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COMMERCIAL GRANITES OF QUEBEC, PART III- NORTH OF SAINT-LAWRENCE RIVER (SECOND SECTION), PART E

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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

1933

JOHN A. DRESSER, Directing Geologist

PART E

Commercial Granites of Quebec

Part III—North of Saint-Lawrence River (Second Section)
by F. Fitz Osborne



QUEBEC

PRINTED BY R. PARADIS
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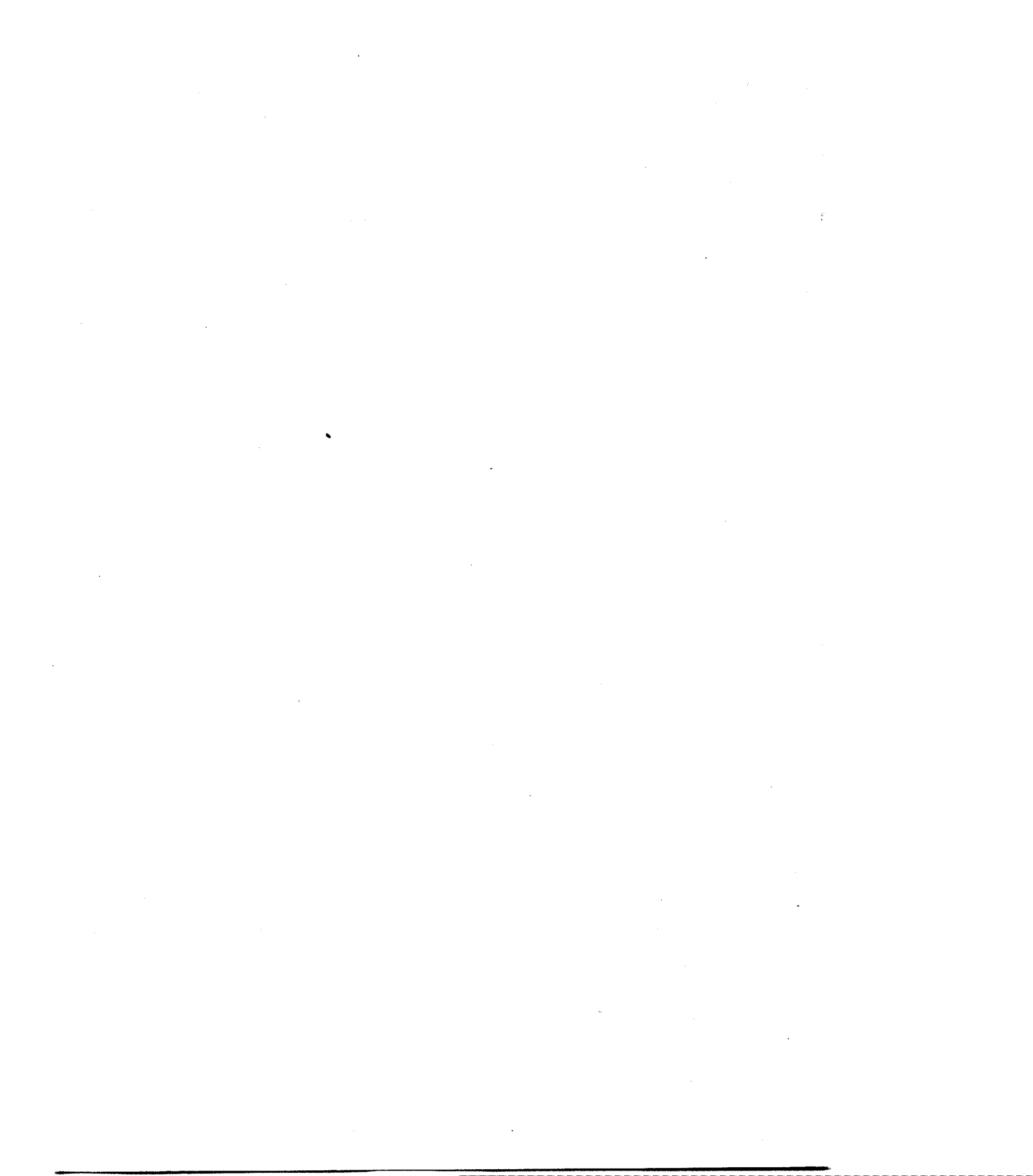
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COMMERCIAL GRANITES OF QUEBEC

PART III.—NORTH OF ST. LAWRENCE RIVER (Second Section)

by *F. Fitz Osborne*

INTRODUCTION

GENERAL STATEMENT AND ACKNOWLEDGMENTS

Fieldwork on the granites in 1933 was confined to the north side of the St. Lawrence river and was a continuation of that in 1932. In all, four months were spent in the field in visiting a number of localities from Ville-Marie on Lake Témiscamingue to Chicoutimi on the Saguenay. The granite in one of the localities visited, that near Roberval, is described by W. A. Parks in the report *Building and Ornamental Stones of Canada* (Volume III), issued by the Mines Branch, Department of Mines, Ottawa, in 1914. None of the other granites in this area are described in that report.

Maurice Scott acted as field assistant and did much to expedite the work. As in the previous season, small-scale maps were made of the important quarries, showing the direction of the structures. The maps of the larger areas were made on the township base-maps. Considerable difficulty was found in ascertaining the lot numbers, especially in those places where quarries have been abandoned.

SUMMARY OF CONCLUSIONS

The fieldwork in 1932 and 1933 shows that the geological relationships of different localities in the Laurentian area from the Ottawa to the Saguenay are alike: similar structures and formations are found in many places.

Granites devoid of gneissic structure are rare and, in general, may be expected only in the younger pre-Cambrian, say younger than the intrusion of the rocks of the Anorthosite series. Many of the granite bodies show a marked parallel arrangement of the minerals, due to flowage in the magma as it crystallized. In most of the quarries in the pre-Cambrian, this is the direction of the grain. Another structure, due to stresses originating outside the body itself, may be superimposed on the primary structure. This shearing may be local and confined to zones from a few feet to a few hundred feet thick. Near St-Gabriel-de-Brandon, such a shear-zone is 50 feet thick. The shearing reduces the stone to a fine or medium granularity, depending on the extent of the deformation, but such a stone is likely to be gneissic or, in the extreme case, layered, thus detracting from its value as a stone for monuments or buildings. The younger granites include the Roberval series, in which quarries have been worked at Roberval, Rivière-à-Pierre, and St-Gabriel-de-Brandon; and the stocks at Brownsburg and Rigaud. The granite at Guenette is probably also a representative of the young group.

The anorthosites and related rocks which form large massifs in many places in the Laurentian area are referred to as the *Anorthosite Series* (1). Some of the rocks of the series have escaped pronounced deformation, but others have been sheared. In some members of the series, the shearing has acted only to reduce the granularity of the rocks and has not rendered them visibly schistose on account of the absence of foliating minerals. The wide variety of colours, from white to black, that are presented by the anorthosite is particularly noteworthy. In addition, some varieties are pleasingly mottled in various colours.

Anorthosite has been considered difficult to quarry on account of the brittleness of the plagioclase and the absence of marked rift, but the difficulties have been overcome in the quarries operated in the anorthosite at St-Gédéon. This work points the way to further utilization of anorthosite in other localities. Large

(1) The term *Anorthosite Series* is here used for the gabbro, anorthosite, and related rocks that have been termed the Morin Series. The latter term is perhaps preferable except for its geographical connotation.

quantities of this rock, presenting a remarkable variety of appearance, are available in the area north of the St. Lawrence river.

Most of the granites older than the Anorthosite series have undergone shearing that has rendered them gneissic or, in a few localities, fine grained. Although most of such stone is unsuitable for polished dies, it may be used for building in rock- or hammered-face finish, provided the stone breaks with sufficient ease parallel to the foliation. Such a gneiss may be used effectively in rock-face in rubble work. An example of its effective use is in the Canadian Pacific Railway station at Témiscaming. At Shawinigan Falls, the Canadian Pacific Railway station has been built, in part, of a green gneiss. The blocks employed are long in proportion to their thickness. Their shape is perhaps due to the ease with which the stone may be broken parallel to the foliation.

Some of the banded gneisses might be used for interior decoration. The contrasting colour of the bands would lend itself to the carrying out of a modernistic 'motif'. The gneisses of the Laurentian could supply many varieties of such ornamental stone. The banded and contorted stone might be used cut into slabs. The writer has seen contorted and variegated gneiss used as a facing in store fronts in St-Paul, Minn. The Laurentian area north of Montreal could supply much material of the same sort.

VILLE-MARIE AREA

VILLE-MARIE

Ville-Marie, on the east side of lake Témiscamingue, was formerly a centre for the lake transportation, and granite quarried there might be transported to market *via* lake boat to connect with the railway at the lake outlet or on the Ontario side of the lake. A pink granite occurs on Pointe au Vin and Pointe au Cèdre, both north and south of Des Pères bay, on which the village of Ville-Marie is situated. A short distance east of the village, a granite consisting of greenish feldspar, pink microcline, black hornblende, and a slightly amethystine quartz crops out over a considerable area. Near Angliers, north of Ville-Marie, a diabase related to the Nipissing diabase has been exploited to some extent.

There has been no large-scale quarrying of granite near Ville-Marie. Some years ago, however, W. Chénier, who was manager of the Ville-Marie Navigation Co., became interested in the possibility of quarrying granite to provide cargoes for the boats then on the lakes. He brought O. Hébert, an experienced stone cutter, to the village in 1918, and Hébert has been engaged there in masonry work and the manufacture of monuments since that time. He has a shop equipped with compressor and a polishing bed on which he polishes stone for local use. Most of the stone is taken from loose surface blocks.

The distribution of the bedrock formations, which are similar to those of the Cobalt district (Ontario), was mapped at the time of the discovery of the mineral deposits at Cobalt. The granites exposed near Ville-Marie are pre-Huronian and, therefore, are grouped with the granites and gneisses, which are the earliest rocks of the district. The granite has no gneissic structure such as might be expected in a pre-Huronian granite. The age relationships of the granite and the Huronian rocks are well shown at the small bay near the south side of Des Pères bay, where the Huronian sedimentary rocks strike N.10°E. and dip 10°E. These rocks pass downward into an olive-green variety of the granite. The colour appears to be due to pre-Huronian weathering, for at 50 feet or so below the contact, the granite has the normal pink colour. The Huronian rocks are quartzite and other clastic rocks, and dip at a low angle. An arkose near the base of the formation is quarried near Ville-Marie for use as a building stone. Some is used as bases for monuments.

POINTE AU VIN

Pointe au Vin, or, as it is sometimes called, Pointe au Vent, west of Ville-Marie, has a knob of granite rising about 150 feet above the level of the lake. It is separated from another area of granite to the east by a saddle through which the Portage aux Sauvages runs. Granite crops out on both sides of the peninsula. The rift, which is marked by cracks extending through quartz and feldspar grains, is N.10°W. and inclined 75°W. The principal joints, which are spaced at intervals of 10 to 20 feet, strike east-west and dip 80° to 90°N. Near the point, the granite appears

to be in the largest blocks. The sheet structure is not well marked except close to the lake shore. On the south side of the peninsula, two series of joints striking N.15°W., one dipping 45°W. and the other vertical, cut the stone at close intervals. These joints have determined the resistance of the stone to erosion, so that the fore-shore has been etched-out along the places where they are closely spaced.

The same granite also crops out at the south end of Des Pères bay. The stone is similar to that of Pointe au Vin except that the grain is slightly finer, and the inclusions are not so numerous. At one place, the rift was seen to be vertical, with strike N.70°W.

THE STONE:

The stone is of a pleasing rose colour and consists of microcline, quartz, and biotite, with some hornblende. It is quite massive; in fact, the lack of foliation suggests a post-Huronian age, but the rock is definitely older than the quartzites of the district that are considered Huronian. In some places the stone has rounded inclusions of a slightly finer granular facies of its own composition; in others the dark minerals have been gathered into clots. These are defects which would detract from the value of the stone for use for monuments. However, sites where the stone is free from these defects may be found, and until a quarry has been opened it is impossible to say what proportion of the stone extracted would be unfit for monuments. It is certain that, elsewhere, granite quarries have been operated with a larger proportion of defective stone than much of the granite exposed on the lake shore here. Pegmatite and aplite dykes, which are commonly major defects, are rare: only two dykes of aplite were noted.

LAVERLOCHÈRE

The greenish granite forming the masses to the east of the railway and village at Laverlochère is commonly known as 'four colour' granite. Some loose blocks have been utilized from a locality a short distance east of the village, which is just east of the north side of the map, Figure 1. The stone, said to be available in large blocks, is saussuritized hornblende granite. The green potassic feldspar contrasts with the rose plagioclase, glassy

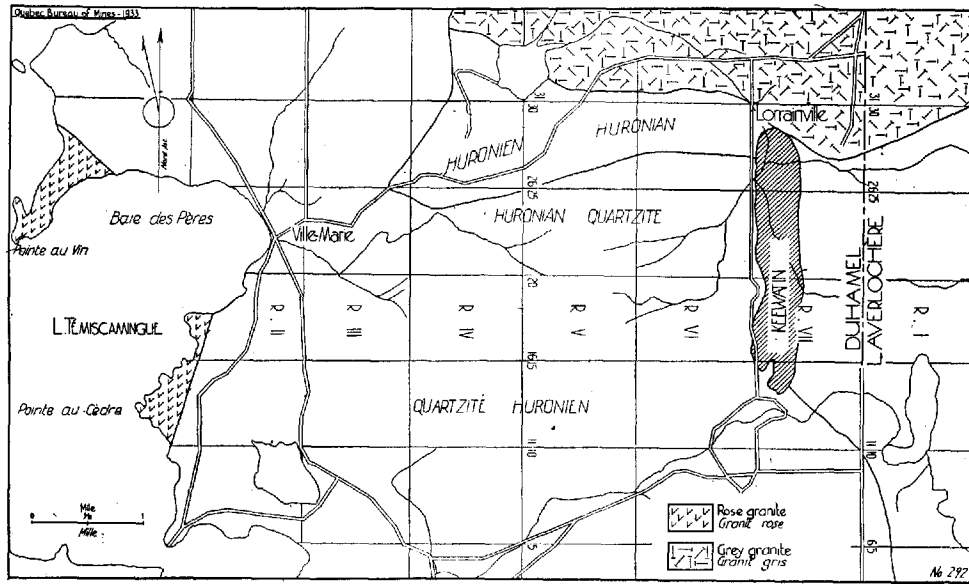


Figure 1.—Ville-Marie granite area, Témiscamingue county.

quartz, and dark-green hornblende. The stone is slightly light in tone for hammered work, and the clots of dark minerals detract from the contrast desirable in carved polished surfaces.

ANGLIERS

The 'black granite' from near Angliers is a slightly altered diabase and has the characteristics of that stone. Crystallization appears to have started about the phenocrysts of dark minerals, and the stone has a clotted appearance in the polished surface. Aside from this defect the stone has a pleasing appearance and lettering contrasts well with the polished surface.

TÉMISCAMING

The lower part of the Canadian Pacific Railway station-building at Témiscaming is of the local granite-gneiss, quarried from loose blocks. The stone has a pleasing appearance and the rock-face of the blocks does not show foliation.

LAURENTIAN AREA NORTH OF THE ISLAND OF MONTREAL

GENERAL GEOLOGY:

The district north of the island of Montreal, which was mapped by F. D. Adams, contains a number of distinct formations, some of which might yield valuable building or ornamental stone. The localities have the advantage that they are relatively close to the consuming centre of Montreal. The oldest rocks of the district belong to the Grenville series and are now gneisses, schists, quartzites, and crystalline limestones. These were intruded and metamorphosed by the plutonic rocks, which have themselves been rendered gneissic by mountain-building forces. The anorthosites and related rocks of the Anorthosite series that underlie a large part of the area intruded gneissic granitic rocks but were introduced while mountain-building stresses were still operative, for they themselves underwent deformation before they were completely consolidated.

The granites younger than the Anorthosite series have escaped the deformation that made the older rocks gneissic. The coarse granite and syenite that crop out near Pine Hill, in Chatham township, and are cut by the east-west trending quartz-dykes, are younger than the Anorthosite series. The quartz-dykes are themselves cut off by the stock of granite and syenite outcropping in Chatham and Grenville townships. The granites and syenites near Pine Hill are representatives of a type widespread in the Laurentian area. The shapes of many of the smaller bodies of this series conform to the structure of the containing rocks, suggesting a phacolithic type of intrusive body. Insofar as known, the only quarry in this formation in the area, aside from pits for road metal, is that at St-Gabriel-de-Brandon, but the granites of the same series are exploited near Rivière-à-Pierre and Roberval.

The stocks and related intrusive rocks in Chatham and Grenville townships, and the composite stock at Rigaud, are the only known representatives of the series younger than the quartz-dykes. The quarries in these formations were described in the writer's report for this Bureau in 1932.

ECONOMIC POSSIBILITIES :

In this area, the formations younger than the Anorthosite series have yielded the most valuable building material, for they are not gneissic. It is not true, however, that the older formations are without value as building or ornamental stone. The anorthosites, or plagioclase rocks, have been sheared, but owing to the peculiar mineralogical composition, the deformation has left them massive. The white anorthosite near New Glasgow is an example of a stone that has undergone some deformation, with a resulting improvement in its quality. Some of the occurrences of anorthosite which might prove useful as ornamental material, more especially as stone with an extraordinary diversity of appearance, include different types which are deep purple to almost black, others deep green, and still others marble-white. In some localities, also, the stone is pleasingly mottled in various shades of green, purple, and rose.

In the opinion of the writer, the anorthosite area north of the island of Montreal contains, in a number of localities, stone of potential value for use as ornamental material, but no attempts have been made to exploit it for this purpose. The experience gained in quarrying anorthosite at St-Gédéon might be usefully applied in this area, which is close to Montreal. In most places, the rift (easiest breaking direction) of the stone is parallel to the planes of shearing, which may be either vertical or, as shown in Plate I-A, horizontal. In quarrying the stone for ornamental uses, it might be advisable to channel and saw it. Much of the stone imported into Canada is won in this fashion.

Laurentian Gneisses.—Many of the older gneisses should not be overlooked as sources of ornamental stone, especially for interior use. The gneissic structure, which, in general, detracts from the value of a stone so far as its use as building material is concerned, makes some of these Laurentian granites of particular interest as ornamental material. The banded structure might be particularly useful in carrying out a modernistic 'motif' in decoration. Examples of these gneisses, selected from the very great variety available, are illustrated in Plates II-A, IV-A, and IV-B. Plate II-A represents one of the group of 'augen', or eyed,

gneisses, a type common in the area north of Montreal. The stone is rose with a black pattern. The pattern can match in intricacy that of some variegated marbles, and the gneiss is much more durable than the marble.

The modern tendency to saw stone and use it as facing would make it possible to quarry domestic material to replace some of the more expensive varieties now imported. It is not suggested that large quarries should be opened. A relatively small opening would yield considerable stone for use as facing.

MOUNT CALVAIRE AREA

MOUNT CALVAIRE

GENERAL GEOLOGY:

Mount Calvaire is the name given to the eminence on the north side of the Lake of Two Mountains. It is an outlier of the pre-Cambrian rocks surrounded by the younger rocks and thus is similar to Rigaud mountain, on the south side of the lake. The village of Oka is near the lake flank of the hill, and the monastery at La Trappe is another landmark on the south side. St-Joseph-du-Lac is on the east side.

The southern slope of the mountain is underlain by rocks of the Grenville series. A band of crystalline limestone more than half a mile wide runs northwest through La Trappe. Gneisses of the Grenville series outcrop east and west of this band. On the north side of the hill, the Grenville rocks terminate against a body of anorthosite and related rocks. The high hill locally known as Mt. Alexis is composed of anorthosite, which is indicated by the rules pattern on the accompanying sketch map (Figure 2). Some very basic rocks of the same age as the intrusive rocks of Mount Royal are restricted to the Grenville Limestones. They form the breccias and dykes near La Trappe and widen to give the large mass of intrusive rock on the Husereau farm.

ECONOMIC POSSIBILITIES:

No stone has been quarried on Mount Calvaire except for road surfacing. The Grenville gneisses and limestones are too

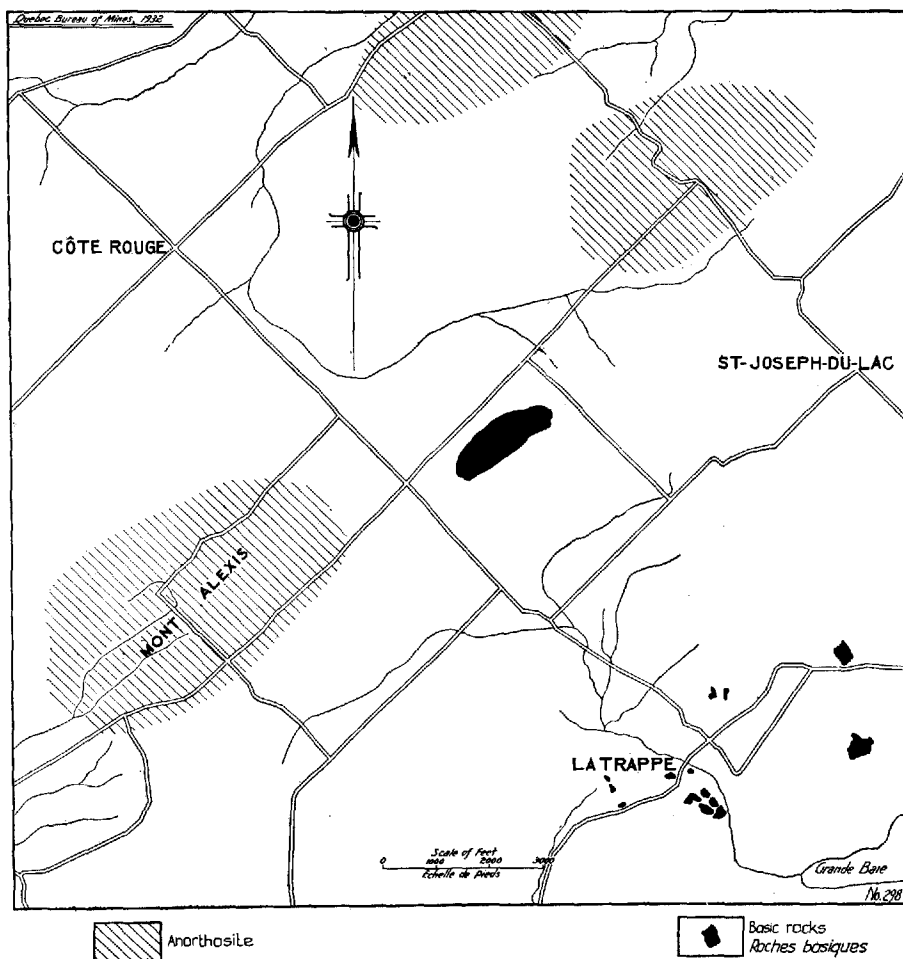


Figure 2.—Mount Calvaire area, Deux-Montagnes county.

broken to give good building or ornamental stone, but the anorthosites present some possibilities.

The anorthosites are not constant in character over a wide area, but uniform patches several hundred feet square may be found. In places, the rock contains much dark mineral and so becomes a gabbro. In others, however, it is devoid of dark minerals and is of marble whiteness. In some occurrences, the

feldspar is pinkish in streaks, and the fresh surface of the rock is very pleasing. The stone might be quarried for building or monument stone. It has the appearance of a high-grade marble and the durability of granite.

Examined in thin section, the typical rock is seen to be composed almost entirely of labradorite feldspar, which is free from iron-ore inclusions; dark (ferromagnesian) minerals are in very minor amount. The rock is high in alumina and lime and low in magnesia and iron, a composition that might enable it to be used in some of the chemical industries.

The basic (Monteregian) rocks mentioned above are not of interest for building or ornamental uses, but they afford serviceable road material. The mineral constituents of the rock become separated from one another on weathering, and in places such gravel-like material is used as road dressing. No true granites were found in the area.

ST. ANDREWS MOUNTAIN

The hill west of Oka shows weathered anorthosite at the summit. A granite resembling that at Pine Hill occurs north of St. Andrews, near where the road crosses the railway.

NEW GLASGOW AREA

NEW GLASGOW

New Glasgow is near the edge of the overlap of the Ordovician rocks on the pre-Cambrian. The pre-Cambrian rocks form low hills, which rise here and there, to the north of the village, through the mantle of the drift. The oldest rocks, those of the Grenville series, have been intruded by igneous rocks of several ages (see Plate III), the most prominent of which are the anorthosite and related gabbros.

The anorthosite and gabbro have been quarried for use as paving blocks. The former is particularly tough and cuts with ease. The blocks suffer from the disability that they are composed only of plagioclase feldspar, which, under the abrasion of traffic, tends to wear to a uniform slippery surface. Several hundred

thousand blocks were cut and sent to Montreal prior to 1914. The stone is pale green, almost white, in colour and could be used for buildings. It breaks easily under the hammer and is suitable for rock-face ashlar for small structures. Its light-coloured surface is very pleasing.

GABBRO:

The Geological Survey map shows a narrow band of gabbro cutting the anorthosite parallel to its strike, which is approximately parallel to the course of the Achigan river. The band emerges from the drift-cover just west of the village of New Glasgow and continues north. The gabbro has undergone deformation along with the anorthosite, for it is markedly sheared and new minerals have been developed. The feldspar has been altered and the original mafic minerals have been changed to amphiboles. Corundum has been formed in microscopic grains. Some polished surfaces have a very pleasing appearance, and the stone might well be utilized for interior decoration, for which its colour and the contrast of its constituent minerals make it particularly suitable. The groundmass is dark green and is studded with abundant pale green crystals of saussuritized feldspar and a few jet-black crystals of mafic minerals. The stone is very tough and could be sawed. It weathers to a buff colour with a pitted surface, and the joints, which are relatively closely spaced, are also etched out. This close jointing is the principal disability of the stone, but in places where the jointing is wide, it might well be exploited for decorative uses. Some paving blocks in use in the city of Montreal are probably from this band, but the site of the quarry is not known to the writer.

ANORTHOSITE:

Anorthosite has been quarried on the land of Eugène Sanscartier, at a place about 400 yards north of the railway track near the station at New Glasgow. The main quarry is 50 by 40 feet and 6 feet deep. The rock, which is very pale greenish, is cut by irregular joints, but their spacing is sufficiently wide that moderate sized blocks can be quarried. The strike is N.50°E. and the dip 70°W, and the most prominent joints are vertical and strike east-

west. Cutting the anorthosite are two gabbro dykes. To the east of the quarry these are fifteen feet apart and each thirty feet wide, but a short distance north of the quarry they coalesce and narrow to six feet. One hundred and twenty yards northeast of the main quarry are two smaller openings in stone of the same kind. The quarrying was done by a Mr. Lawrence.

Two quarries have been opened in a green anorthosite three-quarters of a mile north of the last locality, on the same road, on land owned by Thos. Brophy. The more northerly of these quarries is 40 by 40 feet with a face of 20 feet. The other is 40 by 10 feet with a face of 8 feet. The anorthosite contains sporadic large crystals of garnet. The horizontal joints in both quarries are irregular and no sheet structure is developed. These quarries, also, were operated by Lawrence.

One mile north of here, on the Racine farm, are two other quarries which were worked by Lawrence. These are on the east side of the road, in a green anorthosite containing sporadic garnets. In places the rock contains large crystals of plagioclase which have not been sheared and which have a mauve colour. The foliation is N.15°E. and dip 70°W. The principal opening is 50 feet long and 20 feet wide with an 11-foot face. Another minor opening to the north continues below water level.

Two small openings were made on Miss Hale's property just north of the west end of the village. One is 20 by 20 feet with a face of 5 feet, and is near the falls on the Achigan river. Another quarry, in a bluish anorthosite, is about a quarter of a mile upstream from the last. The opening is 15 by 10 feet with a 7-foot face.

SAINT-JÉRÔME

A small opening has been made near the road that skirts the cemetery about a quarter of a mile from the village of St-Jérôme. The gneissic structure is N.40°E. and dip 65°N. The quarry opening is only about 10 by 15 feet and 6 feet deep. No sheets are exposed in the quarry. The stone is a coarse-grained granite-gneiss and contains a small amount of garnet. The coarse structure and the marked foliation make the stone unsuitable for any use except rough construction.

SAINT-GABRIEL-DE-BRANDON

GRANITE:

A large body of granite crops out east of the village of St-Gabriel-de-Brandon. As delineated on the general geological map of the district, the area has the shape of a parrot, with the beak to the east and the tail extending south of St-Gabriel. Most of the stone has a coarse grain. A finer-grained chilled facies is found near the margins of the massif, and elsewhere, in some places, the grain is medium or fine as a result of local shearing; but this granite is younger than the intense regional shearing, which appears to be of the same age as the Anorthosite series. Also, it contains inclusions of a gabbro, probably related to the anorthosite, at a locality east of St-Alexis, on the south side of Rivière-du-Loup. These evidences indicate that the granite is of the same age as the Roberval and Pine Hill granites. The coarse texture of the granites from the three localities and their mineralogical similarity make the correlation more certain.

A rock with a coarse grain such as this is likely to have widely-spaced joints and thus to be suitable for construction stone and curbstone. In many places, this particular granite is very massive and the joints are widely spaced. It has been quarried in only two places. One quarry was opened 960 yards east of the road leading south from St-Gabriel. A cross-road running east passes within a few feet of the opening, which is 20 by 20 feet with a face of 7 feet. The stone is a coarse-grained biotite granite and was used for the construction of a church in the village.

The church at St-Alexis is built of fine-grained granite gneiss occurring near that village.

In places, along local fault-zones, the granite has been sheared. The fault planes appear to dip north at a low angle, and the zones are about 50 feet thick. The rock has been reduced to a fine granularity by the shearing, but the foliation is noticeable. It is not, however, so marked as to render the stone unsuitable for monument or ornamental purposes, provided due care were taken in the cutting. The colour is a rich rose. Such material is exposed both north and south of lake Mandeville.

A green pyroxene granite crops out near Norbert, which is on the highway south of St-Gabriel. The stone, which is probably a member of the granulite series such as is found at Chicoutimi, has undergone deformation but appears massive. The joints are widely spaced. This stone resembles very closely the green granite of Chicoutimi.

GABBRO:

The gabbro occurring east of St-Alexis and near Lac Caebé might be utilized as 'black granite'. In places, it is massive and the joints are spaced at a sufficiently wide interval to allow quarrying of blocks. As in most black granites, the stone lacks a marked rift.

SHAWINIGAN-GRAND'MÈRE AREA

A geological map of an area about Shawinigan Falls and Grand'Mère was made, not only to show the distribution of the several formations yielding or suitable for building stone, but also to indicate those that might yield minerals that could be manufactured into commercial products, for which purpose abundant electrical energy is available at Shawinigan Falls. Stone of two different formations has been quarried. Some of the material has been employed for building and construction purposes, but most of it has been used as aggregate in concrete for the dams and development work along the St-Maurice river.

GRENVILLE SERIES

The oldest rocks of the district belong to the Grenville series. In this district, just as in the Laurentian area to the east, the series is divisible into two parts.

LOWER PART OF THE GRENVILLE SERIES:

The lowermost part is derived mainly from basic volcanic flows or tuffs, although it may include some completely recrystallized graywacke. The exposed thickness of this part of the series is less than 2,000 feet. The formation tends to be rather massive, although foliation is noticeable in places. The rocks now

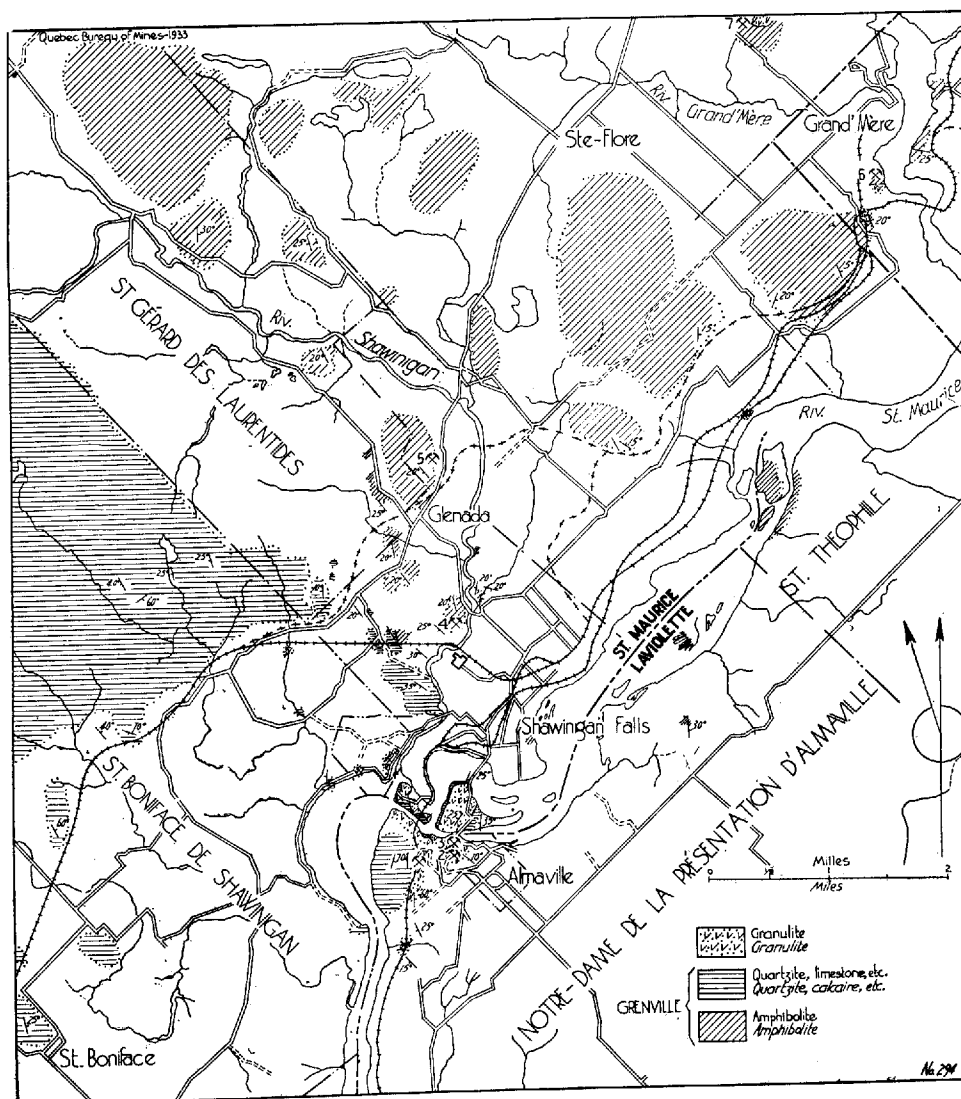


Figure 3.—Shawinigan-Grand'Mère area, Saint-Maurice county.

are all amphibolites and consist essentially of plagioclase feldspar with hornblende. Some varieties contain considerable pyroxene, and a few a small amount of biotite. The dips in most places do not exceed 20 degrees and the folding is irregular.

Economic possibilities.—The lower part of the Grenville series contains some stone suitable for construction purposes, but being uniformly amphibolite, it is unlikely to yield non-metallic economic products.

UPPER PART OF THE GRENVILLE SERIES:

The upper part of the Grenville series is quite different from the lower part. It consists predominantly of quartzite, schists, and gneisses derived from sedimentary rocks, but with some associated bands of crystalline limestone. The upper and lower part of the series appear to pass into one another by rather sharp gradation. The limestone bands are from one foot to 100 feet thick and are associated especially with bands of rusty-weathering gneiss. In fact, it is quite possible to forecast the position of the bands of limestone from the occurrence of this rusty weathering rock.

The limestones seen are extensively silicated. Throughout the whole upper part of the series, garnets are common. In the quartzite they are associated with large crystals of feldspar, and in the gneiss with sillimanite, etc.

Structure.—The upper, sedimentary, part of the Grenville series dips more steeply than the underlying amphibolites. A well-defined syncline, striking north-south and with dip of 50° on the limbs, crosses the west side of the area. During the folding, the rock masses were elongated north and south and minerals were drawn out in that direction.

Economic Possibilities.—In some places, rocks of the upper Grenville series have been quarried for building stone and also for concrete aggregate. The series also presents other possibilities. In places it might yield a quartzite sufficiently pure for other industrial uses. The limestone or dolomites may find some uses, although in most of the outcrops seen they are highly silicated. The aluminous parts of the formation have been altered to garnet-sillimanite gneiss, and in some places there may be an adequate concentration of sillimanite, andalusite, or cyanite for the manufacture of refractories. Near the falls on the St-Maurice river, from which the town gets its name, the gneisses of this part of the Grenville have been altered to hornfels by an intrusion of

granite. The hornfels contains small amounts of chalcopyrite and sphalerite, with pyrite, as well as contact silicate minerals.

PYROXENE GRANITES AND SYENITES (GRANULITES)

The Grenville series is cut by sills of pyroxene-granite and syenite (granulite). These rocks, which contain green monoclinic pyroxene and a little hypersthene, were folded and drawn out together with the enclosing Grenville series. The resulting masses are elongated in a north and south direction and plunge with the structure at angles of 30° or less.

In some places, the deformed phenocrysts of this rock are coloured pink and contrast strongly with the dark matrix, resulting in a stone of very pleasing appearance (see Plates IV-A and IV-B). Some of the stone quarried near Farmer's siding is of this type. Unfortunately, there is not a large amount of this attractive material available.

Economic Possibilities.—The rocks of this formation are quarried for road metal and construction stone. The occurrence of sulphide minerals in the Grenville rocks adjacent to this intrusion was mentioned in a previous section.

GRANITES

Some small bodies of massive granite, of later age than the deformed rocks just mentioned, are found along the railway line between Shawinigan Falls and Grand'Mère, and in places, also, the Grenville rocks are cut by granite pegmatites. The source of the latter may be found in an augen granite which cuts the gabbro northwest of the area covered by the map and which is, in all probability, the local representative of the Roberval granite.

Pegmatite dykes.—Pegmatite dykes of several ages occur near Shawinigan Falls. Some are older than the folding of the Grenville series, for they have been rendered schistose with the surrounding formation. Others are younger than the pyroxene granulites but appear to have suffered some deformation, for the feldspars are of an augen habit. The youngest dykes of pegmatite are of the segregated type and have not been involved in any deformation.

Dykes were noted in a number of places near the town. Several are to be seen on the small promontory west of the Canadian Pacific railway, on the south side of the St-Maurice river. One of these was found to be 95 feet wide and consists of quartz and microcline with a small amount of biotite. A partial analysis of the feldspar it contains is as follows: Al_2O_3 , 17.53%; Na_2O , 3.62%; K_2O , 10.93% (1). The biotite is well segregated and it would not be difficult to make a product low in the dark minerals. The material might be used for glass-making or for abrasive powder.

QUARRIES, SHAWINIGAN-GRAND'MÈRE AREA

QUARRY 1: LOUIS BERTRAND

The principal quarry near Shawinigan Falls, and one that must have supplied a great deal of stone for the construction of the power plant and dams, is near Farmer's siding on the Canadian Pacific railway on the east side of the river, on lots 158-160, Rang des Grès. The main opening is 1,375 feet long and $\text{N.}25^\circ\text{E.}$, with face from 20 to 40 feet high. At the north end of the quarry the face has been advanced farther than that on the south. This part of the quarry is 250 feet long by 200 feet wide, with a face of 75 feet. The jointing throughout is irregular.

The larger part of the quarry is in the granulite, which is in places garnetiferous. The crystals of plagioclase have been drawn out in a north-south direction during the deformation. In some parts of the quarry the drawn-out feldspars have a very striking appearance and the stone might be used as a decorative material (see Plate IV-A). The rest of the quarry is in rocks belonging to the upper part of the Grenville series, which has been converted to a gneiss. Original limestone and shaly beds may be recognized. A small amount of pyrite, pyrrhotite, and chalcopyrite associated with contact silicates are found in the hornfels close to the granulite.

The crushing and screening equipment, as well as the bins

(1) Analysis by M. Archambault, Que. Bur. of Mines.

for storing the stone, have been dismantled. A small amount of stone, principally granulite, is still quarried here by Louis Bertrand and is sold for construction work. The granulite with the elongated augen of feldspar has potential value as ornamental stone.

QUARRY 2: JOS. BERGERON

A quarry has been operated in the village of Almaville by Jos. Bergeron, on lot 160, Rang des Grès. The face is 250 feet long, in a direction N.60°E. The height of the face is 10 feet. The stone is a sheared pyroxene-granulite, containing about 20 per cent quartz and sporadic large crystals of garnet. It has a uniform appearance, with a greenish cast that is lighter in colour than the stone from the City of Shawinigan Falls quarry. The sheets are from two to six feet thick, and the principal joints are N.40°E. (85° N.W.) and N.50°W. (vertical). The foliation dips 10°S.W.

A small opening has been made to the west of the one here described, in a similar stone.

QUARRY 3: CITY OF SHAWINIGAN FALLS

The city of Shawinigan Falls operates a quarry near the road on the south side of the St-Maurice river, near Almaville. The quarry, which is on land owned by the Shawinigan Water and Power Co., is on lot 163, Rang des Grès. It was opened about 1925.

The stone has been used for construction purposes. At the time of the examination, material was being quarried for the facing of the promenade along the river in the city of Shawinigan Falls. The quarry is about 450 feet long, and the face, which is 15 feet high, has been advanced 60 feet to the southeast.

The stone is green, medium-grained, porphyritic granulite and contains garnet in places. The foliation dips at a low angle and is inclined to an indistinct rift, which is approximately horizontal. The joints are closely spaced and irregular, and, in some places, the feldspar of the rock has been stained pink near them.

QUARRY 4: ALPHONSE DONTINGNY

The quarry on lot 13, range 1, Shawinigan, operated by Alphonse Dontingny, is in amphibolite and granite gneiss of the top of the lower part of the Grenville series. The quarry has supplied some material for foundations, but most of the stone has been crushed for the city of Shawinigan Falls in an 8 in. by 14 in. jaw-breaker on the property. Twelve men were employed at the time of the writer's visit in 1933. The total stratigraphic thickness of the series in the quarry is about 100 feet. The strike of the bedding and foliation is N.50°-55°W., and the dip 20°-25°W. The amphibolite and gneiss are cut by pegmatite dykes, which tend to be somewhat steeper than the foliation, and some of the coarser grained dykes have a distinct augen structure.

There are two quarry openings. The eastern one is on the edge of the hill and is triangular in plan, with its two sides 125 feet (N.60°E.) and 100 feet (N.20°W). The face of the longer side is from 10 to 20 feet high, and of the other from 0 to 10 feet. The stone on the west side of this quarry has relatively few pegmatitic stringers.

The other opening has been advanced about 100 feet and is 50 feet wide with a 10-foot face. It is separated from the larger one by 20 feet of unquarried rock. Here, however, the cover of till is as much as three feet and this increases the expense of quarrying the stone.

The more basic amphibolite is considered more suitable than the granite for crushed and coursing stone. The ease with which it may be split parallel to the bedding and foliation makes it particularly suitable for the coarser sorts of rubble masonry.

QUARRY 5: ELIE GRENIER

Elie Grenier has produced some material for concrete aggregate from the talus at the foot of a cliff of amphibolite and gneiss on lot 3, con. Des Piles. The face, which is 95 feet high, consists of gneiss striking N.45°W. and dipping 17°W. About one-third of the material in the cliff is of igneous origin. Work has been carried on here for about five years. A small crusher and bins were being installed in 1933.

QUARRY 6: LOT 42, RANGE SAINTE-CATHERINE, SHAWINIGAN

This quarry was operated in conjunction with a gravel pit for production of concrete aggregate for the power-house and dam at Grand'Mère. The quarry, which is about 100 feet below the level of the Canadian Pacific Railway station, is about 100 feet long with a face of 30 feet. The stone is irregularly jointed and consists of a sill-like body of granulite cutting gneisses of the lower part of the Grenville series. Both rocks appear to have been metamorphosed together. The foliation is N.30°E., with dip 30°S.

QUARRY 7: CITY OF GRAND'MÈRE

This quarry, which was operated by the city of Grand'Mère, is owned by Arthur Gagnon, and is on lot 12, con. De la Grand'Mère. The quarry, which is rectangular in plan, is 190 feet long and 80 feet wide. The highest part of the face is 20 feet. Here, amphibolites of the lower part of the Grenville series have been cut by sills of granulite, which are in turn cut by some dykes of pegmatite. The material has largely been used for road metal. A crusher and bins stand at the entrance to the quarry. The shape of the quarry makes it necessary to use considerable dynamite for breaking the stone.

VALCARTIER

The formations in the vicinity of Valcartier are similar to those at Rivière-à-Pierre, whose granites were described in the report for 1932. Stone similar to the two varieties from Rivière-à-Pierre has been quarried to some extent near Valcartier, but the district deserves greater attention as a possible source of building stone for the market in the city of Quebec, which is distant only about 16 miles.

Several small quarries have been opened near Valcartier. Hills composed of several formations, including granite gneiss, quartz diorite, and granite, rise above the sand plain. No attempt was made to delimit the several formations, nor does Ellis, in the map accompanying his report on the district, distinguish them.

He mentions the fact that stone was quarried here for the railway bridge across the Jacques Cartier river, but does not state the lot from which it was taken. This bridge, which is near St-Gabriel-de-Valcartier, has now been converted to a highway bridge and is just below the dam on the river.

The quarry from which the stone was obtained was opened on a low outcrop on lot 263, St-Gabriel-de-Valcartier, on the McCarthy farm. The stone is a sheared porphyritic-granite of pink colour. The strike of the foliation is N.30°E. and the dip 55°W. The sheets are massive, and the joints are widely spaced. The workings are irregular and stone has been extracted in several places. Little work has been done since the stone for the piers for the railway bridge was taken out.

Another quarry, on lot 277, Ste-Catherine range, is 200 feet long and the face is 18 feet. The joints are spaced 12 to 15 feet apart and the sheets are 12 to 14 feet thick. The stone is coarse-grained hornblende granite containing abundant allanite. The quarry is south of the river, about 100 feet from the road.

The most recent work in this vicinity was done on lot 400 by Ignace Bilodeau, in 1912 and 1913, when curbing and paving stone were shipped. The property is now owned by Wm. Thompson. The stone is a quartz diorite of medium granularity with a foliation N.50°W. and 80°N. The stone is a trifle finer grained than the blue-grey granite of Rivière-à-Pierre, but is probably a related intrusive. The rift is horizontal, and the grain follows the foliation. Only the top sheets, which are about three feet thick, have been extracted. Another small opening was made on the north end of the same ridge as that on which the quarry is located. The stone here is slightly coarser. A body of quartz diorite is exposed along the river near the abutments of the railway bridge mentioned before.

ROBERVAL AREA

Roberval is the largest town on the shores of lake Saint-Jean and is the distributing centre for products for the numerous villages around the lake. The granite quarried near Roberval is

used locally for public buildings and monuments, and some has been shipped as far as Quebec city.

The physiography and geology of the area have been described by Dresser in a report (1) issued by the Geological Survey of Canada. The map accompanying the present report is modified after Dresser's. He divides the area into the lowland surrounding the lake and the highland area farther from the lake. The farmlands are principally in the lowland area, and here the roads are better and more numerous than on the highland. The granites exploited near Roberval form knolls rising above the covering of drift and Palæozoic limestone of the lowland. The quarries are close to roads, and, therefore, the stone is easily transported to the market. Bodies of granite are known in the highland also, but they are considerably farther from transportation facilities.

GRENVILLE AND LAURENTIAN ROCKS

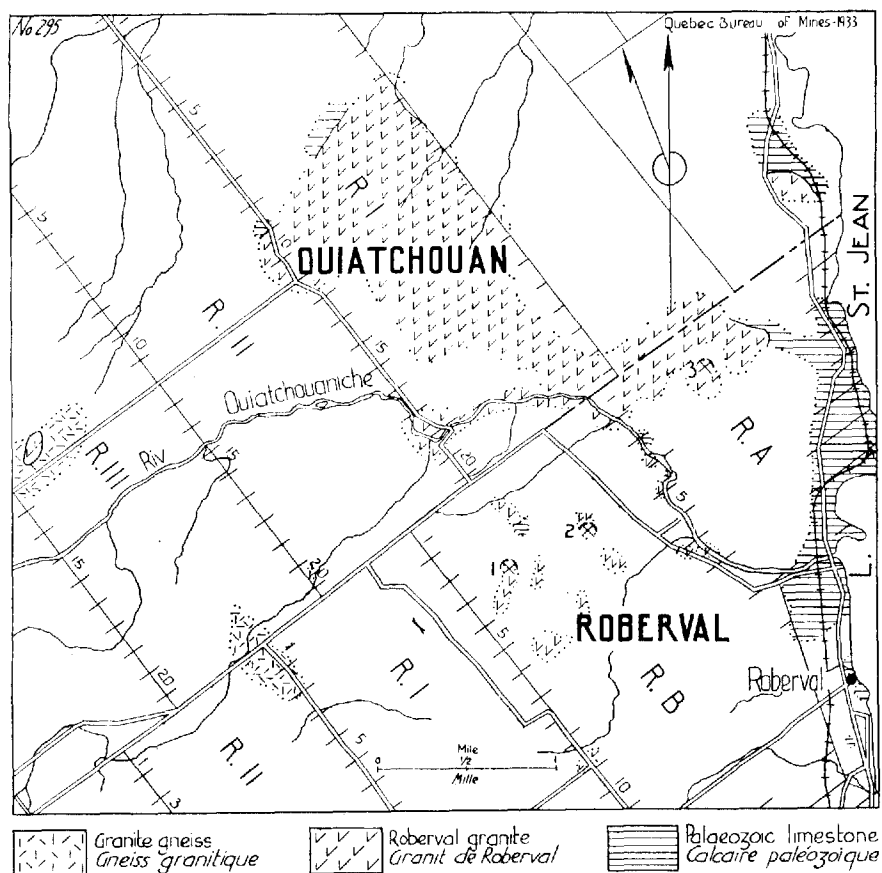
The gneisses and limestones of the Grenville series are not abundant near Roberval. They are found only as inclusions or remnants in the rocks of the Laurentian series. The latter consist of grey, foliated granite or gneiss. The strike of the foliation is approximately north-south, and the dip is steep. The rocks of this series in the vicinity of Roberval are not used for building stone on account of the foliation.

The Grenville and Laurentian rocks are cut by gabbro and anorthosite, which will be described in more detail in the section dealing with the St-Gédéon district, where they were being quarried for monuments during 1933.

ROBERVAL SERIES

The youngest recognizable pre-Cambrian rocks in the vicinity are the granites to which Dresser has applied the name *Roberval*. It is the granites of this series that have been exploited. They are extensively developed in the pre-Cambrian area bordering the St. Lawrence river from the Ottawa river on the west to at least as far east as Baie-Saint-Paul. Throughout the region they show

(1) Dresser, J. A., *Part of the District of Lake St. John*, Geol. Surv. Can., Mem. 92, 73 pp., map. 1916.



features in common that make their correlation relatively certain. Thus, they are noteworthy for their coarseness of grain and porphyritic appearance, the latter due to the relatively large feldspar crystals. The predominant feldspar is microcline, but albite is found as large sporadically-distributed crystals of a purple colour. The quartz content ranges from 5 per cent, in rocks that might be termed syenites, to about 25 per cent in the true granites. The quartz invariably fills the interspaces between the feldspar crystals, and is of the same order of size as the hornblende and biotite. The Roberval granites appear to have escaped the deformation

that accompanied the intrusion of the rocks of the Anorthosite series. They are older than the younger-diabase dykes of the Laurentian area. The only pre-Cambrian granite known to be younger than the Roberval granite is that forming the Chatham-Grenville and Rigaud stocks, which are described in the writer's report for 1932.

Dresser has suggested that the coarse granite at Ha! Ha! bay is of the same age as the Roberval granite, and this conclusion is borne out by the writer's field work. It is certainly similar in age, composition, and structural relationship to the rose granite of Rivière-à-Pierre, also described by the writer. Other large bodies of a similar granite were noted along the line of the Canadian National railway between lake Saint-Jean and Rivière-à-Pierre. The very coarse granite east of St-Gabriel-de-Brandon is also of the same age and structural relationship as that at Roberval. It is described in another section of this report.

STRUCTURE OF THE ROBERVAL GRANITE:

The Roberval granite shows a marked parallel fluidal arrangement of the constituent minerals. This structure dips at a low angle and does not coincide with the direction of the rift. The large crystals of feldspar were brought into alignment by movement in the magma. No part of the body is very massive, but the foliated structure is most marked near the margins. Besides the alignment of the constituents brought about in the magmatic stage, later movements have resulted in a marked granulation, with the production of augen, or eyes, of feldspar along local zones. The granulation is particularly marked near the fault close to St-Prime, where the grain is reduced to such an extent that the gneiss would be considered medium rather than coarse grained. In places, dykes cutting the granite have been granulated along with the granite, and a rock with a gneissic banding results; but some dark dykes that cut the gneissic granite are themselves massive.

Pegmatite dykes.—In some places, dykes of pegmatite are found around these granites. The prevailing coarse grain of the Roberval granite itself suggests that pegmatite dykes should be numerous. A few of these dykes have been exploited as a source

of feldspar (microcline), quartz, and mica, and the occurrence of such dykes in this area should not be overlooked.

PALAEOZOIC LIMESTONE

An outlier of the Palaeozoic limestones that underlie the St-Lawrence lowland is found well within the pre-Cambrian area about lake Saint-Jean. The limestone forms the bedrock beneath much of the agricultural land, and the stone is used for the manufacture of lime as well as for building-construction and road metal. Much of the lowland area is covered with glacial till and gravel. The sand and gravel provide an abundant supply of material for roads and for concrete aggregate.

QUARRIES, ROBERVAL AREA

QUARRY 1: POLYCARPE MOREAU

The quarry of Polycarpe Moreau is on the northwest edge of an outcrop of granite near the northwest side of parcel 82, which is lot 3, range *B*, Roberval township. It is about 800 feet from the public road, with which it is connected by a private road.

HISTORY:

Polycarpe Moreau, who owns the quarry but rents the ground from Meridé Girard, operates a stone-cutting establishment at Roberval. The quarry was opened in 1931 to furnish stone for the new church at Roberval, which required about 15,000 feet. Since the completion of the work for this contract, the quarry has been operated largely for monument stone, and about 200 feet a year has been taken out.

THE QUARRY:

The quarry, shown in Plate V-A, is 120 feet long in an east-west direction, and the face, which is 22 feet at the highest point, has been advanced about 20 feet south into a gently sloping hillside. The joints are irregularly distributed and many of them are 'blind'. The direction of foliation of the rock is N.10°W., with dip 35°E. The rift is approximately horizontal, and the

grain, which is vertical, strikes N.10°W. The stone shows a banding—a primary flow structure—with certain bands richer in feldspar than the adjacent ones. In places, later shearing parallels the direction of this flow structure and has given rise to the augen structure already described. At a place 300 feet toward the summit of the hill, the shearing is seen to cut through the quartz and feldspar grains of the granite and also to cut an aplite dyke.

The granite is different in appearance from that of Bernier. It consists of about 75 per cent of a coarsely-crystalline deep-pink microcline, held in a matrix of biotite, hornblende, and quartz. The stone shows an appreciable foliation, but the rich colouring is very pleasing. Plate I-B is of a monument built of this stone. The base consists of the same stone hammered.

QUARRY 2: BERNIER QUARRY

The Bernier quarry is the largest and best known of the granite quarries at Roberval. It is on parcel 83, which is lot 4, range B, township of Roberval.

HISTORY:

The quarry was opened about 1908 by François Daveau, from whom it was bought by Auguste Bernier in 1910. It is now operated by Bernier et Fils, who cut and polish stone in their own shop at Roberval. The quarry supplies stone for monuments and construction. Some monument stone has been shipped to Montreal and to Quebec. The courthouse and church at Chambord and the church at St-Prime are built of granite from this quarry, which also supplied the whole or part of the stone for the church and city hall at Roberval and the new railway station at Jonquière. No curbstone or paving setts have been cut.

THE QUARRY:

The quarry (see Plate V-B) is on the east slope of a knoll rising about 100 feet above the drift. Two distinct varieties of granite are quarried, and the quarry may be considered in two parts. The northerly part from which a bluish or bluish-rose granite is taken, is about 100 feet north and south, and the face has

been advanced some 60 feet west. The principal face is about 15 feet high and is divided into two sheets. The sheets strike N.-S. and dip 20° E. Cutting the granite are several dykes of aplite and pegmatite, some of which are older than the secondary shearing, others younger. The foliation strikes $N.80^{\circ}$ W. and dips 40° S. The grain is $N.10^{\circ}$ E. and vertical, and the rift approximately horizontal. The principal and most persistent joints are vertical and strike about north-south. They have a tendency to be 'blind'.

In the south 30 feet of this part of the quarry, the stone is mixed blue and pink. The pink granite is younger than, and contains fragments of, the blue, from which it is separated by a zone of pegmatitic granite of irregular width.

In the southern part of the quarry, the stone is rose or pink coloured. This quarry is 130 feet north-south, and the face, which is 20 feet high, has been advanced about 80 feet to the west. The sheet structure, which tends to follow the curvature and slope of the hillside, is very irregular. In the centre part of the southern quarry, the granite is almost without sheet joints over a height of 20 feet, but at both ends of the quarry, sheets 5, 6, and 7 feet in thickness were measured. Pegmatite and aplite stringers are present but are less numerous than in the older blue granite. As in the latter, some of them are older, and some younger, than the secondary shearing. Jointing is like that in the northern part of the quarry, but the foliation strikes $N.40^{\circ}$ W. and is less apparent. The directions of working the stone are the same as in the north half.

THE STONE:

Both the blue and the rose granite consist of large crystals of microcline set in a groundmass of quartz, albite, hornblende (1), and biotite. The stone would be described as coarse-grained on account of the feldspar crystals. That from the northern part of the quarry has a very pronounced bluish-rose cast. The rose tint is from the feldspar and the colour is probably inherent in

(1) The blue granite of Bernier shows the rare optically pseudo-uniaxial amphibole, hastingsite, instead of the common hornblende found in the normal rock. It may be noted that Quensel has found hastingsite in the marginal facies of the granite of Tennberg, Norway.

the microcline, although Parks (1) suggests that it is secondary and due to iron derived from the oxidation of the dark minerals. The microscope does not show any clouding of the microcline such as might be expected if the colour were due to iron oxide, and the colour is not related to any fractures in the minerals. The prevailing blue tone of this stone is due to the considerable quantity of dark minerals and the dark tones of the quartz. The stone in the southern part of the quarry is of somewhat coarser grain than the blue variety. It shows an irregular distribution of the crystals of feldspar, leading to a clotted appearance for the rock. The rose or pink cast is due to the microcline, but in this rock the quartz is whitish or colourless, and hence there is much less colour contrast than in the blue granite.

The pink granite has the following composition (2):

SiO ₂	70.67	MgO	0.20
TiO ₂	0.35	CaO	1.72
Al ₂ O ₃	14.87	Na ₂ O	3.64
Fe ₂ O ₃	0.84	K ₂ O	6.05
FeO	1.62	H ₂ O	0.20

As indicated by the analysis, it is a granite low in dark minerals.

The physical properties of both the pink and blue stone are given in the report by Parks (3), as follows:

	<i>Pink</i>	<i>Blue</i>
Crushing strength, lb. per sq. in.	30,650	28,150
Transverse strength, lb. per sq. in.	2,393	1,810
Shearing strength, lb. per sq. in.	1,867	1,305
Specific gravity	2.653	2.789
Pore space, per cent	0.397	0.432

Despite its inferior physical qualities, the blue granite is more desirable than the rose for monuments and for building. Its constituent minerals have a greater colour contrast, and the stone is more uniform in composition and finer-grained than the pink. Unfortunately, the amount of blue stone available appears to be restricted to a very small exposure, and stringers of aplite and pegmatite, which detract from its appearance, are more numerous in it than in the pink stone.

(1) Parks, W. A., *The Building and Ornamental Stones of Canada*, Vol. III; Dept. of Mines, Ottawa, 1914, p. 143.

(2) Dresser, *op. cit.*, p. 26.

(3) *Op. cit.*, p. 144.

QUARRY 3: NERÉE BOILY

About ten years ago, a quarry was opened on the property of Nerée Boily, on the southeast side of lot 4, range A, about a quarter of a mile east of the road. Most of the stone was sold for building-foundations in Roberval. The quarry, which is on the southeast side of a large hill of granite, is 50 feet long with a 12-foot face, which has been advanced 10 feet. The granite here shows more closely-spaced and more regular joints than in the two quarries previously described. The joints have facilitated the quarrying of material for rough construction work. The stone has a pronounced gneissic structure, with the strike of the foliation N.60°E. and the dip 35°S.E.

SAINT-GÉDÉON AREA

ANORTHOSITE SERIES:

St-Gédéon, in the township of Signay, is the village nearest a number of quarries in the Saguenay gabbro-anorthosite. The precise limits of this large body of rock are not known. The main body does not extend very far west of the limits of Signay township, and on the south it covers only part of Labarre township; but it crosses both discharges of the Saguenay river and extends up the Shipshaw and Péribonea rivers. It is certainly one of the largest areas of anorthosite in Canada, if not in the world; though possibly the occurrence on the Moisie river (Saguenay county) has a greater extent. Thus anorthosite is a typically Canadian rock, for the most extensive developments known are to be found in the Laurentian areas of Canada. Some was at one time marketed under the name *Granit des Laurentides*, and such a name is not inappropriate, for the stone is the most distinctive of the igneous rocks of the Laurentian area in Quebec; however, it is not a true granite but is related to the gabbros.

The development of quarries in the anorthosite in the St-Gédéon district is especially significant, inasmuch as the success of the mechanical operations of these quarries points the way to a utilization of the anorthosite of other localities in Quebec: as in the Morin area, north of Montreal, with about 900 square miles

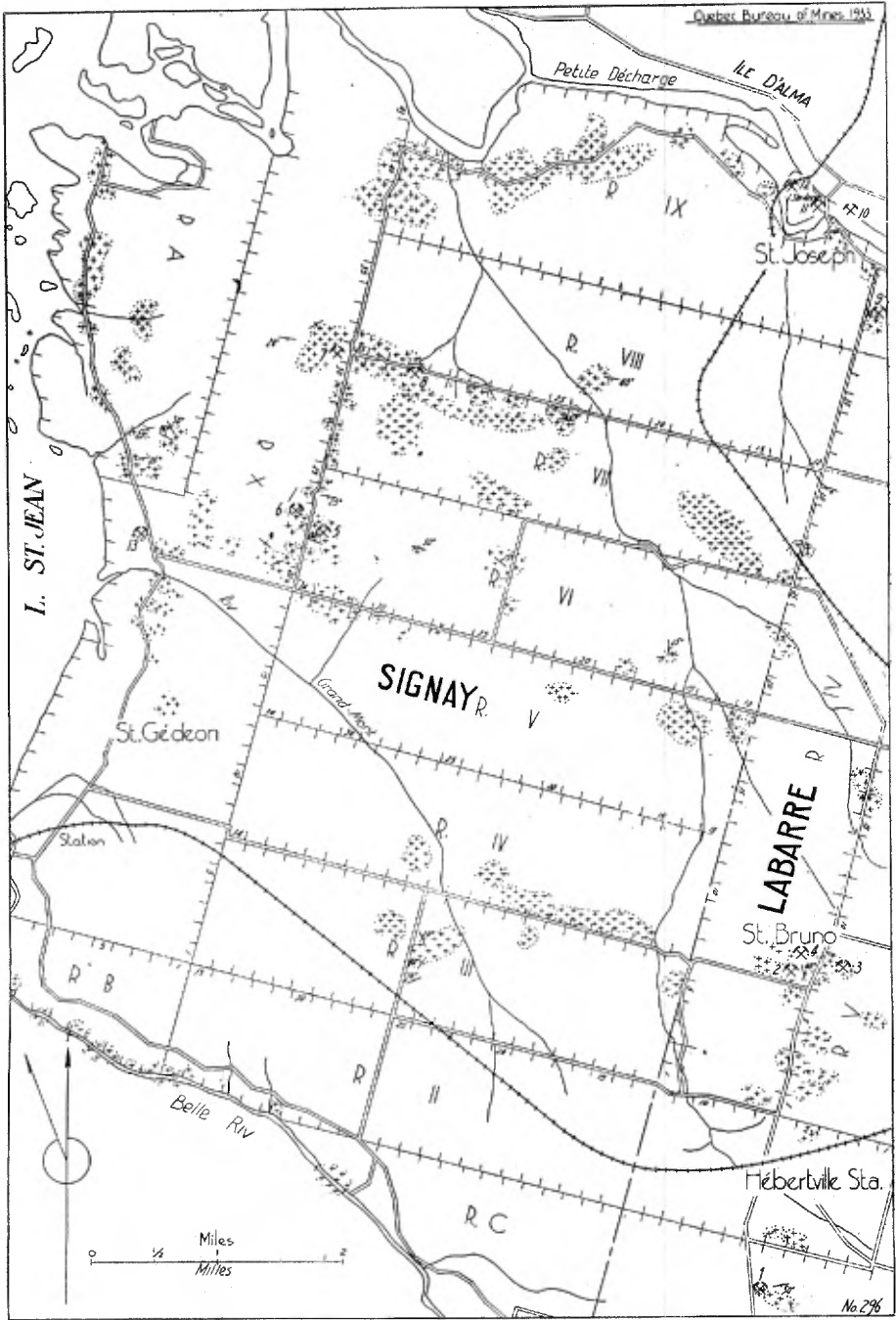


Figure 5.—Saint-Gédéon area, Lac-Saint-Jean county.
 Small crosses: Outcrops of gabbro and anorthosite.

underlain by anorthosite and related rock, and in the hills on the north side of the Lake of Two Mountains, near Oka, where there is a considerable area of the rock. It is probable that rocks of this series underlie areas totalling over 50,000 square miles in Quebec.

FACTORS AFFECTING QUARRYING:

In most granites, the direction of greatest ease of breaking (the rift) is determined by cracks extending through quartz and into feldspar. In the rocks of the Anorthosite series, quartz is not abundant, even if present, and the direction of the greatest ease of breaking is determined by the alignment of the feldspar crystals or by the direction of shearing of the rocks in the late stages of, or subsequent to, their complete consolidation. This leads to some complication of structure. The earlier structure in the St-Gédéon district now dips at 20 degrees east or west, and the 'rift' of the stone in some quarries is in this direction. In places, however, the 'rift' has a steep dip, and this appears to be due either to a second movement in the magma itself or to a later movement breaking across the older rock structure. The attitude of the structure changes abruptly from place to place, making the problem of forecasting the direction of the rift difficult.

In most quarries where the rift is nearly horizontal, the stone breaks with equal ease also in two other planes at right angles to the 'rift'. The coarse crystallization of some varieties of the anorthosite makes it difficult to procure flat broken surfaces, and, moreover, the feldspar is somewhat brittle, thus adding to the difficulty of quarrying. The stone, however, is being successfully quarried near St-Gédéon and dressed in stone-finishing establishments at Roberval.

THE STONE:

The stone shows considerable variation in grain from place to place. Near the contact with the gneisses in Labarre township, the grain is about 4 mm., and the stone is a gabbro with a marked banding. In and around the principal quarries, the stone has a coarse grain. Crystals as long as one foot are not uncommon. The largest noted were seen on the summit of a hill in lot 21,

range IV, of Signay, where one crystal was found to measure 2 feet by 10 inches. In some places, the finer-grained anorthosite is the result of granulation of the coarse variety, and, where crushing has not been complete, residuals of the larger feldspar crystals may still be seen in the rock. Such is the case in the large quarry opened for road metal near Hébertville. The granulation of the feldspar may be accompanied by a loss of the deep colour in the granulated parts. This is the rule in the area north of Montreal, but in much of the St-Gédéon area the colour is retained in the granulated feldspar. This latter is an advantage, for the colour is due to very minute inclusions in the feldspar, which render it more resistant to weathering than would otherwise be the case. This may be verified on the weathered surface of some granulated varieties, for the smaller feldspar grains without inclusions tend to form pits or depressions, with the darker, inclusion-rich feldspar standing out, by contrast, in relief (see Plate II-B). The inclusions are largely of ilmenite and, therefore, are themselves only very slowly attacked by weather.

The anorthosite or gabbro is deep brown or purple to black in colour. The contrast between polished and chiselled or sand-blasted surface is good. The coarse grain and yellow streaks of incipient alteration detract from the appearance of some of the stone in polished surface. A deep-green pyroxene occurs as large crystals in some varieties; in others, the crystals of this mineral are small and of a pale green tint. Ilmenite and magnetite form spots which give a noticeable mottling on the polished surface. In these spots, which have a diameter of 3 or 4 inches, the ilmenite or magnetite fills the interstices between the plagioclase crystals.

The stone has provided an inexpensive substitute for some of the imported black granites. Some varieties could probably be used for interior decoration. Sawed panels would have to be somewhat thicker than usual, because of the brittleness of the component minerals.

PEGMATITE DYKES:

The anorthosites are cut by numerous dykes of pegmatite, some of which are composed almost altogether of feldspar. One, on lot 10, range VIII, Labarre, is 10 feet thick. A partial analysis

of the feldspar gave: Al_2O_3 , 19.96%; K_2O , 8.64%; Na_2O , 4.83% (1).

QUARRIES, SAINT-GÉDÉON AREA

Quarry 1.—This quarry, opened for road metal, is close to the road from Hébertville station to Hébertville, on lot 5, range C, Signay. It has dimensions 80 by 70 feet, with a face of 20 feet. The stone is a medium-grained purple anorthosite showing sporadic larger crystals of mauve-brown plagioclase feldspar. It is a somewhat unusual type, in that the granulated feldspar, forming the bulk of the rock, is of a deeper colour than the larger residual crystals, whereas the reverse is commonly found. The foliation is $\text{N.}80^\circ\text{E.}$ and dip 50°S. So far as the writer can learn, this stone was only used locally, for road metal. Several small openings for road stone have been made near Hébertville station, but were not examined in detail. The stone is everywhere anorthosite.

Quarry 2.—Stone has been quarried for road metal at several places on lot 7, range IV, Labarre. A small amount of the material has been used for construction, and the quarry has also supplied the stone for several dies. The foliation is $\text{N.}10^\circ\text{E.}$, with dip 35°E. The stone is a medium-grained dark anorthosite with crystals of hypersthene as much as one foot long. The principal opening is 35 feet long, and the face is only 6 feet; the exposures do not rise much above the drift cover. A part of the stone for the church at St-Bruno may have come from this quarry. The church was built about 30 years ago, and the stone in question is used in rock face. It retains its colour unaffected by the weather.

Quarry 3.—Some blocks have been quarried from a low outcrop on lot 8, range V, Labarre, by Bernier et Fils of Roberval. The characteristic outcrops of the anorthosite here are shown in Plate VII-A. The stone has granularity of about four inches and contains small clots of pale-green pyroxene. In part, the anor-

(1) Analysis by M. Archambault, Que. Bur. of Mines.

thosite has been sheared and the reduction in granularity of the rock to one-sixth inch has been accompanied by a change to paler colour. The sheet structure is irregular, and the joints are discontinuous.

Quarry 4 is on lot 8, range 4. The finer grained variety of anorthosite referred to in the last paragraph continues on the west side of the road, where it is cut by an irregular dyke of fine gabbro, which has been blasted out in a few places for road metal.

Quarry 13.—Quarry 13, on lot 20, range X, Signay, is 60 feet by 30 feet with a face of 20 feet, and is opened on the west face of a knoll of coarse anorthositic gabbro. The stone is altered in places to a greenish aggregate of saussurite which does not detract from its value for road metal.

Quarry 5.—This quarry, shown in Plate VI-A, is on the west end of a ridge of anorthosite rising about 25 feet above the level of the drift. It was opened by the Black Granite Co. in 1930 and worked for about a year. The main part of the quarry is 50 feet long by 16 feet wide. A smaller shelf has been worked on the east. The stone is coarse-grained gabbroid anorthosite, in which the dark coloured feldspars are much larger than the pyroxene crystals. The foliation is N.70°W., with dip 80°N. The quarry was opened by drilling and blasting several holes along the long face, then cutting the stone horizontally and vertically with wedge and feather. The rift is parallel to the foliation. The joints are irregular; two, which strike N.25°W. and dip at 80°W., mark the ends of the quarry. The operations have yielded considerable waste on account of the 'tightness' of the ends and the difficulty of working the stone.

Quarry 6.—Quarry 6 is on lot 23, range X, Signay, on ground owned by J. R. Lessard. A little work has been done on the top sheet by Bernier et Fils, who leased the quarrying rights from the Black Granite Co. The stone is similar to that in quarry No. 5, across the road, and is more nearly a gabbro than anorthosite. It is brown or purple, almost black, in colour, and consists of coarse crystals of plagioclase and hypersthene. Magnetite forms sponge-like clots, as much as four inches in diameter, which contain crystals of plagioclase.

Quarry 7.—The most extensive work on the anorthosite has been carried on by National Granit Enrg., on lot 31, range 10, Signay. Pierre Fortin and G. La Liberté, both of Roberval, are president and secretary of the Company. The quarry was opened in 1930 and about 4,000 feet of stone have been won and utilized for monuments. Most of the stone is polished in the Company's workshop at Roberval and the product shipped to Quebec and Montreal. The principal market has so far been in Quebec city.

The Quarry.—The quarry, shown in Plate VI-B, is west of the road and has an irregular ground-plan. Its dimensions are about 40 feet by 35 feet, and the face at the highest point is 19 feet. Fifty feet west, another quarry has a face 60 feet long, which is being advanced to the south. The eastern quarry is on an edge of the outcrop and the stone is, therefore, more accessible for quarrying than that in the west quarry. The stone has a perceptible foliation, with dip 20°S. , which is also the direction of rift.

The Stone.—The stone is a dark-coloured anorthosite of 4-inch grain. In some places, hypersthene crystals as much as a foot long are found. Generally, however, the dark minerals are in relatively small crystals. Clots of magnetite, enclosing small crystals of the rock-forming minerals, are present, similar to those in the stone from quarry No. 6. A short distance north of the quarry, gabbro is found containing schlieren of the anorthosite which strike $\text{N.}60^{\circ}\text{E.}$ and are vertical. A series of vertical N.-S. joints cut the rock at intervals of 4 to 8 feet. Another direction of jointing is $\text{N.}60^{\circ}\text{W.}$

Quarry 8.—Quarry 8 is close to the road, on lot 32, range VII, Signay. It has been operated by Polycarpe Moreau, who owns a dressing shed at Roberval. The opening is triangular in plan, with sides of 20, 20, and 30 feet. The stone is similar to that of the National Granite quarry. In places, yellowish streaks of incipient saussuritization are found that detract from the appearance of the stone.

Quarry 9.—Quarry 9, shown in Plate VII-B, is on lot 1, range Saguenay. It has been used only for supplying material for the road from Saint-Joseph-d'Alma to Saint-Bruno. There are two openings: one 70 ft. by 80 ft. with an 8-foot face, the other 60 ft.

by 30 ft. with a 7-foot face. The anorthosite here is cut by stringers of Roberval granite. At the contacts between the two rocks, the plagioclase of the anorthosite shows no noticeable alteration, but the hypersthene is altered to biotite.

Quarry 10.—A fine-grained facies of the Roberval granite outcrops on Alma island in the Saguenay river, south of the tip of Ste-Anne island. The stone is a fine-grained hornblende granite. Some thin sections show the rare amphibole, hastingsite. Loose blocks and some stone from below the normal river-level have been quarried for the church and presbytery at St-Joseph. The stone has a dark grey colour and is finely gneissic, but the foliation does not detract from its appearance for use in rock face.

Quarry 11.—Quarry 11, on Ste-Anne island, just west of the road across the Petite Décharge of the Saguenay, is owned by François Gagné. The stone has a pale rose colour and a pleasing 'mixture', but is slightly gneissic. The grain is vertical and runs N.30°W. The sheets are from 2½ to 4 feet thick and dip 10°E. In thin section, the rock is seen to be a fine-grained hornblende granite. In hand specimen it resembles the granite from Brodie's quarry at Guenette, except that it is lighter in colour. The stone was being quarried for stock and for local construction at the time of the writer's examination. It is sufficiently fine-grained that it might be suitable for paving blocks.

Quarry 12.—This quarry is near the railway bridge across the Petite Décharge and shows a granite with a marked foliation, N.50°W. and vertical, cutting anorthosite. The stone has been largely used for concrete aggregate.

SAINT-JÉRÔME

A small quarry was opened on lot 1, range 1, Métabetchouan, to supply stone for the church in St-Jérôme. The stone was quarried by Eugène Robitaille in 1927. It is a coarse-grained facies of the Roberval granite, rising above the drift-covered lowland surrounding lake Saint-Jean. The colour is rose. The quarry is about 75 feet long and 50 feet wide on the incline. The stone is cut by numerous dykes of pegmatite and aplite and by several inclined joints. The foliation is N.80°W., with dip 30°N. The

grain, however, appears to be about N.-S. and vertical. The rift is horizontal.

As built into the church, the stone has a pleasing appearance. The difficulty of quarrying, owing to the inclined joints, may, however, make it unduly costly, unless for local use.

CHICOUTIMI AREA

Little detailed geological work has been done in the vicinity of Chicoutimi: the region was explored in the early days by Richardson, Laflamme, and Adams, but detailed reports and maps have not been published. Sections of the townships on the north side of the Saguenay have been examined by B. T. Denis of this Bureau. In the map accompanying the present report, the outlines of the outcrops on the north side of the river, west of Ste-Anne, are taken in part from Denis' map. The map is more detailed than an ordinary reconnaissance sheet, but somewhat less accurate than a detailed map. However, the writer believes that the boundaries of the formation are essentially as shown on the map.

GENERAL GEOLOGY

GRENVILLE SERIES:

The limestones and quartzites of the Grenville series are not well developed in the district: however, amphibolites and some related gneisses survive as remnants included within the large areas of younger gneisses derived from granites and related rocks. On the north side of the Saguenay, noteworthy areas of Grenville are found, but in the vicinity of Chicoutimi the series is recognizable only as dark-coloured bands within the granite gneisses.

PYROXENE GRANULITES:

The pyroxene granulites appear to be older than the normal granite gneisses, but they are younger than the Grenville series, which had been altered before the granulites were intruded. These rocks form sill-like bodies in the Grenville rocks and also cut across them. The bodies appear to be complex in form and rather

variable in composition. Parts of the series are gabbro, others are syenite, and the most acidic facies are low-quartz granite. Pyroxene is the common mafic mineral in most of the series, but biotite is found in some of the granitic types. A granulated structure and small red garnets are found in all the rocks. 'Augen' remnants of large crystals of feldspar are not rare. The most distinctive feature is the green colour, which is found in even the most acidic facies.

The pyroxene granulites have undergone marked deformation, possibly during their intrusion, and this has caused the augen and breccia structures that characterize them.

GRANITE AND SYENITE GNEISSES:

The granite and syenite gneisses are apparently younger than the pyroxene granulites, for in places they appear as dykes cutting the latter rocks; but both series have been deformed together and the intrusive relationships of the gneisses have been masked by the deformation. In a few places, offshoots of a pink gneiss have been found in the granulite, but generally the two rocks appear to pass into one another by rather abrupt transition.

The granite and syenite gneisses contain abundant remnants of the Grenville rocks. Some of these persist as biotite and hornblende gneisses and schists, forming small blocks, but usually they appear only as *schlieren* or dark streaks. With few exceptions the syenite gneisses are hornblendic and biotitic, with microcline and oligoclase-albite as the principal minerals. A pronounced foliation with a steep dip is a characteristic feature, along with an augen structure.

ANORTHOSITE SERIES:

The anorthosite and gabbro in this locality are medium to very coarse grained dark-purple rocks. Some facies are nearly black. A gently-dipping foliation is evident in some exposures, but much of the rock is quite massive.

In places, the rocks of this series contain deposits of magnetite and ilmenite. Several such are known along the Saguenay river.

ROBERVAL SERIES:

Granite and syenite lithologically similar to, and doubtless belonging to the same series as, the granite at Roberval, are found in two places within the area covered by the Chicoutimi sheet. A massif of considerable size crops out near Cap Ouest, at Bagotville, and another body, of syenite, is found on the north side of the Saguenay. Both the syenite and granite are characterized by a pink or mauve tinted microcline, with subordinate plagioclase feldspar. Several quarries have been opened in this series near Bagotville, and the stone might be utilized to a considerable extent for construction and for curbing, if cheap water transportation to the consuming centres were available. The syenite has a pleasing appearance, in deep rose to mauve or brown tones, but the absence of quartz, and hence of a well defined rift, makes it more difficult to quarry than granite; however, with its rich colour, it would be very suitable for monument stone. After the writer left the field, Messrs. Delwaide and Goffin, of Chicoutimi, opened a small quarry in the syenite near Ste-Anne. No other stone like this in colour is produced in Quebec. It should find considerable use for monuments.

PEGMATITE DYKES:

Pegmatite dykes are found in several places. They consist of microcline with quartz and biotite. One of these dykes, on lot 14, range VII S.W., Chicoutimi, has been worked to some extent for feldspar. The feldspar is flesh coloured, but the dyke is lenticular in plan, and the shoots rich in feldspar are short. Allanite is abundant on the west wall of the dyke. Another and larger dyke is found along the road, on lot 12, range V S.W. A few occurrences of pegmatite were noted in other places. The minerals to be won from them are microcline and quartz.

The pre-Cambrian rocks such as described in the preceding sections were exposed at the surface and worn down by erosion for a very long time, after which the Ordovician limestones were laid on top of them. Only one patch of the limestone was noted in the area covered by the map. This is in a small quarry opened for railway ballast at the summit of the hill along the railway

track north of Ha! Ha! bay. The youngest formations are Pleistocene and Recent, which comprise the silt, sand, and gravel found along the valleys as terraces, and on the upland. These formations provide an abundance of gravel and sand for building purposes.

ECONOMIC PRODUCTS:

Aside from the granite and limestone available for building and construction purposes, as well as the sand and gravel, few products of economic value are found in the area. Feldspar and quartz have been exploited in two places. The feldspar is flesh-coloured and relatively free from iron. In the dykes that have been exploited, feldspar and quartz are well segregated. As already noted, one of the dykes shows a considerable amount of allanite on one wall.

The selvage of the body of basic rock against the granite, on the northwest side of Ha! Ha! bay, is a banded gabbro rich in iron-ore minerals. In some places a concentration might be found that would be a low-grade iron-ore.

Although not a geological formation, the extensive peat deposits on the level area along the line of railway north of Ha! Ha! bay are worthy of mention as a possible domestic fuel for the several communities in the vicinity.

QUARRIES, CHICOUTIMI AREA

Quarry 1.—This is not strictly a quarry but is part of the development for the Alcoa Power Co. dam at Chute à Caron. The large amount of gabbroid anorthosite extracted, and the installation of the large crushing plant to prepare the material for use in concrete, make the development of importance. The crushing plant is still intact, and a large amount of crushed anorthosite is in stock-piles.

Quarry 2.—This quarry was opened and abandoned some time ago. It is a small opening in a dark coloured anorthosite of finer grain than that described from the succeeding quarry (No. 3).

Quarry 3.—This quarry is on lot 14 of range 4, Jonquière. The stone is a coarse-grained anorthosite containing fine granular mafic minerals. Some of the crystals of feldspar are as much as one foot long. The whole output of the quarry is crushed in a plant on lot 15 and used for aggregate in bituminous concrete and for the crushed stone on the shoulders of the Chicoutimi road. The quarry was opened in 1931 by E. R. Truchon of Roberval. It is on the west side of a small knoll and is 240 feet east and west. The face is about 35 feet high and has been advanced some 80 feet. A strongly rusted zone crosses the centre of the quarry. The stone is blasted and then broken with hammers to a size such that it can be loaded into horse-drawn dump-carts to be conveyed to the crushing plant.

Quarry 4.—This 'quarry' is the reservoir for the waterworks at Arvida. The opening is on the top of a low hill rising back of the village and is easily accessible from a wood road. The stone is a paragneiss of the Grenville series and strikes N.30°E. Although not opened as a quarry, the work has resulted in a dump of about 40,000 tons of granite that might be utilized for construction or for crushed stone.

Quarries 5, 6, 7.—These three quarries, in rose granite-gneiss, on lots 3, 4, and 5 of range XIV S.W., Chicoutimi, have been worked in a desultory fashion to supply stone for the Chicoutimi-Ste-Anne bridge. The easternmost quarry (No. 5) is 110 feet long and has a face of 10 feet. The foliation is N.25°E., with dip 85°E. The rift cracks are vertical and N.70°W. Some basic bands show a gradation to the more acidic types. Allanite occurs in the rock in small crystals. The centre quarry (No. 6) is in a granite tending toward the augen type. A pseudo-sheet structure strikes N.80°W. and dips 30°N., making the quarry irregular. The western quarry (No. 7) is similar to the other two. All three are useful as a source of construction or crushed stone and have the advantage that the stone is so broken by joints that it may be quarried near the surface without the use of explosives.

Quarry 8.—This quarry, which has supplied crushed stone, is on lot 14, range I S.W., Sydenham road. It is in a somewhat weathered granite-gneiss. The face is 260 feet long and about

20 feet high. The disintegration of the stone along the joints has facilitated the breaking.

Quarry 9 is in a porphyritic grey rock which is transitional from the granite gneiss to the pyroxene granulite but is probably a part of the latter formation, which crops out to the east of the quarry along the cliffs. The quarry is on the edge of the cliff and is owned by Jos. Gauthier. It was opened to supply stone for building the wharf at Chicoutimi. Advantage has been taken of the configuration of the cliff to allow cheap quarrying. A triangular area of about 100 feet to the side was benched-out over a vertical distance of 75 feet. The stone was allowed to fall to the bottom of the cliff where it was easily loaded on scows for transportation across the river.

Quarry 10.—This quarry is similarly situated to that just described. It is, however, in the green pyroxene granulite, the foliation of which strikes N.30°E. and is vertical. The quarry, which is about 200 feet long, was opened by Robertson and Janin, of Montreal.

QUARRY 11:

This is the most important quarry in the district. It is operated by Rieverin and Rieverin, of Chicoutimi, for building and construction stone, and by Delwaide and Goffin, of Chicoutimi, for monument stone. The quarry is close to the river and the stone was formerly loaded at a wharf for transportation to Chicoutimi. Now, however, most of it is moved by truck. This quarry has provided much stone for building and construction in Chicoutimi.

The main quarry, which extends northeast, is about 250 feet long and 100 feet wide. The quarry operated for monument stone is on the south of the main working, and is about 40 by 60 feet with a face of 25 feet. Its floor is 20 feet above the floor of the main quarry. Sheets 16 feet lower than the floor of the main quarry have been opened.

The stone is the medium-grained green pyroxene syenite (granulite) containing only a small amount of quartz. The foliation is N.40°W., with dip 75°S.E. The grain of the stone on the northeast end of the quarry is considerably coarser than that

on the southwest. The rift is approximately vertical and about E.-W. The reason the rift is vertical and not horizontal is that the rock contains very little quartz, and it is the cracks in this mineral that ordinarily determine the direction of rift.

The joints, which belong to several systems, are closely spaced. A prominent set is N.30°W., with dip at about 75°, either to west or east. Another set strikes N.E., dips 80°S.E., and is spaced at one- to five-foot intervals. All these joints are rusty. A dyke of pegmatite, four inches wide and containing allanite, strikes N.20°W. and dips 70°E. A number of dark coloured stringers, about a quarter of an inch thick, cut this stone in the same direction. In some parts of the quarry they are so numerous as to render the stone useless for monuments.

A basic dyke, two feet wide, strikes N.30°W. and dips 35°W. It forms the footwall of the small quarry used for monument stone and appears to form the dividing line between the finer grained stone on the southwest and the coarser variety on the northeast.

The stone has a very pleasing green colour that is well brought out on the polished surface, but the blind joints and nearly-invisible streaks make it inadvisable to ship the stone otherwise than as finished dies. In places, sporadically distributed crystals of feldspar are conspicuous.

This stone supplied material for the new hospital and the new city hall at Chicoutimi. The dark colour of the rock face in the city hall is relieved by the lighter, hammered surfaces as well as by some polished panels. Much of the stone has been used in foundations, and for crushed stone. Many monuments of the stone have been erected in the cemetery, and dies are shipped to Quebec city.

Quarry 12, on lot 9, range XI of Chicoutimi, is in a rose augen-gneiss. The foliation, which is barely noticeable, is N.25°E., with dip 80°W. The quarry is 130 feet square, and the face, which is on the east end, is 40 feet high. The upper sheets are broken and thin, but the lower ones are more massive and might be utilized for construction stone. Most of the output has been crushed for road metal.

Quarries 13, 14, 15.—The City of Chicoutimi operates several quarries for crushed stone : the three principal ones are indicated on the map as numbers 13, 14, and 15. All of them are on the northwest slope of a bald hill rising above the drift. The hill is largely a pink syenite gneiss, the foliation of which is vertical and strikes N.25°-30°W. On the lower levels of the knoll, one of the quarries has been advanced about 30 feet on a face 140 feet long which trends N.50°E. The face is 25 feet high. The stone is much jointed, rusted, and not of uniform colour. Fifty feet to the east of this quarry, another has been opened which is 90 feet long with a 12-foot face. To the west of the main opening, another working is about 60 feet long.

The quarry nearest the road and immediately beneath the power line is 150 feet long with a face trending N.80°E. The stone is a dark syenite interbanded with lighter material.

The principal quarry-opening is 350 feet by 150 feet. On the south end the face is 20 feet and on the north 6 feet. The stone on the north side is a grey gneiss and this passes into a rose gneiss on the south.

The output of this quarry has been used largely for crushed stone, for which it is very suitable. At the time of the writer's visit, the stone for the bridge from Chicoutimi to Ste-Anne had been quarried and crushed here and was stored in stock piles.

Quarries 16, 17.—Delwaide and Goffin, in 1929, operated two small openings for monument stone on lot 14, range VIII. The foliation dips east at a low angle, and the stone has a pronounced augen structure. It may be a sheared Roberval granite. The quartz content is low. The jointing is irregular. The stone, which has been taken only from the top sheets, is of a pleasing rose colour and has been used for dies and bases, most of which have been sold in Chicoutimi.

Quarry 18.—On lot 48, range I S.W., Chicoutimi, a small opening has been made in a granite gneiss for road stone. The foliation is N.65°E. with dip 80°S.

Quarry 19 is not in granite, but in thin-bedded Palæozoic limestone. It is close to the right-of-way of the Ha! Ha! Bay railway. The stone was used for ballast.

Quarry 20.—This quarry, opened for road metal, is in a fine-grained inclusion within the Roberval granite. The inclusion is a grey gneiss, which has been baked by immersion in the granite while the latter was still liquid.

Quarry 21 is on the brow of the hill overlooking the town of Bagotville and opposite the Academy St-Louis. It is in a small massif of granite which is undoubtedly of the same age as the Roberval granite and probably also as the Pine Hill series near Brownsburg described in the writer's report for 1932. The rock has a coarse grain and consists largely of pink feldspar with quartz. Crystals of mauve plagioclase over two inches long are sporadically distributed. The rift is horizontal, and the grain vertical with strike N.80°E. The jointing and sheet structure are both irregular. The quarry is rudely semi-circular in ground plan, with a face of 200 feet. The stone has been used for the Academy St-Louis, which is situated across the road from the quarry.

Quarry 22.—A quarry in a similar granite on lot 7 N.W., Rang des Mars, is 130 feet long and 40 feet wide.

Quarry 23.—This quarry is operated by the City of Port-Alfred and supplied the stone for the construction of the city hall of that town. The stone is the coarse-grained rose granite, very similar to that of Rivière-à-Pierre, although slightly coarser in grain. The rift is horizontal and the grain vertical with strike N.60°E. The workings consist of two quarries each about 200 by 50 feet. The sheets are of variable thickness: the thickest is about 5 feet, in the south quarry; in the north opening, the thickest sheet is about 2½ feet.

Quarry 24.—This quarry was opened by E. R. Truchon for road material, about 1930. The stone, which is closely jointed, is a paragneiss, with strike N.80°E. and dip 70°S. It is cut by many dykes of granite and syenite. The quarry face is about 300 feet long and 75 feet high.

Quarry 25.—Several sheets of granite are exposed along the main road where it passes close to the shore of Ha! Ha! bay. The top sheets have been quarried for construction stone for use in the village of Grande-Baie. The stone is the coarse-grained granite similar to that of quarries 22 and 23.

LAKE KÉNOGAMI

Angers et Noel have operated two quarries in a coarse granite gneiss on lot 5 of the north range of Jonquière. The large quarry, which is visible from the road, is about 200 feet long and has a face of 30 feet. The foliation strikes N.70°E. The stone is of a pleasing red colour. Two hundred and fifty yards east, another quarry has been opened in a finer-grained gneiss, which is somewhat porphyritic. Stone from both quarries has been used with good effect in the new church at Temagami.

The granite gneiss is in contact with anorthosite near the highway, on the road that branches to the quarry.

BAIE-SAINT-PAUL

Baie-Saint-Paul, on the north side of the St. Lawrence river, is situated on the Gouffre river, which forms a break in the front of the Laurentian escarpment. The cliffs along the St. Lawrence at this point are formed of crystalline rocks of the Laurentian series, and Palæozoic sedimentary rocks have been folded against, and tilted away from, them. The crystalline rocks are possible sources of granite for building.

F. X. TREMBLAY QUARRY

The output of the quarry owned by F. X. Tremblay has been used only for stone for roads. The quarry is beside a small stream on lot 1197, just west of the village. The granite here is unconformably overlain by the Palæozoic limestone; in fact, a small patch of the limestone in which are fragments of the granite, may be seen near the front of the quarry. These fragments, as well as the granite of the main body, show alteration along fractures to chlorite and other secondary minerals. The granite is grey-rose, medium grained, and gneissic, the foliation striking N.30°E. with dip 50°E. The weathering is such that the stone, on most fractured surfaces, has a green colour; however, for the use as road metal, the fractures facilitate crushing and quarrying. A carbonate-bearing vein, similar to some found cutting the Palæozoic limestone, cuts the granite and contains a small amount of galena and sphalerite.

The quarry, which was opened about 1922 to supply stone for the road along the north side of the bay, is rudely crescentic in plan. The distance between the horns, which are north-south, is about 110 feet. The face is about 35 feet high.

The church at Baie-Saint-Paul, erected in 1908, is a good example of the use of local stone. The stone used has come from several quarries and shows great differences in colour, but all of it is gneissic. The writer was not able to learn the locations of all the quarries. One locality that supplied stone was on the northeast side of the river, and the material quarried here may have been field stone; another was along the road to the old government pier. Several places may be seen where suitable stone could be won. The stone includes a green 'augen' granite, almost certainly the same formation as the pyroxene granulite at Chicoutimi; a rose granite; and a light-coloured coarse granite in which the gneissic structure is not prominent. The stone has been used in course work in fairly large blocks. In the opinion of the writer, the effect of the different stones makes this one of the most pleasing of the village churches. Undoubtedly other sites could be found from which stone similar to that used in this church could be won.

ESCOUMAINS

According to Dr. Carl Faessler (1), the region east of the Saguenay and bordering on the St. Lawrence river has much good granite. It has been quarried near Escoumains for the village church and for the church at Trois-Pistoles.

A specimen collected by Faessler and seen by the writer is a rose-coloured gneissic granite resembling the stone from Moreau's quarry at Roberval, but of finer texture. The foliation is the direction of the 'grain' and the cracks defining the rift cut across the foliation at right angles.

According to Mr. Goffin, of Chicoutimi, the stone is in heavy sheets and works exceedingly well.

(1) Quebec Bureau of Mines, Ann. Report 1929, p. 88D.





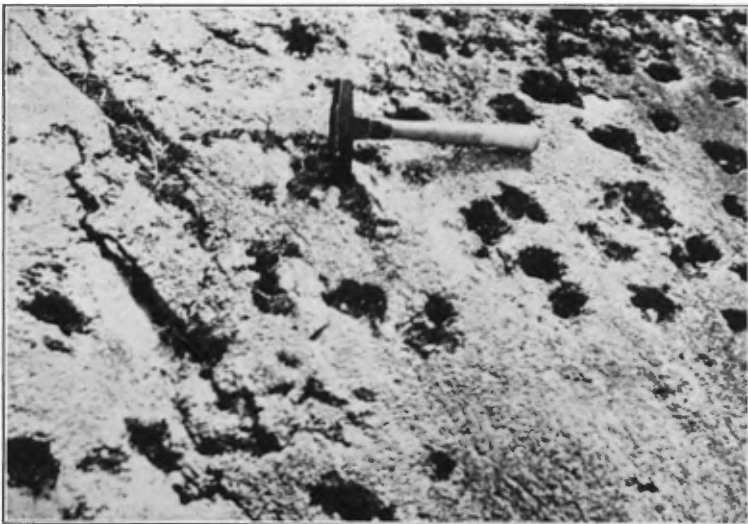
A.—Medium-granular anorthosite northwest of Rawdon, showing the horizontal structure. Some stone has been taken from the base of this cliff which is about 25 feet high.



B.—Polished die with hammered base made from Roberval granite from Polycarpe Moreau quarry.



A.—Augen gneiss in rose and black developed from Roberval granite. Rocks of this texture are common in the Laurentian area and might be used for ornamental material.

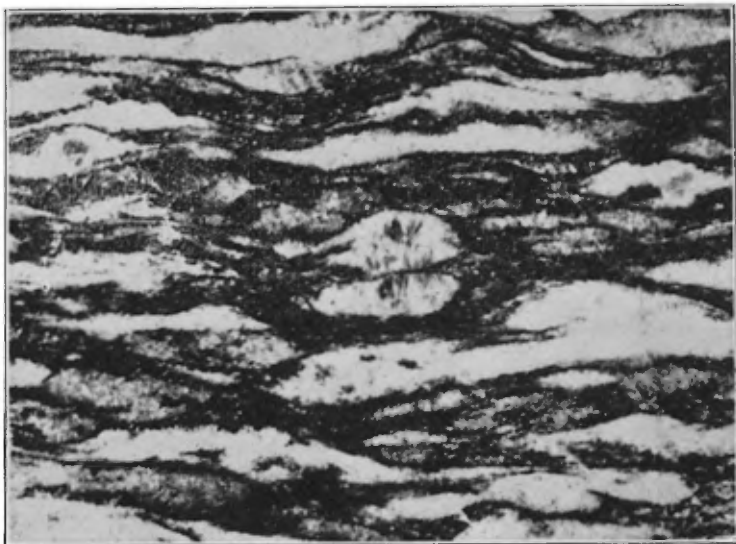


B.—Weathered depressions formed by solution of clots in anorthosite near Petite Décharge. In some localities the dark minerals are iron-ores, in this they are hypersthene.

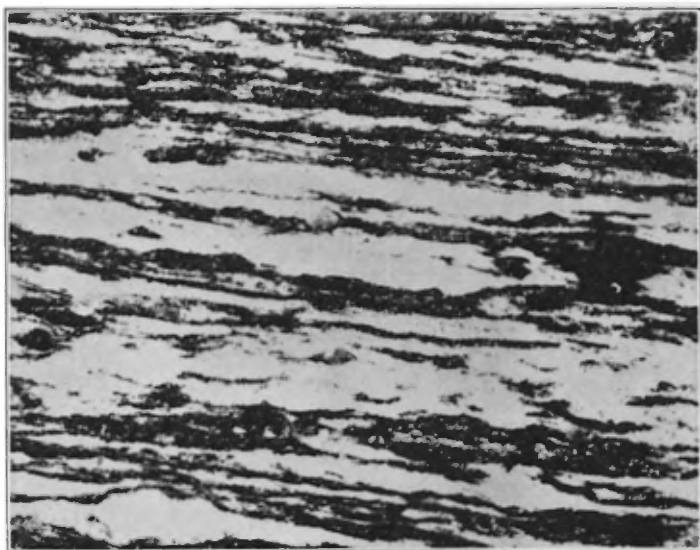
F. F. Osborne



Quartzite of the Grenville series cut by a coarsely-granular red granite north of New Glasgow. The quartzites (to the right of the figure) were folded before the intrusion of the granite, then the two deformed together.



A.—Augen gneiss from Farmer's siding, Shawinigan Falls. The light parts are deep rose microcline and green albite set in a black matrix. The stone is highly ornamental.



B.—Banded Laurentian gneiss. The light parts are rose and white. Such a stone might be used for ornamental work.



A.—Moreau quarry in Roberval granite, showing the massive character ordinarily associated with a coarse-grained granite such as this.



B.—South end of the Bernier quarry in Roberval granite, showing the slope of the sheets and their irregularity.



A.—Abandoned quarry of the Black Granite Co., Saint-Gédéon, showing the streaks in the stone and the character of the breaks.



B.—Quarry of the National Granit Enrg., Saint-Gédéon, in black anorthosite. The rift structure may be seen dipping to the left back of the derrick's boom.



A.—Hills of anorthosite rising above the drift south of Saint-Gédéon. The type of quarry site available is shown.



B.—Anorthosite brecciated by offshoots of Roberval granite. Road-metal quarry on road Saint-Joseph-d'Alma to Saint-Bruno.



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