the rock may be called an *augen gneiss.* In a few places the shearing has gone farther than this and the rocks have a *flaser* structure, that is, the feldspar has been drawn out so that it is very thin with respect to its length.

A band of this series that crosses the Rouge river at Labelle, and forms the falls there, is narrow and slightly more rich in dark minerals than the bulk of the rock. The band at Labelle is narrow and vertical, but to the south it widens rapidly and dips to the east.

This series is believed to be the same as gave rise to the anorthosites and related rocks east of du Diable river. It appears to have been introduced along planes that were determined by the intrusion of the anorthosite. The similar colour of the plagioclase in the anorthosite and in the rocks of this series is perhaps a reason for believing the two to be related.

Rolland Granite

A strip of granite on the east side of the map-area is given the name 'Rolland' granite from its occurrence in Rolland township. The granite shows some variation in composition from place to place, but owing to lack of time it was not found possible to

delimit the several varieties in the field. Near Sugar Bush tower, it is rose and coarse grained, and it has this character for some distance to the south and north. Where found at the south end of Montagne-Tremblante lake, it is medium grained, but is rose and low in mafic minerals, as it is to the north, which suggests that the coarse- and medium-grained rocks belong to the same series. The primary flow-structure in the several facies strikes west of north and is inclined to the strike of the contact.

Microscopic examination of the rock shows that it is a biotite granite with abundant accessory minerals of a sort indicating a high concentration of volatile constituents in the magma. Tourmaline is so abundant in one thin section that the rock might be termed a tourmaline granite. Apatite and sphene are also abundant.

The age of this granite is not known, but it is believed to be younger than the Labelle series, and it may be of the same age as the Loranger stock. The high content of volatile constituents (indicated by the accessory minerals) in both the Guenette and Rolland series suggests that the Guenette may be an aplitic facies of the Rolland.

Two small patches of coarse-grained rose granite are given the same colour as the Rolland on the geological map, but it is not certain that they are of the same series.

Lack of time prevented the writer from making close examination of the contacts of the Rolland with the Grenville, but the high content of mineralizers in the granite should make the contacts worthy of examination. In this connection, it is of interest to recall that, in Cornwall, England, tin deposits are found in association with tourmaline granite.

Guenette Granite-Aplite

The important granite quarries at Guenette (1) are in a dyke of aplitic granite that can be traced for some 14 miles with a maximum width of about a mile. The rock is a rose, fine- to medium-grained, granite-aplite. Despite its dyke-like attitude,

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(1) Osborne, F. F., *Op. cit.*, pp. 40-48.

indicated by the vertical contact with Grenville rocks (*e.g.*, as exposed along the highway north of Brodie's quarry), the granite has a perceptible horizontal foliation (the rift). A rock of identical appearance forms sills in the map-area here described, and the foliation, which is at a low angle, is parallel to the walls of the sills. Most of the sills are not more than 25 feet thick and they are younger than the abundant pegmatites and aplites.

The rocks of the Guenette formation resemble the fine-grained rose gneisses. The flatter dip of the foliation in the Guenette helps to distinguish the two, but the principal criterion is the presence in the Guenette of radioactive minerals surrounded by minute red spots. The common radioactive mineral is allanite, which is apparently a constant accessory in the rock of this formation.

Some parts of the formation might be used as building or monument stone, but in view of the fact that an identical stone is quarried on a large scale at Guenette, where there are large available supplies, the stone in this area is only of potential value as building stone, inasmuch as the freight rates to Montreal from both localities are the same.

Loranger Series

The stock lying east of Petit Lac Nominingue and west of Castor lake in the townships of Loranger and Marchand is one of the most prominent features of the geological map. The stock is composite, that is, it is made up of a number of injections of magma of related chemical composition that came up along the same general zone. Near Castor lake, a body of basic syenite, which could be termed shonkinite, has been outlined on the map but is given the same colour as the more abundant and less mafic syenite. The shonkinite shows a chilled contact against the country rock and is probably older than the other rocks of the stock. A body of related rock of fine grain is found west of the south end of Castor lake. The most abundant facies is the coarse-grained rose syenite. The joints are widely spaced, giving the rock a massive appearance. Types intermediate between shonkinite and syenite are found, but it is not necessary for purposes of this report to describe them.

The structure of the stock as a whole is complex. The dip of the contacts, and of the flow structure on the south, east, and west contacts, is steep. On the north side of the stock, near the school-house, the contact is observed to dip at 40° to the north beneath the Grenville, and a mass of Grenville exposed south of the school-house appears to rest on the syenite. North of Blanche lake, inclusions and flow structure are nearly flat.

The stock contains many inclusions, largely of Grenville quartzite. It appears that the syenite was unable to incorporate much of the quartzite and this remains as inclusions or is found around the margins of the stock. South of Paquet lake, inclusions of other rocks than quartzite are numerous, which probably indicates proximity to a floor. The composite intrusion is probably a 'sickle stock' (Cloos), that is, the magma came up along steep channelways on the three sides and plunged beneath the Grenville to the north. The form of the stock thus differs from the composite stock at Brownsburg, where all the contacts are steep.

The microscope discloses a considerable range in composition in the rock. A pale green (iron) pyroxene is a constant constituent. In places, hornblende is found as an alteration of the pyroxene or as a primary mineral. A deep-brown biotite is also common. Both plagioclase and potassic feldspar are present. A few facies show plagioclase almost as calcic as andesine, but this is restricted to the cores of zoned crystals; oligoclase is the normal feldspathic constituent, except in rocks with abundant potassic feldspar, where albite is found in small amount. Quartz occurs sparingly in almost all the rocks of the stock.

The age of the syenite is unknown: it is entirely surrounded by Grenville except for a small mass of granite gneiss on the east. It is believed to be one of the younger intrusives in the area, for it appears to have been unaffected by the deformations, although it is cut by the regional tension-cracks and local shear-zones. It may be of the same age as the alkaline syenite north of Tiberiade lake. Certain rocks from each occurrence have similar colours, and both contain pyroxene as an essential constituent. The pyroxene of the alkaline stock is richer in alkalies than that of the Loranger rocks.

A part of the stock is so rich in quartz that it may be termed a granite. This facies forms a band extending north from Paquet lake. It has a pleasing rose colour, is medium grained, and low in dark minerals. Stone of fairly good quality is well exposed at a locality northwest of the limestone quarry. The most attractive and best quality stone was found as loose blocks. Presumably there are ledges of such rock in the vicinity, and if so the material might well be used as building or monument stone to supplant similar stone now imported. Massiveness of outcrop, which was mentioned as characteristic of the syenite, is also a feature in this part of the series.

Alkaline Syenite (Pulaskite and Nepheline Syenite)

An unexpected result of the mapping of the Labelle-L'Annonciation area was the discovery of a large area of alkaline and feldspathoidal syenite. The manner of discovery, an application of boulder prospecting, is fully described in the section on glacial geology in the hope that the description might enable prospectors to apply the method in the search for mineral deposits. This is the first record of such rocks in the Laurentian of Quebec, although alkaline syenites are well known and economically important in the corresponding region in Ontario. Many occurrences of corundum in such rocks were formerly successfully exploited, and other non-metallic minerals that are being increasingly used as industrial raw-material are found in them.

Only the southern tip of the occurrence extends into the present map-area, and it is largely covered by drift. The approximate distribution of the rocks is shown on the accompanying outline map (Figure 2). The most abundant facies is a pulaskite, a pearly-grey rock of coarse grain with the tabular feldspars lying in a vertical plane striking N.60°W. The joints in the rock are widely spaced, and the stone is not easily disaggregated. This accounts for the large size and angularity of the blocks in the drift, features which first led to their being noticed.

A reddish or purplish syenite is found associated with the pulaskite. It has a grain even coarser than the latter, but lacks the marked parallel fluidal arrangement of the feldspar. With weathering, this rock is easily disaggregated: boulders are re-

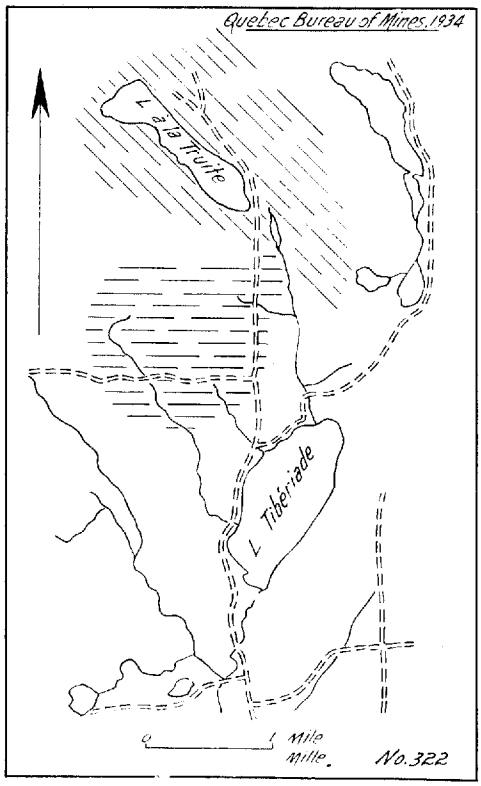


Figure 2.—Outline of area of alkaline syenite.
Diagonally ruled: pulaskite; horizontally ruled: coarse red syenite.

duced to 'rotten stone', and outcrops are covered with the friable disaggregated material. The microcline of the weathered rock remains fresh. The colour of the rock is due to the microcline and is similar to that of some facies of the Loranger stock. This syenite, however, differs from that of the Loranger stock in the complete absence of quartz.

The pulaskite contains small patches of nepheline, the presence of which may be inferred from the pits developed on the weathered surface, or the actual mineral may be seen when thin sections of the rock are examined under the microscope. In some

parts of the stock nepheline is abundant and the rock is a nepheline syenite. The nepheline is in coarse angular grains of pink colour. No large extent of nepheline syenite was found, but the stock was not examined thoroughly, for most of it lies beyond the limits of the present map-area.

The alkaline stock is perhaps the youngest bedrock formation present in the area, but its geological age is uncertain. Lithologically similar pulaskites and nepheline syenites are known in the Monteregian hills which rise above the St. Lawrence lowland 130 miles south of this locality. Although the Monteregian intrusives cut the flat-lying lower Palæozoic limestones, they must have penetrated the underlying basement of pre-Cambrian. Such a relationship can be actually demonstrated in the Laurentian outlier at Oka. Is the stock described here a representative of that series? On lithological grounds alone, one would say it is, but one important difference is seen under the microscope: the Monteregian intrusives lack pleochroic haloes about the radioactive minerals, whereas such haloes are well developed in the stock here described and have an 'over-exposed' look, which is taken to indicate geological antiquity. The stock is for this reason believed to be older than the Monteregian intrusive and may be co-magmatic with the alkaline syenite of the Haliburton-Bancroft region (1) previously mentioned. The Ontario rocks are thought to be of pre-Cambrian age but may be younger.

ECONOMIC SIGNIFICANCE OF THE ALKALINE SYENITE:

The alkaline syenite in Ontario has corundum associated with it. Nepheline itself is rich in alumina and soda and is finding industrial application, especially in the manufacture of glass. For a commercial supply, however, it would be necessary to find nepheline-rich facies of the rock, *i.e.*, pegmatitic dykes. Such occurrences are not rare in the Haliburton-Bancroft area and may possibly be found in this new Quebec body. Mention also may be made of the fact that, in Russia, a deposit of graphite which occurs in association with rocks of this composition has been exploited.

(1) Adams, F. D., and Barlow, A. E., *Geology of the Haliburton and Bancroft Areas, Ontario*; Geol. Surv. Can., Mem. 6, 1910.

The pulaskite might be used as building stone, although the typically coarse grain would detract from its value for this purpose. Finer grained facies might be found, however. It may be noted in passing that the 'pearly granite' (laurvikite) which is imported from Norway and used extensively for high-grade monument and ornamental stone is a rock related to pulaskite.

Gabbro

The prominent hill rising east of Labelle lake is formed of gabbro with so marked an ophitic texture that it might be described as diabase. This is the only representative of this series known in the region: two smaller masses of gabbro that are marked on the map are almost certainly members of an older series. The main body of gabbro is cut by the east and west tension joints. Farther south, rocks of this composition occur as dykes occupying the joints, but such dykes are lacking here.

A noteworthy feature of the outcrop of this rock is the occurrence within it of streaks of rock of the same composition but of much coarser grain than the surrounding rock. The *schlieren* may consist of only two or three crystals as much as one inch long, but larger aggregates are found. The clots perhaps represent accumulations of crystals.

The microscope shows that the dark minerals are augite and hypersthene replaced by an aggregate of deep-green hornblende which preserves the ophitic relationship against the labradorite.

If the gabbro were found free from the clots of crystals it might be utilized as a 'black granite'.

ECONOMIC GEOLOGY

Garnet

The Labelle-L'Annonciation district has every indication of becoming an important producing centre for garnet. Two deposits have been exploited, and at one of these properties a mill was operating at the time of the writer's examination. Work on the other was suspended during a reorganization of the company.

It has been mentioned on an earlier page that garnetiferous

gneisses and amphibolites are characteristic of certain parts of the Grenville series. In most of the occurrences, the garnet is fine granular (from one to three millimeters) and a deep red colour, and it is so abundant in some places as to form 40 per cent of exposed surfaces; but the small size of the garnet in these rocks would make it difficult to concentrate it without fine crushing. Rarely, the garnets in these rocks are half an inch in diameter, but in such cases they are not abundant, and, moreover, they usually have much dark mineral associated and intergrown with them. Both types of occurrence are found near the deposits that have been worked but neither is the principal source of the commercial garnet, for the richer ore of the types to be described in the following paragraph is more suitable for exploitation.

The larger and more abundant garnets are found in white or grey dykes of pegmatite, common only in the Grenville rocks, made up of quartz, feldspar, and garnet. A pale green oligoclase is abundant and is associated with a white microcline. The writer considers that the pegmatite magma was able to pick up an excess of lime and alumina from the Grenville rocks rich in those constituents and later to deposit it as garnet. The origin of the pegmatite magma is uncertain. It represents either an original magma contaminated by contact with hot Grenville rocks or the first stages of fusion of the Grenville due to elevated temperature and under the influence of 'juices' derived from subjacent bodies of granite. In either case, the grey pegmatites appear to be restricted to the Grenville rocks. Many occurrences of such pegmatite were noted. In some places the intrusions are only a few inches long but nevertheless contain large garnets where they are in contact with garnetiferous Grenville rocks. Some quartz veins also appear to have picked up the garnets in the same fashion as the pegmatites. The pegmatites or quartz veins have injected the gneisses parallel to their foliation and have introduced garnet.

Yet another mode of occurrence is found on the property of La Belle Mining, Incorporated. This is a high-temperature or contact-metamorphic deposit. The garnet is associated with pyrrhotite, sphene, magnetite, and quartz. The garnets are darker than those found in the gneisses, quartz veins, or pegma-

tites, and, as indicated by the darker colour, are probably richer in iron than the others, the iron having been introduced with the solutions that deposited the iron oxide and sulphide. This type of occurrence was noted only in the one place, the remaining garnetiferous bands on the property belonging to one or other of the preceding types.

La Belle Mining, Incorporated:

The deposit formerly worked by the Labelle Nickel and Garnet Company, on lots 16 and 17, range *J*, of Joly, is now owned by La Belle Mining, Incorporated. The old Company, which failed toward the close of 1932, stripped the property of overburden and made open-cuts along the high-grade parts of the 'ore', and also sank a shaft to a depth of about 20 feet (see Figure 3). A donkey boiler was installed to operate a compressor and also a hoist, the latter being to haul the empty cars up a ramp for loading. La Belle Mining, Incorporated (head office, 4203 Brébœuf Street, Montreal; president, Victor Lévêque) was incorporated in January, 1934. They maintain a caretaker on the property, and it was reported that they planned to do some work on the deposit in the fall of 1934. However, up till the time the writer left the field, no work, other than some minor repairs to the waggon road, had been started.

The deposit is on a hillside rising above a small lake, and is in rocks of the Grenville series. The banding of the Grenville is shown in Plate III-A. Examples of each of the several modes of occurrence of garnet described above are to be seen on the property. Deep red garnet forms as much as 20 per cent of some of the micaceous gneisses, but the garnets are small and concentration would be difficult. A band of this material 100 feet wide is indicated on the map. It weathers yellow on surfaces of the open cuts. Nearby are other bands of Grenville gneiss and also of limestone, low in garnet. The bands of Grenville rock have been broken and the limestone has been forced into fractures in the gneisses due to the metamorphism. Usually, this limestone has been extensively altered by the formation in it of silicates, but in a number of pods, whose positions are shown on the map, the true nature of the rock is still determinable.

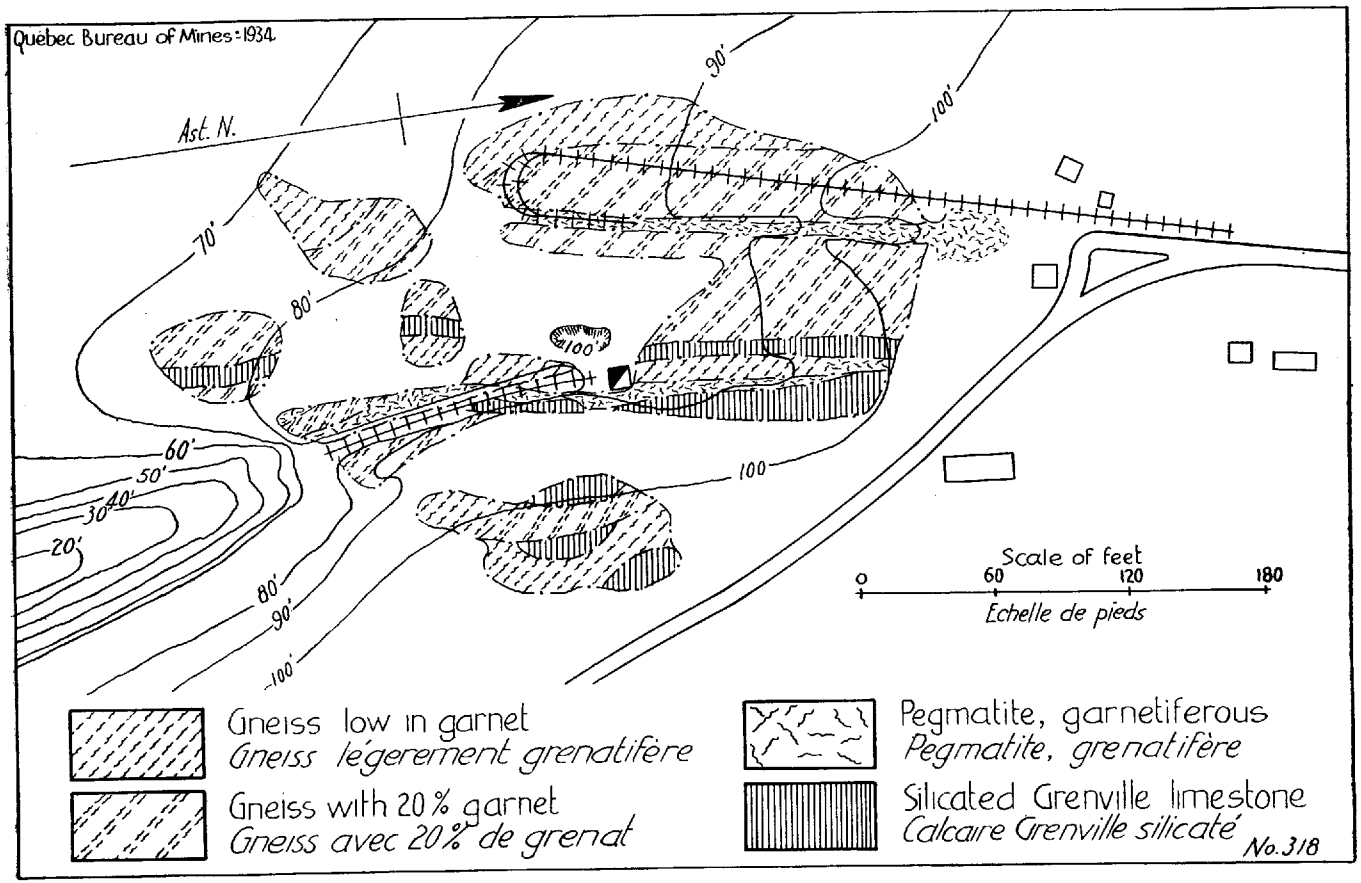


Figure 3.—Quarry of La Belle Mining Incorporated.

Much of the better grade of garnet rock on this property is in pegmatite dykes that cut the Grenville. The garnets in these dykes are as much as half an inch across, and clotting may give aggregates much larger than this. Many of the garnet crystals contain inclusions of quartz, feldspar, and dark minerals. In places, the pegmatites contain much deeply coloured hornblende, but these parts of the dykes are not rich in garnet. A garnet pegmatite probably underlies the open-cut along which the car-track runs on the west side of the stripped area shown on the map. Another pegmatite zone is found along the stripping where the shaft is located.

The most desirable material is of a different type. It is a replacement of crystalline limestone by an aggregate rich in pyrrhotite, magnetite, deep-green amphibole, sphene, and garnet. The garnet is in relatively large clots and is of a much deeper colour than that in the pegmatite dykes, as might be expected from its association with iron-rich minerals. This part of the deposit is without question a high-temperature, or contact-metamorphic, replacement of the limestone. It may have resulted through the agency of the same emanations that produced the pegmatite dykes.

The largest garnets are in the pegmatite dykes and in the deposit formed by the replacement of limestone, and both types of occurrence on La Belle property afford material suitable for concentration. Inasmuch as some of the most commercially desirable American garnets are of the deep colour of those occurring in the replacement deposits, these latter might yield the more easily marketable material.

Quartz and feldspar of value for sand-blasting could be produced as a by-product of the concentration of the garnet.

McLean and McNicoll, Limited:

The most recently opened garnet property in this area is that of McLean and McNicoll, Limited (head office, Confederation Building, Montreal), on lot 25, range *B*, of Joly, close to the village of Labelle. The Company started work in January, 1934, and erected a mill to crush about 40 tons a day.

The quarry is along a steep face rising above the Rouge river (see Figure 4 and Plate VI-A). The rock exposed is, in part, a garnetiferous Grenville gneiss, rich in biotite. This includes a small pod of silicated Grenville limestone and is cut by veins or dykes of quartz and dykes of garnetiferous pegmatite, which have the same strike as the gneiss. In the quarry, the biotite-rich gneiss and the limestone are sorted from the mill feed, owing to the fact that the presence of biotite and calcite would reduce the efficiency of the product for sand-blasting. The veins or dykes of quartz, however, are quarried and sent to the mill with the garnetiferous pegmatitic material.

The mill, shown in Plate VI-B, is located close to the quarry. It is a frame building covered with sheet metal. The material is delivered to the mill in lumps weighing as much as 25 pounds. It passes through a jaw breaker and then over an oscillating screen, the undersize from which is conveyed to the first of two Niagara screens. The oversize is passed through a hammer-mill, whose product goes to the Niagara screen already referred to. The oversize from this screen passes to a pair of rolls and the product from these is combined with the undersize from the first Niagara screen, both going to a second set of Niagara screens. The oversize from the latter is returned to the rolls. The finished product from the second set of Niagara screens is raised by elevators, to be dumped into storage bins. The dust is collected by a suction system and exhausted to atmosphere. Electrical power at 220 volts is used throughout.

Two principal products are made, *viz.*, through-10 on-20 mesh and through-20 on-40 mesh. A small amount of material through-40 on-60 mesh is also marketed and is produced by re-screening the undersize. The products are used for sand-blasting.

The product consists of an equigranular mixture of quartz with a small amount of feldspar and garnet. The presence of the feldspar apparently does not detract from the abrasive quality of the mixture, and the garnet increases its efficacy for this use. The principal development to date has been on the quartz rocks and pegmatites, but the Company hopes to develop sufficiently large pockets of garnet to justify them in making a garnet concentrate.

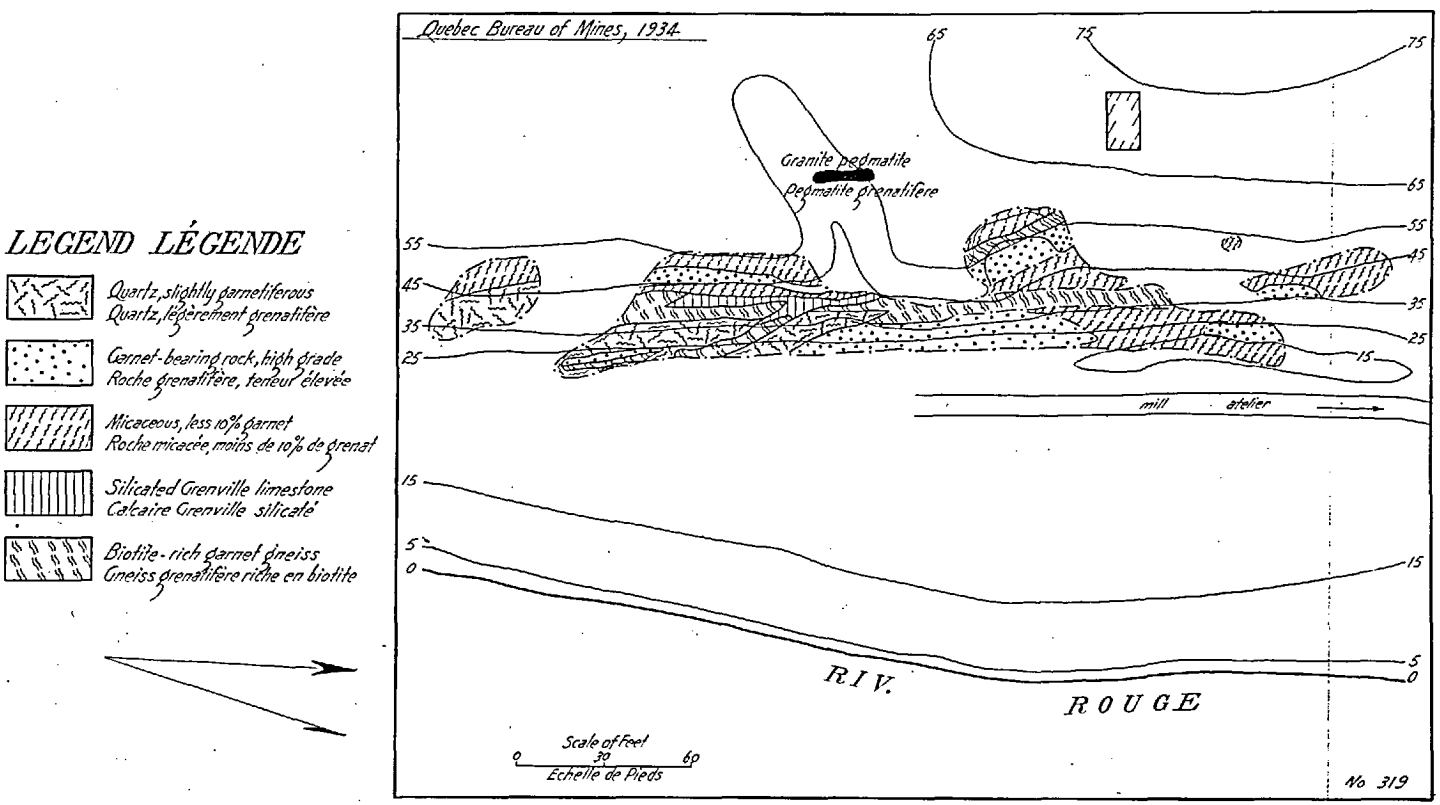


Figure 4.—McLean-McNicoll garnet deposit.

Graphite

Graphite is common as disseminated flakes in the crystalline limestones of the Grenville series, but is in too small amount to constitute an ore of the mineral. One occurrence, however, was examined by the writer where the grade is much higher than in the usual disseminated type. Other deposits of possible commercial value are said to exist in the area east of Labelle, but their locations are unknown to the writer.

The graphite occurrence studied is on the side of Castor lake, on lot 20, range *N*, of Joly. Highly metamorphosed Grenville rocks are exposed here along the base of a small cliff that rises above the lake about 150 feet from the water's edge. Near the lake-shore, the rock is quartzite, but along the base of the cliff, diopside rocks, derived by contact metamorphism from Grenville dolomites, are found. The cliff itself is granite of the Labelle series.

The graphite is in cleavable masses of considerable size and resembles the best grade of graphite from Ceylon. It occurs in veins and irregular masses cutting the diopside rock and granite pegmatites, and is definitely younger than both. A small amount of sulphide, mainly pyrrhotite, is associated with it.

The occurrence is not well exposed. Some stripping was done many years ago, but the trenches are now filled with débris, and a shaft sunk at that time has caved around the collar. At the present time, the exposed length of the deposit is not much in excess of 40 feet; the width is unknown but is over 10 feet near the shaft. The irregularity of the distribution of the veins makes any estimate of the amount of graphite available hazardous, but numerous masses of graphite of good quality, eight inches in diameter, were observed on the old dump.

According to a farmer near Labelle, the property was worked about 20 years ago along with others not seen by the writer. The shaft was sunk at that time. Some interest has evidently been taken in the deposit within the last three years, for claim-lines have been cut and tag numbers (9927 H. Menu) placed on claim-posts.

The mode of occurrence suggests that the graphite has

originated through reduction of carbon dioxide which was released during the conversion of the Grenville dolomite to diopside rock. This would make it later than the metamorphism of the dolomite and the injection of the pegmatite dykelets.

Lime Rock

The Grenville series in the district contains some beds of crystalline limestone and dolomite. In places these have been exploited as sources of lime and magnesia. Deposits of limestone free from silica are, however, relatively rare. One limestone quarry is at present operated near L'Annonciation. Similar material is known to occur on the Belowsky farm, near Macaza station. The whitest crystalline limestone observed was along the small stream that flows out of lac à l'Equerre, near the southwest corner of the map-sheet. The rock is of medium grain and paper whiteness. It contains some masses of amphibolite that have been deformed with it and broken. Unfortunately, the limestone outcrops along a stream and there is little place where the stone might be quarried. Also, the locality is a long way from the railway. No occurrences that might be valuable as marble were observed.

Canada Marble and Lime, Registered:

A quarry, which supplied the lime for the plaster in the village church, was opened many years ago near the village of L'Annonciation. It was later operated as L'Annonciation Marble Company. In 1932 it was taken over by the present Company, Canada Marble and Lime, Registered, with office at 630 Cathcart Street, Montreal, and is under the direction of Malcolm Lemieux. An oil engine supplies power for the operation of the air compressor for quarry work and for the mill in which the dolomitic limestone is crushed and sized. The product is carried by road to the station at L'Annonciation, less than two miles away.

The quarrying operations have been extended along a hillside that slopes east to a small stream and swamp. On the west, the limestone extends to the contact with the Loranger syenite that forms a prominent ridge here (see Figure 5 and Plate VII-A).

The material quarried is a part of the Grenville series and

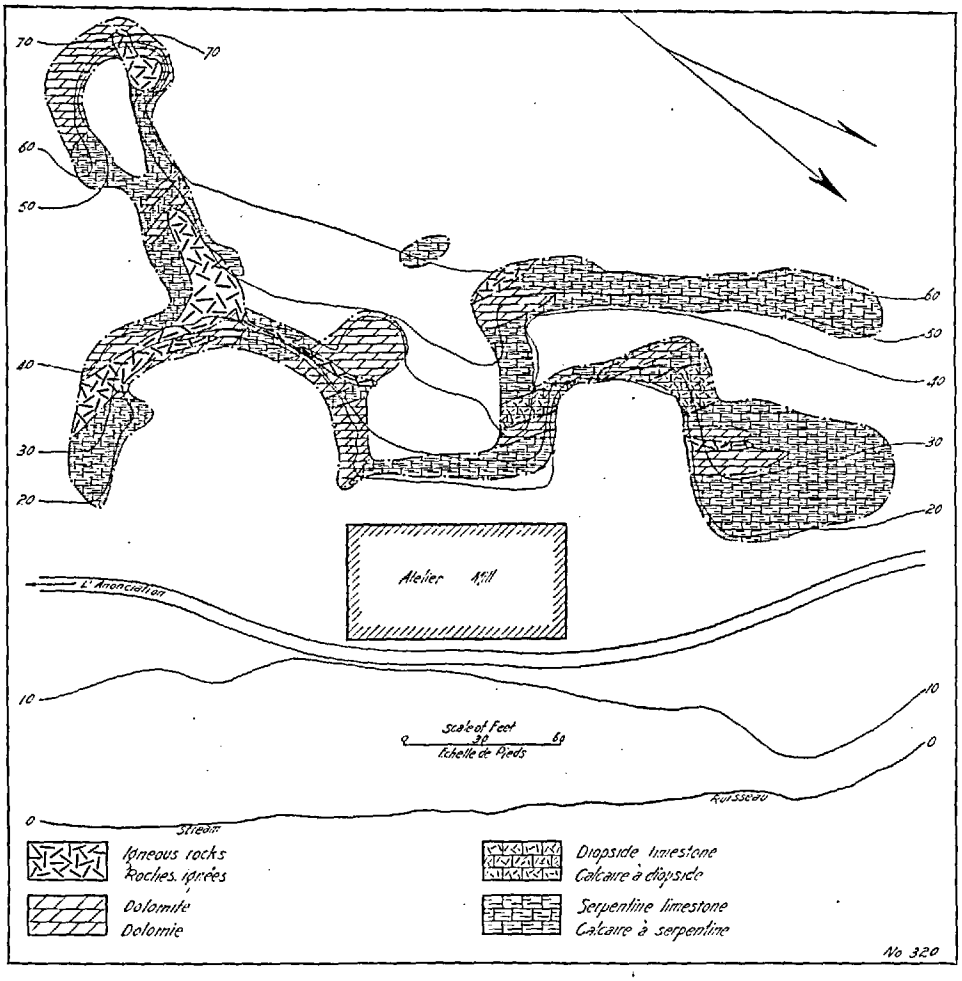


Figure 5.—Quarry of Canada Marble and Lime, Registered.

is a dolomitic limestone. Shearing has been intense and the former folds have been drawn out and broken to such an extent that the original beds cannot be traced. The quality of the material quarried varies in different parts of the quarry. Certain bands of the limestone are rich in silicate minerals, such as diop-

side and serpentine, and these bands are shown by patterns on the map. In addition, some dykes cut the limestone. One is a syenite porphyry, an offshoot (apophysis) of the nearby stock of syenite.

Serpentine is quite abundant in the limestone. It has several modes of occurrence. Much of it occurs as grains in the carbonate rock, some is in green aggregates, and some, an amber variety locally known as 'onyx', forms rims around a diopside rock. The serpentine of the rims appears to have escaped the deformation that affected the diopside rock. The latter is one of the unusual materials in the quarry. It is medium grained, very tough, and of a pure white or slightly blue colour. The diopside rock has been drawn out during the deformation of the limestone and now is in pods and disconnected lenses lying in poorly-defined bands. Such material must be rejected during the hand-sorting in the quarry. It is possible, however, that the amber serpentine and white diopside might be utilized for ornaments.

A number of other minerals are found in minor amounts. Tremolite is found in bladed aggregates growing along joints. The altered variety of scapolite known as wilsonite occurs in blue or lilac aggregates, and some cinnamon-brown chondrodite was found. The three last mentioned minerals were probably introduced by contact metamorphism due to the neighbouring syenite and are much later than the diopside rock.

At the time of the writer's examination of the property, the part of the south pit on the footwall (north) side of the syenite porphyry was being worked. Mr. Lemieux informs the writer that stone of good quality, covered by nine feet of drift, has been developed south of the upper working.

Following are analyses of the dolomitic limestone from this property. Analysis I is of a composite sample taken by M. F. Goudge, Mining Engineer, Mineral Resources Division, Department of Mines, Ottawa, from working faces. Analysis II, also supplied through the courtesy of Mr. Goudge, is of the ground product. Both analyses are by chemists of the Department of Mines, Ottawa.

ANALYSES OF DOLOMITIC LIMESTONE

	I	II
SiO_2	7.92	5.96
Fe_2O_3	0.35	0.22
Al_2O_3	0.40	0.20
P_2O_5	0.01	0.02
CaO	31.33	31.46
MgO	20.18	20.03
CO_2	35.91	40.04
H_2O	3.71	1.78
S	Tr	Tr
	99.81	99.71

BELOWSKY FARM:

A similar white carbonate rock, also containing diopside, is exposed on the Belowsky farm, near Macaza station.

OCHRE

As already mentioned, Nominingue lake was so named by the Iroquois, because it is the "place of red paint". The early white settlers about the lake used the mineral as paint for their houses. Such names as 'Petit Nominingue' for the stream flowing by the ochre deposits south of L'Ascension, and the nearby la Peinture lake, also attest to the common occurrence of rust or hydrated iron oxide in this district. Rusty bands are seen in the gravels where these have been cut by the Rouge river.

The ochre deposits that have been exploited are found in kettle-holes in the drift-plain south of L'Ascension. The 'kettles' are the pits left by the melting of large blocks of ice that were entrapped in the drift. They provided places in which the iron oxide could be accumulated. The ochre has originated as follows: oxygen-bearing waters percolated through the porous sands and attacked the iron-bearing minerals contained in them. The iron was taken into solution and migrated through the sand to lower levels. Much of it came to the surface again in the kettles and was precipitated in them by atmospheric and other agencies. The balance entered streams and rivers and was carried down to the

Ottawa without opportunity for precipitation. Bacteria and swamp plants probably played an important role in the precipitation of the iron. The deposits continued to grow, filling up the undrained depressions with the hydrous iron oxide, or ochre.

CANADIAN SIENNAS, LIMITED:

Some of these occurrences of limonite or ochre were known to the Indians and the early settlers. The material was first exploited commercially about 1919, by François Dufresne. The deposit he operated has since been worked by several companies, *viz.*, Canadian Products, Iron Oxide Products, and, most recently, Canadian Siennas, Limited. The bogs occupy 'kettles' (left by melting ice), and are on lot 18 of range IV, and lots 19, 20, and 21 of range III, Lynch township. Lot 19 is owned by Médéric Legault; the others by Oscar Dufresne.

Since 1922, operations have been in charge of L.X.L. de Livi and one bog only has been exploited. In the earlier operations, the limonite, with admixed sand impurities, was ground in a buhr-stone mill and calcined in a cement-mill type of kiln. This practice was not satisfactory, because the siliceous material was not reduced in size in sufficient degree and it diluted the ochre, and, after the mill was burned in 1924, the practice was abandoned. A process was then evolved in which the ore was washed and the siliceous material thus removed. No crushing was necessary, the ore being sufficiently pulverulent to break in the washing. This plant, in turn, was burned down in 1926 and no work has been done since.

The outlines of three bogs are shown on the accompanying sketch-map (Figure 6). Of these, only the centre, or No. I, bog has been exploited. Material was raised from it along an inclined wooden skipway to the mill. The surface water was drained off in a ditch. The surfaces exposed at present consist of brown earthy limonite grading outward at the margins into sand discoloured with iron oxide. The surfaces of the other bogs, *viz.*, No. II northeast, and No. III southwest, of No. I, are covered with swamp vegetation. No. III bog is said to contain very finely-divided green ochre.

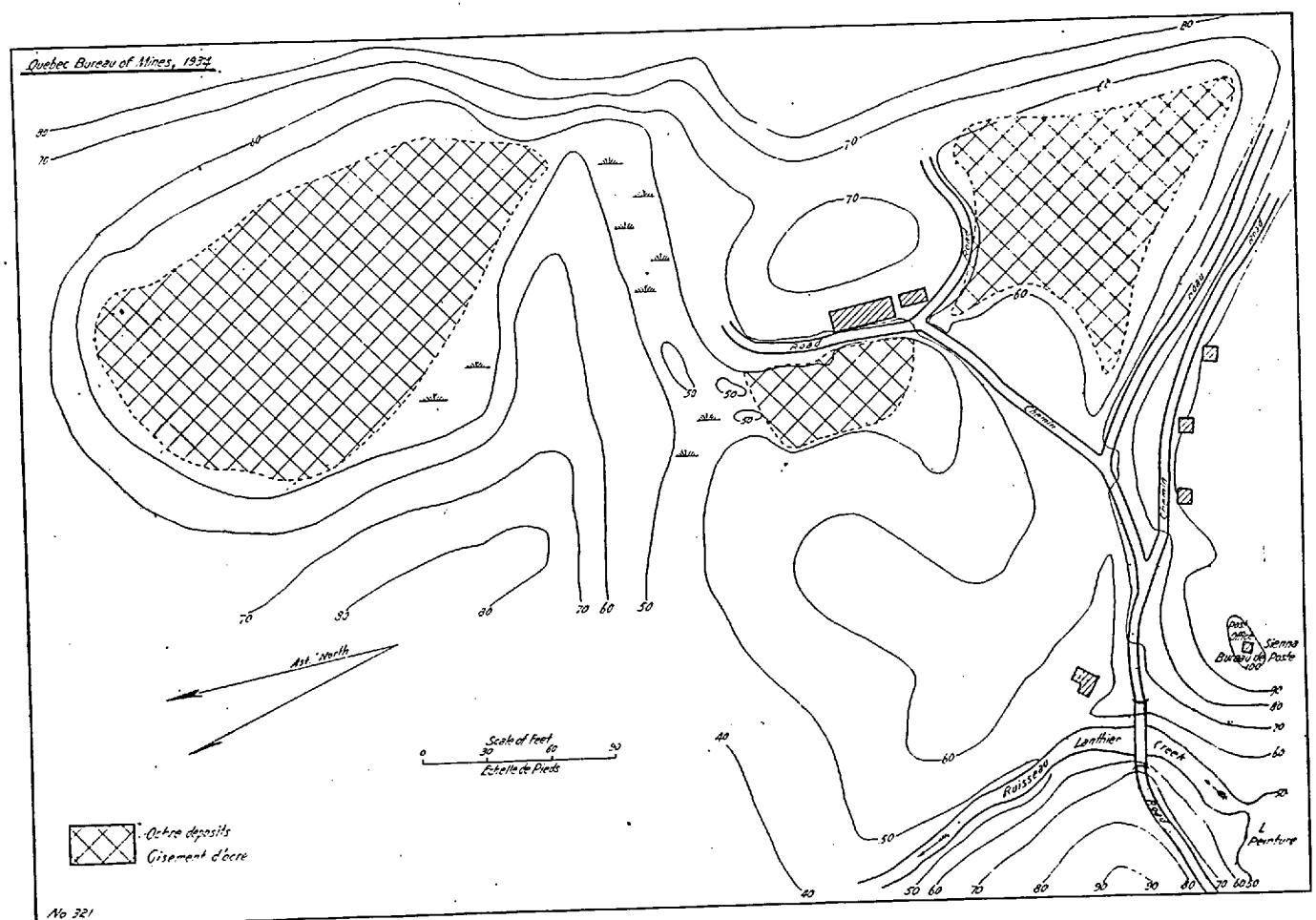


Figure 6.—Outline of limonite bogs, Canadian Siennas, Limited.

Mr. J. R. Macaulay, of the J. T. Donald Co., Montreal, has given the writer access to a part of the results of an extensive drilling campaign carried on under the supervision of Dr. John A. Dresser. The drilling equipment available could not be used to penetrate more than 18 feet, and this depth was reached in a number of holes in No. I and No. II bogs. In No. III, or green-ochre, bog, a series of holes along an east and west line showed 12 feet of limonite. The bogs I, II, and III are estimated to contain respectively at least 850,000, 4,735,000, and 830,000 cubic feet of limonite which, in the dried but uncalcined state, contains 50 per cent Fe_2O_3. Allowing a liberal estimate of 32 cubic feet to the ton, the three bogs contain about 200,000 tons of ochre of commercial grade.

Another bog, with depths of 4 to 46 feet of limonite, is said to lie northwest of No. II and to contain "at least as much ochre as any of the three bogs tested".

Quartz and Quartzite

Quartz is not mined in the Labelle area, except insofar as it forms a large percentage of the 'garnet' product shipped by McLean and McNicoll, Limited, from their property at Labelle and used for sand-blasting. Quartz is used as an abrasive material and in the chemical industries, particularly for glass making and the production of ferro-silicon. For glass making, a high degree of purity is essential, particularly as regards freedom from iron and infusible minerals.

Two types of material may be recognized in the area—quartzite, and vein or dyke quartz. The quartzites of the Grenville series are relatively resistant to erosion and form hills along the Rouge south of the present map-area; but they are not so well developed here as they are in adjacent areas. It was mentioned that quartzite is resistant to incorporation by syenite magmas, and inclusions of quartzite are common in the Loranger stock. It forms a band extending southeast of Blanche lake (east of Petit Lac Nomininge) to the edge of the stock. Parts of the band are worthy of attention as a source of silica, for the quartzite has been recrystallized and, in some measure, the impurities have been leached from it by the magma. It was not found possible to

sample the quartzite with the equipment available, for the places of easy access are near the joints, and there the impurities are higher than in the bulk of the rock. Search along the band mentioned should disclose material sufficiently pure to be industrially useful. The localities that seem to offer greatest promise are close to a road leading to Belle Rive station on the Canadian Pacific railway. It must be emphasized that the opening of the material by blasting is essential for proper sampling of the rock. Contamination by iron from the hammer or pulverizer used in the breaking of the material must be considered and guarded against.

Quartz also occurs in the area as dykes or veins. A series of nearly parallel-trending dykes are encountered north of Labelle lake. These are exposed sporadically northeast from this place to a locality in the bed of the river Rouge. The dykes vary considerably in purity from place to place. Analysis of a specimen from one dyke, in which the quartz appeared to be very free from impurities, gave : SiO_2, 98.54%; Fe_2O_3, 0.26%.

In places, however, this dyke contains biotite, pyrite, and tourmaline associated with the quartz. The grain is coarser than in the quartzites and the rock has the texture of an igneous rock. A series of cracks, comparable to the rift cracks in granite and pegmatite dykes, cut the dyke and render it more easily broken than is commonly the case with quartz rocks. In comparison with quartzite, which is difficult to crush, the cost of breaking the stone from this locality should be relatively low. Exposures of this dyke, where it is fifty feet wide and exposed over a range of 50 feet vertically, were noted east of the north end of Labelle lake (indicated by *Q* on the geological map). In some localities, quartz dykes or veins similar to this are gold-bearing. A specimen from the more impure part of this dyke, containing some sulphide, was collected and sent to the laboratory of the Bureau of Mines for assay, but was found to contain no gold.

Other Non-Metallic Minerals

Narrow and short veins of *chrysotile asbestos* were observed in the dolomitic limestone in several localities, but in none of them did the fibres exceed a quarter of an inch in length. With the abundant supply of chrysotile available in the Eastern Town-

ships of Quebec, such occurrences are only of mineralogical interest.

Sillimanite (silicate of alumina, Al_2SiO_5) was observed as a constituent of some of the Grenville gneisses. This mineral is used as a refractory for the manufacture of such articles as spark-plugs. It was hoped that some commercial concentrations of this material might be found, but none were observed.

Talc occurs in small amount as an alteration of pyroxene and amphibole formed in the crystalline limestone, but no extensive concentrations of the mineral were observed. The large talc deposits near Madoc, in Hastings county, Ontario, are in Grenville limestone.

Commercial deposits of *feldspar* are found mainly in pegmatite dykes, but such dykes are rare in this district. Some were observed in lot 24, range II, Marchand township. The feldspar is a potassic variety of deep red colour and is associated with biotite and magnetite. It is possible that places may be found where the feldspar in these dykes is well enough segregated to be mineable. In most of the pegmatite dykes seen elsewhere, however, the feldspar grains are too small and too intimately associated with other minerals to offer any commercial possibilities.

So far as is known, there are no commercial deposits of *china-clay* or of *magnesite* associated with the Grenville rocks in this area. Both minerals are mined in adjacent areas, however—china-clay at Saint-Rémi-d'Amherst, 18 miles south of the present map-area, and magnesitic-dolomite at Kilmar, 30 miles south. The geological conditions that have been responsible for the formation of deposits of these minerals in the localities named are not well understood, and it is not known whether the requisite conditions were active at any point in the present map-area.

Dolomite deposits exploited for their magnesia content have been referred to on page 39.

Building and Monument Stone

The writer spent the field seasons of 1932 and 1933 in an examination of the occurrences of building stone, particularly

granite, in the Laurentian area (1). It was concluded, as a result of this work, that many of the granites, and especially some unusual varieties, that occur in the region, but are not at present exploited, might have commercial possibilities as building or monument stone. Some of these might take the place of certain stones that are at present imported into Canada because no satisfactory domestic stone of similar appearance has been found or at least exploited. The examination of any new area opens the possibility of finding unusual varieties of stone that might be economically valuable.

Several varieties of granite occurring in the present map-area have been mentioned and described in earlier pages of this report. The Guenette type, although similar to the occurrence at Guenette, cannot compete with the latter stone because of lack of transportation and other advantages. The pink granite forming a facies of the Loranger stock appears to be of good quality. Reference has been made to the possibility of quarrying the pulaskite and also to the finding of a 'pearly granite' associated with it.

No stone that might be utilized as a 'black granite' was found nor was any deep-red granite suitable for quarrying seen. In general, stone occurring in this area that might be quarried offers no advantage over stone already developed in more accessible localities in the Province. Parts of the Labelle series might provide a brownish granite, but there is little demand for such stone.

Gold

One of the reasons for doing field-work in the Labelle-L'Annonciation map-area was to gain knowledge of a typical Laurentian area which would provide a basis for geological examination along the projected provincial road from Montreal to Abitibi. The road will pass from a typical Laurentian region, in which there are no gold mines and but few known gold occurrences, to a region in which gold has been reported at numerous localities and where there are a number of mines operating and under development. It was thought that the geological mapping might disclose some reason for the differences in mineralization

(1) *See* Que. Bur. Mines, Ann. Rept. 1932, Pt. E; 1933, Pt. E.

in the two areas and show whether the Laurentian district has possibilities of becoming a gold producer. It is well known that gold occurs in several places in the Laurentians, but so far it has been found in the rocks only in traces or at least in amounts too small to constitute ore. In almost any district, pits and trenches will be pointed out where work has been done in the hope of finding valuable metals.

The gold-bearing belt of western Quebec is well-known from the mining activity in recent years. It is now believed that it and the Laurentian area form separate and distinct parts of the Canadian Shield. The most obvious way to gauge the possibility of gold deposits having formed in the Laurentian areas is to consider the similarities and differences in the geological conditions of the two sub-provinces. In the gold-bearing belt of western Quebec, the meta-sedimentary Grenville series is lacking and its place is taken by the meta-volcanic Keewatin series, which is of as great, or greater, antiquity than the Grenville. The difference in the chemical composition of the two series is not so great as might at first appear likely, for certain parts of the Grenville are similar to parts of the Keewatin. Great chemical difference in the composition of the rocks in the two districts may therefore be ruled out.

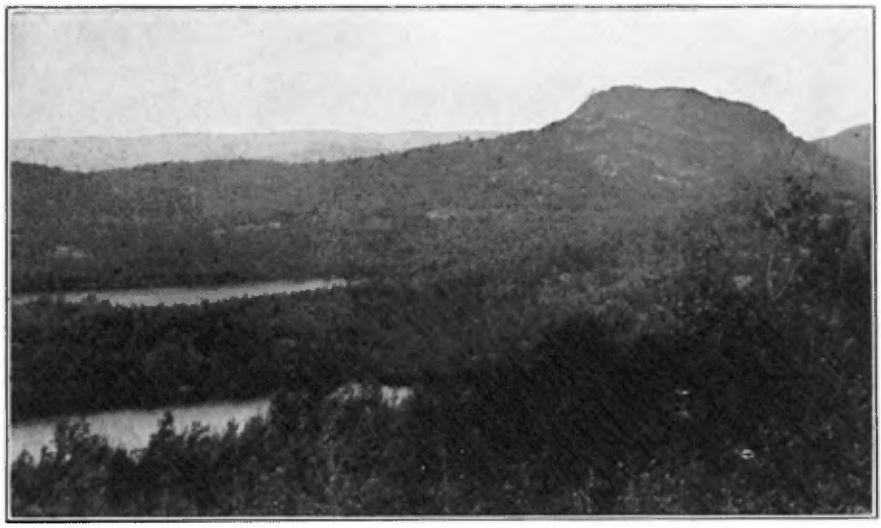
The rocks of the gold-belt tend to strike east and west, whereas those of the typical Laurentian tend to run north and south. This difference in trend indicates some difference in the geological history, but is not enough in itself to account for the absence of gold deposits in the Laurentian.

The most important difference is in the texture of the igneous rocks exposed in the two districts. Porphyries are common in the gold-belt and many of the gold deposits are related in space to them. The porphyries are commonly characterized by fine-grained matrices, indicating a satellitic rather than a plutonic habit, but they appear to be offshoots of the magma that gave rise to plutonic rocks nearby, which are commonly farther from the deposits. In the Labelle-L'Annonciation area, porphyries are almost entirely absent; all the igneous rocks are of plutonic habit. The differences in character of the two series of intrusives may be considered as a result of the rate of cooling. The porphyries crys-

tallized more rapidly than the plutonics. It is a matter of geological experience that, the closer to the surface, the more rapid the cooling, so that the rocks of the gold-bearing belt may be considered to have been consolidated closer to the surface than were the equi-granular and coarse- or medium-grained rocks. If this surmise is correct, the gold deposits that were related to the magmas that gave rise to the plutonic rocks in the Labelle-L'Annonciation area have long since been removed by erosion, along with the porphyries.

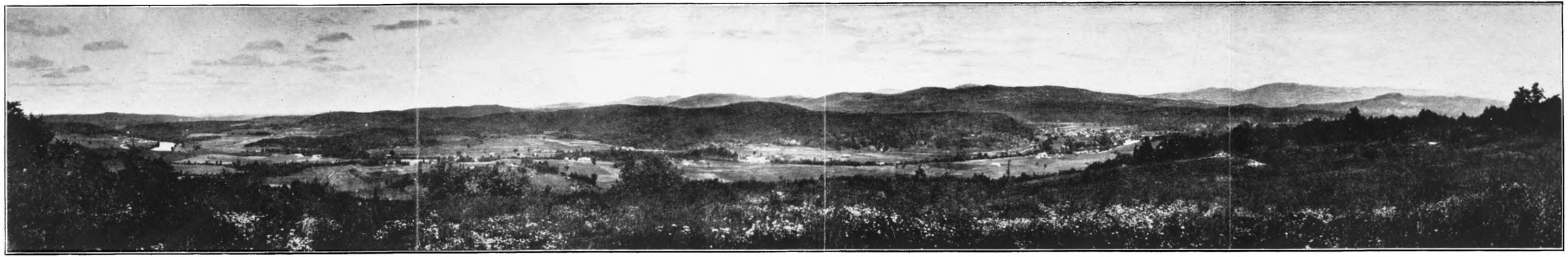
In prospecting for gold in the Laurentian province, it should be borne in mind that the porphyries are significant and search should be made near them. It is noteworthy that some of the younger intrusive rocks show narrow chilled zones, and it is possible that gold might be found along these.

One Laurentian area deserves mention as a gold-bearing zone. This is the Eastern-Ontario gold belt on the north side of lake Ontario, in Hastings and adjacent counties. This is the site of the first 'gold rush' in Ontario, in 1866. The writer examined the deposits in the zone for the Ontario Department of Mines in 1929. The geology of that area and of the Laurentian area of Quebec is not dissimilar. The Grenville series is well developed in both. In these Ontario deposits, the arsenical-gold ores are believed to be related to a medium-grained red granite. One deposit (at Cordova) appears to be related to a diabase or gabbro intrusion, and prior to 1903 it yielded gold valued at $285,000. These occurrences of gold in eastern Ontario, under conditions quite different from those in the western Quebec belt, suggest that the search for gold in the Laurentian of Quebec is not so futile as might appear. In fact, geological similarities of the Labelle-L'Annonciation and Eastern-Ontario regions led the writer to examine some small quartz veins in the hope of identifying arsenopyrite, the diagnostic mineral of the Hastings county gold occurrences. No arsenopyrite was seen, however.



A.—Prominent hill east of Labelle. The two small lakes occupy round-bound valleys gouged out by moving ice.

B.—Glacial grooves and striae in syenite. The ice moved toward the camera in the direction of the edge of the Brunton compass. The flow structure in the syenite strikes parallel to the hammer handle and the edge of the notebook.



Panoramic view of Rouge valley near Labelle. Montagne Tremblante on right. The line of demarcation between the two structural and physiographic divisions may be seen in the photograph. Note the rock cut terrace near Labelle and the gentle slope of hill tops toward the Rouge river on left.

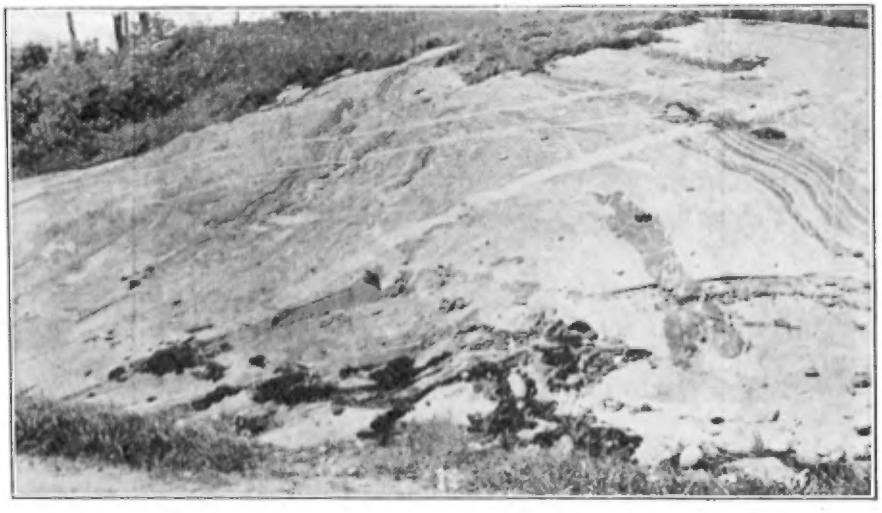
(Photo by Royal Canadian Air Force)

A.—Regional structure in Grenville (left) and granite gneiss (right). The La Belle Mining Incorporated is near the small lake upper left. An east and west tension joint runs through the small lake near the centre of photograph.

(Photo by Royal Canadian Air Force)

B.—North end of Labelle and Alphonse lakes. The northeast is the regional structure. A regional tension joint runs northwest.

F. F. Osborne



A.—Contorted Grenville series south of Sainte-Véronique.
Note how the basic bands have been pulled apart.
The light-coloured dykes are aplite.

B.—Thinly-bedded Grenville amphibolites near Lac Macaza.

A.—Contacts of granite porphyry sills (Lacoste series?) against Grenville amphibolite (under hammer).

(Photo by Royal Canadian Air Force)

B.—Lac Caribou, showing hill with "mackerel scale" topography to right of lake. The topography is due to intersecting joints in Labelle series.

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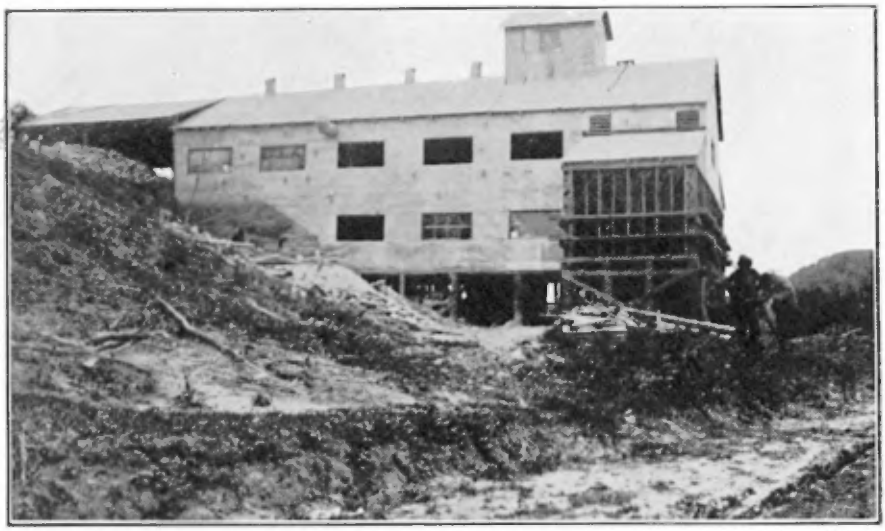
A.—Workings of McLean and McNicoll Ltd. garnet and quartz property from east side of Rouge river.



B.—Recently-erected mill, McLean and McNicoll Ltd. property.

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A.—Canada Marble and Lime Co's quarry. South end, showing apophysis of syenite (upper left).

B.—Canadian Siennas, Ltd. Stack of old mill. The bogs are on the left of the photograph.

ALPHABETICAL INDEX