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UPPER ROMAINE RIVER AREA, SAGUENAY COUNTY

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GEOLOGICAL REPORT 38

UPPER ROMAINE RIVER AREA

SAGUENAY COUNTY

by

Jacques Claveau

QUEBEC
RÉDEMPTI PARADIS
PRINTER TO HIS MAJESTY THE KING

1949

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SAGUENAY COUNTY

By Jacques Claveau

INTRODUCTION

During the summer of 1945, a reconnaissance survey of the geology along the upper part of Romaine river and some of its tributaries was undertaken in order to continue northward the work begun by J.A. Retty along the lower part of the river in 1941 (1).

Retty's mapping along the river extended from its mouth, on the gulf of St-Lawrence, to a point about one hundred miles upstream, at latitude 51°05'N., where he encountered exceedingly difficult conditions of travel. The river here flows for several miles in steep gorges (the 'lower gorges'). In order to gain some idea of conditions northward from this point, the present writer, before leaving for the field, made a study of aerial photographs of the country. From inspection of these it was evident that, starting at a point eighteen miles above the limit of Retty's mapping, the river for a stretch of twenty-three miles is again very turbulent and for the southern part of this length (referred to in subsequent pages as the 'upper gorges') is apparently unnavigable. This stretch of the river extends northward from Garneau river to a point two miles below river Petite Romaine, tributaries which enter the main river from the east and west respectively. The photographs indicated that, northward from here, the Romaine offered no serious obstacles to navigation.

It was therefore decided to establish a base camp at Garnier lake, which is just east of Romaine river, about four miles north of the point where it is joined by the Petite Romaine, and from there to work southward as far as possible, and northward as far as time permitted. The party assembled at Garnier lake on July 7th.

Descending Romaine river, it was found possible to travel by canoe as far as the two falls (the upper gorges) two miles above Glapion river, and beyond that, on foot, to the mouth of that river. At that point, difficulties of travel were such that it was deemed inadvisable to attempt to proceed farther southward. However, several aeroplane flights at low level were made later over the country between here and the northern limit of Retty's mapping, and the geology along this unnavigable section of Romaine river was established with reasonable certainty.

The work of mapping northward from river Petite Romaine was, by comparison, relatively easy and, despite the shortness of the season, it was carried as far as Lozeau lake, at latitude 52°05'N., or seventy miles in a straight line north-northwest of the point reached by Retty.

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(1) RETTY, J.A., Lower Romaine River Area Saguenay County. Que. Bur. Mines, G.R. 19, Map No.582. Scale: one inch to two miles, 1944.

The mapping covered a strip ten to twenty miles wide along and adjacent to Romaine river, except in the part below Glapion river, where the air reconnaissance was restricted to the river banks.

Means of Access

It will be obvious, from what has been said above, that the area – or at least the lower part of it – is not accessible by canoe by way of Romaine river. Low (1), in 1894, described a portage route over which Romaine river (above the upper gorges) may be reached by way of St-John and Petite Romaine rivers, and some trappers still use this route. However, travel is extremely difficult and the trip from St-John river takes a month and a half. Obviously, this is impracticable for a survey party whose work season lasts only about three months. Thus, the only logical means of access to the area is by air. From Seven Islands, the closest summer base of Canadian Pacific Air Lines, the distance to Garnier lake is one hundred and forty-five miles.

Seven Islands can be reached from Rimouski, on the Montreal-Halifax line of the Canadian National railway, by overnight boat service operated twice a week by La Compagnie de Transport du Bas St-Laurent, or from Montreal or Quebec city by boats of the Clarke Steamship Company which sail weekly and call at Seven Islands and various other points along the coast.

Other means of access include the 'plane service of Canadian Pacific Air Lines, twice weekly, between Montreal, Quebec, Baie Comeau, and Mont-Joli, and a secondary line with daily flights between Baie Comeau and Mont-Joli. Mont-Joli is on the Canadian National railway, eighteen miles east of Rimouski, and Baie Comeau, on the north shore of the St-Lawrence, ninety miles west of Seven Islands, is a port of call for the boats mentioned above.

Travelling downstream along Romaine river in the lower part of the area becomes difficult (Figure 8) from a point two miles below the mouth of the Petite Romaine, and strongly inadvisable, when not impossible, below Baubert river. It is possible, with precarious maneuvring and juggling (Figures 7 and 8), to bring a light canoe down the upper gorges as far as some two miles above Glapion river. At this point, however, the presence of two large falls (Figure 2) necessitates long portaging which, actually, is not feasible as the country adjacent to the gorges is floored with heaps of huge boulders covered by entangled trees, fallen since the forest fire of 1941 and treacherously concealed beneath a thick growth of low brush (Figure 3). Travelling on foot beyond this point does not meet with much success. Progress is discouragingly slow, as,

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(1) Low, A.P., Report on Explorations in the Labrador Peninsula along the East Main, Koksoak, Hamilton, Manicouagan, and portions of other rivers in 1892-93-94-95; Geol. Surv. Can., Ann. Rept., Vol.VIII, Pt.L, 1895.

in this vicinity, it involves continuous steep climbs and descents, commonly through dangerous obstructions (Figure 1).

At the foot of the upper gorges, the river expands into a long, narrow lake at the head of which Garneau river joins Romaine river. The lake terminates in a steep fall followed by cascades, below which the river appears, from the air, to flow gently between very high walls of anorthosite for about ten miles, until it begins a new roaring descent down steep winding gorges — the lower gorges — which continue for ten to twelve miles. The fifty-mile stretch from a point two miles below the mouth of the Petite Romaine to the foot of the lower gorges is the most inaccessible portion of Romaine river along its entire 300-mile course.

The stretch of relatively quiet water between the upper and lower gorges appears easily navigable, but, being closed at both ends by impassable gorges, it remains inaccessible for practical purposes. It can be reached by way of Garnier and Rougemont lakes and West Garneau and Garneau rivers, but, unfortunately, the lower reaches of Garneau river below Legendre lake are characterized by gorges which, from the air, appear to be obstructed and as unnegotiable as those of the Romaine.

As already noted, northward from the upper gorges the Romaine presents few obstacles to travel by canoe. For ten miles above the first north-flowing tributary downstream from the Petite Romaine, it follows a wide, multi-channelled course among sand bars and maintains a velocity of about three miles an hour. Along the next sixteen miles, the sand bars become less conspicuous, the river gradually diminishes in width, and its gentle flow is occasionally broken by short, strong currents. Then, for four miles, very strong currents prevail, grading upstream into mild rapids and, above these and not far apart, two falls.. At the next bend above the falls, more strong currents and a short cascade are encountered, above which the river assumes again a moderate flow. The two falls are avoided by portaging over rock ledges and boulders on the east bank, and the cascade by walking a short and well-beaten trail through the underbrush of the west bank. Above the cascade, quiet water continues for thirteen miles, beyond which the current is very strong for a stretch of one mile, and again, less than two miles farther upstream, for a distance of a mile and a half. Then, for the remaining twelve miles to Lozeau lake, the river flows idly between sand banks, except at the outlet of the lake, where it cascades twice in quick succession down a sloping bed of boulders (Figure 17).

Northward from the upper gorges, the country adjacent to Romaine river is easily accessible at several points by ascending the larger tributaries or following chains of lakes. Although navigation along some of the streams is not easy — river aux Touladis, for example, is characterized by shallow water and numerous rapids — the region lends itself to easy portaging. In most places, only a very scant vegetation has grown since the very destructive forest fire of the late 'nineties', and portaging can commonly be done without any trail-cutting.

Acknowledgments

The writer is much indebted to the Department of Lands and Forests of Quebec for providing copies of all available plans of the region, for permitting access to their records and library, and for photographic services rendered. Thanks are also due to the Surveys and Engineering Branch of the Department of Mines and Resources, Ottawa, for their obliging enlargement to the scale of four miles to one inch of topographic maps of an area 200 miles long by 65 miles wide in the region of the upper part of Romaine river.

Two short-wave transmitting and receiving radio sets were loaned to the party by Mr. Henri Kieffer, Chief of the Forest Protection Service. Extremely valuable help in the matter of radio communication and in the use of the sets was given by Mr. R. Nadeau, of Quebec.

The party was serviced in the field by Canadian Pacific Air Lines, who did an excellent job under most difficult conditions. Labrador Mining Exploration, Ltd., helped to relieve the problem of transporting the party to the base camp at Garnier lake by permitting the use of their largest aircraft for one trip, a service which effected a saving of several days.

The party included Nelson Gadd, a geology student at the University of Western Ontario, as assistant; George Vigneault, of Havre St-Pierre, cook; and Philippe, Omer, and Aimé Lebrun, also of Havre St-Pierre, canoemen. All discharged their respective duties in a highly commendable manner.

The report was prepared and thin sections studied in a laboratory equipped and loaned by the Faculty of Science of Laval University, to which the writer wishes to acknowledge his deep gratitude.

Previous Work

The only previous geological work in the area was a reconnaissance survey in the fall of 1894 by A.P. Low (1), at that time completing three years of exploration in the interior of Ungava. Coming from the north, he entered Romaine river at a point eight miles above Burnt lake. He descended the river as far as river Petite Romaine which he ascended, following the portage route leading to St-John river. Of Romaine river below the mouth of river Petite Romaine, Low writes (p.170):

" ... it flows southeast for four or five miles in a wide, shallow channel that slowly contracts as the current increases, and finally breaks into heavy rapids where the river passes into a narrow cut between steep, high hills. Nothing is known of the river for over fifty miles below this point, except that it is quite impassable for canoes, probably on account of long rapids with perpendicular rocky walls, where portages are impossible. Nothing but the absolute impossibility of passing up and down this part of the river would induce the Indians to make use of the

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(1) Low, A.P., op. cit.

present portage route between the Romaine and St-John rivers, which is the longest and worst of those known to the writer anywhere in northeastern Canada"

This fifty-mile stretch referred to by Low is that extending from a point two miles below the mouth of river Petite Romaine to the foot of the lower gorges. As noted earlier, information gathered locally by the writer, and his air reconnaissance along this section of the river, substantiate Low's statement that it is impassable for canoes.

In his rapid trip down Romaine river from Burnt lake, Low had the opportunity of examining rock exposures at only five points because of the almost continuous heavy overburden. Three of these outcrops were granite (the northern granite mass); the others were a dark-green hornblende schist at Burnt lake, and a grey garnetiferous hornblende-mica gneiss four miles above the mouth of river Petite Romaine. The present work did not reach as far as the outcrop of hornblende schist, which is undoubtedly an altered member of the many olivine gabbro masses of the region. The garnetiferous rock has been recognized by the writer as an undoubted paragneiss; it is described in a later section of this report.

J.A. Retty (1), in the course of his mapping along the lower part of Romaine river and its major tributaries in 1941, reached a point somewhere in the midst of the lower gorges, about one hundred miles from the mouth of the river. At that point, he had penetrated eight miles within a mass of anorthosite, presumably the southern part of the large body of this rock which was encountered by the writer in the upper gorges and along Little Romaine river, and by Low along St-John river. An offshoot of this body occurs also in the region of Legendre lake and West Garneau river.

Vegetation and Animal Life

The region was devastated by several forest fires prior to 1894 and only a scant and dwarfed vegetation (Figures 10, 11, and 18), consisting chiefly of black spruce with some balsam and white birch, has grown since. A more recent fire (1941), whose northern limit follows approximately the margin of the anorthosite mass through Little Romaine river and the upper gorges on Romaine river, has largely destroyed the meagre growth that had made its appearance in this southern part of the map-area.

Animal life is moderately abundant. Partridge, rabbit, porcupine, muskrat, and beaver were seen occasionally. Of the larger animals, only brown bear appear to be plentiful. Pike and trout were caught in most of the lakes and rivers, on which several types of migratory game birds were seen.

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(1) Retty, J.A., op. cit.

PHYSIOGRAPHY

The area in general is of moderate relief except south of the northern border of the large anorthosite mass, where the terrain has the ruggedness typical of the southern margin of the Canadian Shield (Figures 1, 2, 5, and 6).

Where Romaine river enters the anorthosite just below the mouth of Baubert river, its valley, which for some eleven miles above this point is fairly open with occasional high hills on the south side only, contracts abruptly to a narrow, winding passage with steep walls — the upper gorges — through which the river falls an estimated two hundred feet in its first twelve miles through the anorthosite.

Although the river does not everywhere maintain its turbulent course as it continues southward, its deep, narrow, canyon-like entrenchment persists to the southern limit of the map-area and for several miles beyond.

Along the upper gorges (Figures 2, 5, and 6), the anorthosite forms rounded, stout hills with steep and often jaggedly broken sides rising from five to six hundred feet above the river and increasing in altitude southward. They are partly to almost completely bare and light grey in colour, with coarse talus commonly lying at the base of the steeper faces.

Eleven miles above the upper gorges, the aspect of the country changes abruptly. The river valley widens suddenly and, except for rare narrow stretches, it maintains, as far as Lozeau lake, an average width of one to two miles (Figures 12, 13, and 15). The hills, which consist of gneiss, granite, or gabbro are, as a rule, more elongated, much less abrupt, and more gently rolling (Figures 10, 11, and 18) than those of anorthosite farther south. Many of them, however, seem to owe much of their less rugged aspect to the fact that they are mantled, to a greater or lesser height, with a blanket of unconsolidated material similar to that which covers the valley bottoms. This is apparent in some places, where rocky hilltops emerging from the loose sand and gravel have angular and somewhat rugged features. Nevertheless, the jagged ruggedness and round, stout, steep-sided forms characteristic of the anorthosite hills are never equalled by the hills of granite and gneiss. And even when the anorthosite is heavily drift-covered, as it is east of Rougemont and Garnier lakes, the overburden which partly disguises the rugged relief does not prevent the half-bare, steep-sided, whitish hills of anorthosite from standing out conspicuously by their characteristic shape, height, and colour, from the hills of gneiss to the north and northwest. Although some of the gabbro hills rising between the upper gorges and Lozeau lake (see Figure 15) assume outlines which are a close approach to those of the anorthosite hills, they usually lack the bareness of, or, if partly bare, they are much darker in colour than, the characteristically whitish hills of anorthosite.

Rivers, Streams, and Lakes

The whole map-area drains to the St-Lawrence through Romaine river, which has a fairly well established course as far upstream as Lozeau lake. Most drift barriers have been incised to the level where the rate of reduction is

almost negligible. At many points the river is assuming a strong tendency to meander and to migrate laterally along its valley bottom. Old channels are visible on aerial photographs and in some places in the field, especially along the stretch of rapids between Sauterelles and Touladis rivers. One such channel, near the head of the rapids, stands at twenty to thirty feet above the present river bed. Along the part of the river above the upper gorges, evidence of this lateral migration is seen in several small lakes, land-locked remnants along the former channel of the river.

A remarkable effect of erosion by water along Romaine river is a giant pot-hole (Figure 4) in the anorthosite on the north side of the falls two miles above Glapion river. The depression is twelve feet in diameter and about twenty feet deep. One wonders at the powerful action and at the length of time required to carve a hole of such dimensions out of a rock as hard as the anorthosite.

From Lozeau lake northward for 25 miles, the Romaine is represented by a chain of five lakes before resuming its course as a true river. These lakes owe their existence to failure of Romaine river to reduce below its present level the barrier of very coarse drift that dams the outlet of Lozeau lake (Figure 17). From south to north, the lakes are Lozeau, Anderson, and (beyond the limit of the present map-area) Lavoie, Burnt, and Marc. Burnt lake, by far the largest, has a length, northwest, of twenty-two miles and a width, at its most open part, of four miles.

Of the larger tributaries, rivers aux Sauterelles and Petite Romaine have well established courses. West Garneau and aux Touladis, on the other hand, probably due to their small volume, to their low power of degradation, and to the nature and abundance of obstructions along their valleys, appear to have made little progress since early post-glacial time. They still consist of a series of lakes, each spilling into the next over a bed of coarse drift.

The large lakes of the region are clearly features of a poorly developed drainage. They seldom lie in basins of rocky basement, but are, as a rule, the result of water accumulated behind glacial obstructions. In the central part of the map-area, most lakes are long and narrow bodies of water lying between drift barriers along clogged pre-glacial valleys. Among outstanding examples are Garnier, Rougemont (Figure 9), and Moyen. In the northern part of the region, where the broader, drift-filled valleys and the lower hills of the central Quebec-Labrador plateau prevail, relatively low obstructions have caused the waters to spread over large areas of favourable flatness, thus forming broad, shallow lakes with, commonly, low shores, such as Norman, Lozeau, Anderson, and Burnt lakes.

Altitudes in the Area

The altitude of Garnier lake was established by simultaneous readings of aneroids at the lake and at sea level at Seven Islands. This altitude served in turn to compute the altitudes of Rougemont and Moyen lakes, in the central part of the map-area, of Romaine river below the

mouth of the Little Romaine, of Barthe lake upstream from the latter, and of a few other points. Unfortunately, an accident then left the party with only one aneroid. It was possible, however, with this and by various expedients to secure approximate altitudes of other points of the area.

Along Romaine river near the mouth of the Little Romaine, the elevation is 1,510 feet. At Barthe lake, a tributary of Little Romaine, although the height-of-land between Romaine and St-John rivers is still ten miles distant, the altitude is already 1,835 feet, and rugged hills of anorthosite which rise about the lake and to the south presage a rough climb over the watershed. The highest hills of the region rise along this watershed as a series of east-northeasterly trending ridges of anorthosite which cross Romaine river in the neighbourhood of latitude 51°15'N. It is estimated that most of these hills have an altitude exceeding 2,500 feet and that the average of the crest line is probably close to that figure. As it would seem that no hills to the north (as far as Lozeau lake) rise much over 2,300 feet, it is likely that the 2,500-foot crest line marks the divide of the Quebec-Labrador plateau between its southern edge – which slopes markedly toward the south — and its gently to imperceptibly north-sloping central part.

In the vicinity of Norman lake, a few hills appear to have altitudes close to the 2,300-foot mark, and one hill at least, eight miles southeast of the lake, exceeds this figure, but the average crest line in the upper one-third of the map-area is markedly lower than 2,300 feet. To the south, the hills around Moyen lake, north of Rougemont lake, west of Romaine river between rivers Petite Romaine and aux Touladis, and along the latter river, are estimated to rise to heights between 1,900 and 2,300 feet. In the small anorthosite mass east of Garnier lake, the highest summits are found in the northern portion, due east of Rougemont lake, where some hills may exceed 2,300 feet and where the average elevation is noticeably greater than in the adjacent area to the north and northwest.

The obvious conclusion regarding the attitude of the plateau is that it slopes to the south below latitude 51°15'N.; but north of this line, although the plateau probably slopes to the north, its gradient is so nearly imperceptible that it will require accurate measurements to establish it with reliability. It is a matter of common observation that northward along Romaine river from the upper gorges to Lozeau lake, the relief becomes progressively more subdued. This, however, may be due to the presence of increasingly thicker and more extensive drift deposits along the valleys northward, rather than to an actual decrease of the true altitude of the plateau as measured by the elevation of the average crest line or bed-rock.

At the foot of the upper gorges, the altitude is estimated to be less than 1,300 feet at the level of the river, and probably exceeds 2,500 feet in some neighbouring hills. Above the gorges, at the mouth of Little Romaine river, the elevation is somewhat over 1,510 feet. In the several falls and rapids along Romaine river between here and Lozeau lake, there is a fall of more than 100 feet, but elsewhere along this stretch of about sixty miles the gradient is less than one foot per mile. Thus, the elev-

ation of Lozeau lake is in the neighbourhood of 1,700 feet. It is about the same at Rougemont lake, which is on the east side of Romaine river some 9 miles north-northeastward from the mouth of the Little Romaine. Garnier lake, a short distance south of Rougemont lake, stands at 1,625 feet, and the group of lakes around Moyen lake, northeast of Rougemont, have altitudes ranging from 1,750 feet to 1,790 feet.

GENERAL GEOLOGY

Table of Formations

QUATERNARY		Recent	Reworked sands
		Pleistocene	Glacial drift, bedded sands, fine gravel
PRECAMBRIAN	INTRUSIVES	Pegmatite and granite dykes	
		Biotite-hornblende granite	
		Intrusive Contact	
		Diabase and lamprophyre Gabbro, diorite, and altered derivatives Anorthosite Syenite to quartz syenite gneiss; granite gneiss	
	Sedimentary rocks	Coarse impure quartzite Garnet-sillimanite paragneiss Pyroxene amphibolite Pyroxenite	

General Statement

The bed-rock of the area, which comprises large masses of anorthosite and granite, and lesser extents of gabbro, gneisses, and sedimentary rocks, is commonly overlain by a thick mantle of unconsolidated glacial deposits, which greatly restricts the number of outcrops. This general statement must be qualified, however, since the anorthosite which occupies the southern part of the area is profusely exposed. Elsewhere, outcrops are to be found occasionally along rivers and around lakes, or more commonly at some distance from them on the flanks of hills that rise steeply from the drift.

Sedimentary rocks, which form a very small percentage of the rock outcropping, include quartzite, paragneiss, and metamorphic derivatives of limestone, such as pyroxenite and pyroxene amphibolite. Igneous gneisses – syenite, quartz

syenite, and granite – are more abundant but still much subordinate to anorthosite and granite. Anorthosite underlies the south part (in all, about one-quarter) of the area mapped and is known to extend far beyond its limits. Olivine gabbro, diorite, and their metamorphic derivatives are found in large and small masses intruding the granite and also the gneisses, with which they share equal rank in order of abundance. Granite, which prevails in the northern part of the area, is the youngest rock of major importance; it appears to be the southern part of a body of this rock which extends far to the east, north, and west.

Lamprophyre and diabase dykes were seen cutting the gabbro and anorthosite, but not the granite. The latter, however, as well as the older rocks, are cut by granite and pegmatite dykes.

Metamorphic Sedimentary Rocks

Sedimentary rocks occur in two main localities: (1) in the southern part of Moyen lake, and (2) to the west of Romaine river between rivers Petite Romaine and aux Touladis. There is a suggestion of continuity between the isolated outcrops in these two localities and it is reasonable to assume that they belong to bands or inclusions of notable size in the gneisses. Other occurrences of sedimentary rocks were noted as isolated outcrops or as inclusions in complex assemblages of all other rocks.

Sedimentary Rocks of Moyen Lake

In the course of a southward traverse from Moyen lake, sedimentary rocks were found to outcrop dispersedly across a width of more than one mile. The exposures are on the west shore of the south end of the lake and along the east shore of a smaller lake half a mile to the south.

At Moyen lake, the rocks exposed are very coarse, hornblende-bearing, glassy quartzites interbedded with finer-grained, dark grey to black, biotite-amphibole gneisses and schists, in beds one inch or more in thickness. Some narrow bands of plagioclase-hornblende rock which follow the quartzite bedding are quite massive and have a gabbroic appearance; they may be concordant basic dykes, which are of common occurrence in all the rocks of the region. The quartzites give place northward to a rusty syenite gneiss. The actual contact, which is not exposed, probably strikes close to N.55°E., which corresponds to the strike of both the sedimentary rocks and the syenite gneiss. The dip of the gneiss is steep to the northwest, whereas that of the quartzites is erratic, being steep but shifting within a few feet from northwest to southeast.

The beds exposed at the small lake to the south have about the same strike as those at Moyen lake, with dip steep to vertical, but they are of entirely different type, being fairly massive to poorly bedded pyroxenite and pyroxene amphibolite. The former is cut by granitic dykes, tends to weather spheroidally, and is pale green, with veinlets, rosettes, and patches of whitish-grey scapolite. Under the microscope, it shows an equigranular aggregate of very pale green diopside, in grains less than 0.5 mm. in diameter. In addition to the scapolite, which may form

about 10 per cent of the volume of the rock, there are present a few interstitial flakes of biotite; some pale greenish hornblende; minor amounts of calcite, quartz, wollastonite, and apatite; and magnetite, in corroded granules and fine dust.

With no contact exposed between the two, the pyroxenite gives place southward to several prominent exposures of dark mica-pyroxene amphibolite. The latter rock conveys the impression of being strongly schistose, but close examination shows that it is rather massive with the exception of a rough alignment of the mica flakes. Along these planes of poorly developed schistosity, the rock has been injected in lit-par-lit fashion by evenly spaced veins, up to two inches wide, of quartz-rich pegmatite or aplite. Their regular spacing and rectilinear character suggest that they occupy planes which coincide with the bedding planes of the original rock. Under the microscope, the rock is found to have a granoblastic texture and the schistosity is even less apparent than in the hand specimen. Straw-yellow biotite, pale green fresh diopside, fresh to uralitized hypersthene, and deep green equigranular hornblende, constitute 40 per cent of the rock. The remainder is plagioclase of intermediate composition (andesine) occurring either in well-twinned, rectangular to sub-rectangular crystals or as irregular grains in which twinning is poorly developed or absent. The latter type is probably slightly more sodic than the well formed crystals and it is definitely later, as it corrodes and replaces them. Magnetite also is present, but in very minute amount.

Even if the inferred presence of bedding in the amphibolite cannot be used as direct evidence, there seems to be little doubt from the mineral assemblages found in the pyroxenite and in the closely associated amphibolite that both are metamorphic derivatives of calcareous sedimentary rocks. The rock that gave rise to the pyroxenite was possibly a siliceous limestone (or a relatively pure limestone in which quartz was introduced during metamorphism) as evidenced by the presence of greatly preponderant diopside, of subordinate scapolite, and of grains of calcite which may be remnants of the original carbonate. The amphibolite, on the other hand, probably originated from a more aluminous and dolomitic calcareous sediment as indicated by the abundance of plagioclase and biotite, and by the presence of important amounts of hypersthene and hornblende, in addition to diopside.

Sedimentary Rocks Between Rivers Petite Romaine and aux Touladis

Groups of outcrops of gneiss were encountered at several points along and near the first and second tributaries that enter Romaine river from the west above the mouth of river Petite Romaine. In all these occurrences, the rocks exposed are similar in appearance and composition. They all contain sillimanite and, chiefly on this account, they are believed to be paragneisses.

Such rocks outcrop along Romaine river near the mouth of the first tributary, at the north nose of a prominent ridge that forms the west side of the broad Little Romaine River valley. Westward from here, they are found

again, outcropping in the hills northwest of the lake from which this tributary emerges some two miles from its mouth. It is to be noted, however, that between these two groups of gneiss exposures there lies a body of diorite of unknown size, outcrops of which are found along part of the southwest shore of the small lake referred to. Farther north, the first three groups of exposures encountered along the second tributary, at points between two and three miles from its mouth, are paragneiss.

The representative paragneiss is a medium-grained, strongly gneissic to banded, garnetiferous rock. It is intruded generally, but not invariably, in lit-par-lit fashion, by basic and pegmatitic dykes which seldom exceed a few inches in width. The strike is somewhere between north and northeast and the dip is steep to the west. Associated with this typical gneiss in some of the outcrops along the second tributary are subordinate amounts of finer-grained, biotite-rich paragneiss, and also of a quartz-rich rock that might better be termed impure quartzite than paragneiss. In at least one of the outcrops, this quartzitic rock displays recognizable bedding.

The paragneiss exposed on the Romaine near the mouth of the first western tributary above river Petite Romaine can be regarded as representative of the sedimentary rocks between rivers Petite Romaine and aux Touladis. As a whole, it is grey with a creamy tinge, but there are darker bands along which are rows of tiny red garnets. In thin section, the rock shows signs of having been largely granulated except for a few large crystals of feldspar which, although fractured, are not actually disrupted. Quartz and feldspar constitute more than 70 per cent of the rock. The former occurs in irregular patches of grains, and in separate grains. The feldspar is predominantly orthoclase, in large and small crystals with microperthite intergrowths of sodic feldspar; there are also occasional small crystals of twinned oligoclase. The perthitic guest in the orthoclase consists of tiny but stout blades or lenticles and of globular to oval blebs oriented along definite directions in the host crystal; even in a single crystal, they may be distributed along as many as three different planes. Their shape and distribution suggest that they are of exsolution origin. Other minerals present in the paragneiss include biotite, which may be in part chloritized; garnet; sillimanite, in typical tabular crystals of medium size; hypersthene, which exhibits an unusually strong pleochroism; deep green, probably chloritized, diopside; and magnetite, in streaks, veinlets, and blebs.

The mineral assemblage in general, and the presence of sillimanite in particular, seem to leave no doubt as to the sedimentary origin of this gneiss and, by inference, of the similar gneisses outcropping at the localities mentioned. Indeed, it is probable that all these exposures of paragneiss form part of one or more bands of sedimentary rocks occupying most of the area between river Petite Romaine and the second tributary above it that enters Romaine river from the west. The northerly trending ridge forming the west side of Petite Romaine River valley, and which is known to consist of paragneiss at its northern end, may well be composed of paragneiss throughout its length.

Sedimentary Rocks in Other Localities

Contorted beds of paragneiss occur near the granite on Romaine river a few hundred feet above the first rapids below the mouth of river aux Sauterelles. Although the rocks are complexly recrystallized, their bedding is still well preserved. They tend to be rich in hornblende, biotite, and plagioclase, and are traversed along their foliation by pegmatite ribbons and lenses containing quartz and white and pink feldspar. The outcrop is further confused by the presence in the paragneiss of ill-defined patches of altered gabbro.

Eleven miles farther north, on the west flank of a high hill on the east shore of Romaine river, about midway between the outlet of Norman lake and the mouth of river aux Sauterelles, small patches of highly contorted paragneiss can be seen included in a most complicated assemblage of igneous gneisses, gabbro, and granite. Schists and gneisses which appear to be of sedimentary origin can be observed also in a somewhat similar setting along the portage route between Norman and Anderson lakes.

Syenite and Granite Gneisses

Distribution

Judging by the distribution of observed outcrops, igneous gneisses having the composition of syenite or quartz syenite appear to form a broad zone surrounding the small anorthosite mass between Garnier lake and West Garneau river and to extend southward from this mass toward the large anorthosite body at Legendre lake and above the upper gorges. It is not known whether they continue as a belt completely across the zone between the northern and southern anorthosite, isolating one from the other in surface outcrop, but in any case it is believed that these two bodies are connected at no great depth. The gneisses are prominently exposed north and northwest of the small anorthosite mass, that is, between Moyen and Garnier lakes and the lower part of river aux Touladis and of the next stream to the south. Between the two anorthosite masses, they are found in the area between Little Romaine river and the head of the upper gorges, and at the north end and south end of Legendre lake, which is along the course of West Garneau river.

Gneisses of granitic composition, apparently of restricted extent, outcrop at various points along Romaine river and its western tributaries in the area west and northwest of Rougemont lake.

Along Romaine river four miles above the mouth of river aux Sauterelles, and along the portage route between Norman and Anderson lakes, both syenite and granite gneisses occur in complex assemblages which consist chiefly of gabbro.

Syenite and Quartz Syenite Gneisses

The syenite gneisses outcropping in the area between Moyen and Garnier lakes are for the most part white to

rusty – more rarely pink – rocks having very pronounced gneissic structure. Between river Petite Romaine and the head of the upper gorges, and at Legendre lake, the rock is uniformly pink with less prominent foliation and, as a rule, lesser amounts of dark minerals. All the gneisses on the border of the anorthosite are characterized by their partial to complete granulation, which has given rise to a friable rock of remarkably fine saccharoidal texture. Away from the anorthosite, as in the vicinity of Moyen lake, the gneiss lacks this uniform sugary texture; the banding is still pronounced but the grain is coarser and granulation is restricted to certain zones.

Farther southward, in the zone between the two anorthosite masses, the gneiss outcropping at various points between river Petite Romaine and Legendre lake exhibits a relict texture which seems to indicate that it was originally a coarse grained rock with dominant pink potash feldspar and lesser bluish-grey plagioclase. The outlines of the original grains of the latter are still recognizable as bluish-grey blotches consisting now of finely granulated plagioclase, and not infrequently the core or even almost the whole of the original grain has been preserved. Only rarely have the potash feldspar grains escaped complete granulation. There is a remote possibility that the large plagioclase crystals were introduced in the syenite by emanations from the anorthosite and that they were crushed in part, or completely, in later deformation. In some instances, these large crystals seem to replace the finer plagioclase of the groundmass. This could be a result of recrystallization during granulation. Since, however, the plagioclase forming the large crystals and that occurring in the groundmass has the same composition, it is more likely that the large crystals were part of the original syenite.

Under the microscope, the average syenite gneiss shows a striking granoblastic texture, with grains averaging 0.15 mm. in diameter. The predominant feldspar is usually microcline, and associated with this are varying amounts of orthoclase and oligoclase. Small amounts of microperthite of both exsolution and replacement types were noted in some of the thin sections. Generally, quartz is rare or absent and where present is restricted to small granules or streaks along the cleavage of biotite flakes or, as seen in one section, to myrmekitic blebs in plagioclase. Rarely, however, the rock contains sufficient quartz to warrant the designation quartz syenite. A specimen collected close to the anorthosite on the east side of a lake along West Garneau river and five miles south of Moyen lake was found to contain as much as 20 per cent of quartz. The gneiss of Moyen lake carries about five per cent and that of Legendre lake approximately fifteen per cent of eight specimens of the syenite examined in thin section, only these three contained quartz in appreciable amount.

Dark minerals seldom account for more than five per cent of the total constituents of the syenite. In general, biotite is the most common but in some facies it is exceeded in amount by hornblende or green diopside. The latter is almost invariably present. It is occasionally rimmed or partly replaced by green hornblende, which becomes more abundant as diopside decreases. In the Moyen Lake gneiss,

diopside is accompanied by hypersthene. Subordinate but persistent accessories include magnetite, apatite, zircon, and, more rarely, sphene. Secondary minerals include sericite and paragonite, from partial to complete alteration of feldspar, principally the plagioclase; muscovite, apparently derived from biotite; and chlorite, replacing hornblende and diopside. The rusty staining of the gneiss in some areas, and its friable nature, are due to a limonitic coating along the grain interstices of the rock.

Granite Gneiss

Judging from the limited number of outcrops encountered, granite gneiss appears to be of relatively rare occurrence in the area. In the present report, the term is used to include various types of gneisses of approximate granitic composition and of ill-defined field relations rather than to designate a typical granite gneiss series. A few isolated outcrops of such rock were seen along the lower part of river aux Touladis, along the next tributary to the south, along Romaine river a few miles north and south of the mouth of river aux Touladis, and as inclusions in the northern granite.

The outcrop on the east side of Romaine river, to the northeast of one of the largest bodies of olivine gabbro of the area, consists of a strongly banded and granulated pink gneiss with mica and hornblende as the main dark minerals and much quartz visible in the hand specimen. The same description applies to the rock exposure along Romaine river near the mouth of river aux Touladis. A similar gneiss along the latter river has suffered pronounced contamination from the nearby olivine gabbro and contains an abundance of chloritic and other dark green constituents.

A fine-grained rusty gneiss, cut by granite and pegmatite, which outcrops near the point on Romaine river where a long portage leads eastward to the lake lying north of Rougemont lake, is classed as granitic for lack of a better name for it.

The granite gneisses outcropping along the first tributary below the mouth of river aux Touladis resemble those described above and include also a medium-grained, grey, strongly foliated facies.

Age Relations

In the vicinity of the contact between the anorthosite and the syenite gneiss at Rougemont lake and at the head of the upper gorges, both rocks exhibit a strong foliation. The actual contact was not seen, but its location was narrowed down to within a few feet. It must, then, be fairly sharp, which eliminated the possibility of a gradation from the anorthosite to the syenite. Granulation occurs in the anorthosite, but it appears to be more restricted and less thorough than in the syenite. It is likely that the granulation in the anorthosite is a protoclastic texture – a texture which is common in most anorthosites and dates from their period of consolidation — whereas the thorough granulation of the syenite is a cataclastic texture produced by the emplacement of the anortho-

site. This reasoning would thus place the syenite as older than the anorthosite.

Within the area of outcrop of syenite gneiss in the sharp U-bend of Romaine river, four miles below the mouth of river Petite Romaine, there occur a few outcrops of anorthosite which are rusty and carry large, dark grey phenocrysts of plagioclase in a medium-grained groundmass of feldspar and dark minerals. These outcrops could, of course, be inclusions in the syenite gneiss, but it is much more likely that they represent a small boss of anorthosite intruding the gneiss. It is true that pure anorthosite, because of its high melting point, is not likely to form small apophyses, dykes, or similar small bodies, but anorthosite with a fair proportion of dark minerals may be expected to do so.

Thus, at the present time, there is insufficient evidence to establish with certainty the relative ages of the anorthosite and the syenite (or granite) gneiss. Tentatively, for purposes of this report, the gneiss is regarded as older than the anorthosite.

Anorthosite

Distribution

A large mass of anorthosite which occupies the southern part of the map-area has as its northern boundary an irregular east-west line passing through the lower part of Little Romaine river, the head of the upper gorges, and the south end of Legendre lake. The extent of the mass to east and west beyond the limits of the present map-area is unknown. Its southern boundary is only imperfectly established; the anorthosite is known to cross Romaine river in a south-southwest direction some eight miles downstream from the point reached by Retty (1) in the lower gorges, and possibly to continue irregularly with a general southward trend as far as the head of Puyjalon lake, thirty-five miles to the south. From this point, it swings westward in a broad, open arc and passes only a few miles north of the mouth of Romaine river, continuing in the direction of St-John river, which it crosses just above the point where it is joined by Chambers river (2), at some eight miles from the coast. Except for occasional exposures of gneisses which are presumably restricted inclusions, the anorthosite appears to form a continuous mass between its northern limit on Little Romaine river and its southern limit near Chambers river, some seventy-five miles to the south (3).

A much smaller body lies a short distance to the north of the larger mass, in the region of upper Romaine river. It extends from Garnier lake to West Garneau river, beyond which its boundaries remain undefined. It appears to be a somewhat oval-shaped body, of which only the western half is known. Coming from the east across the upper

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(1) Retty, J.A., op. cit., p.13.
(2) Low, A.P., op. cit., p.237-L.
(3) Ibidem.

Figure 1—The middle part of the upper gorges viewed from a vantage point two miles west of Glapion river. Note the anorthosite topography and the recent "burn".

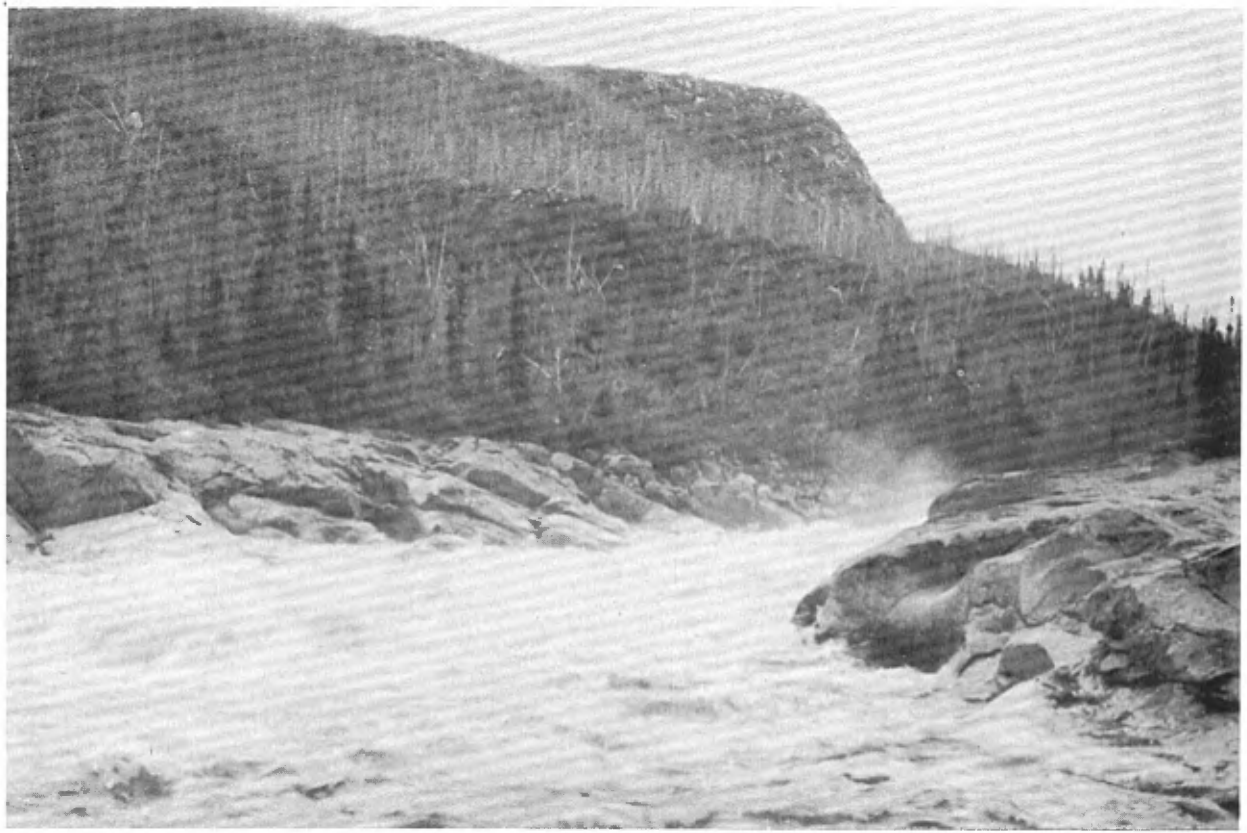

Figure II—Falls on Romaine river along the upper gorges two miles above Glapion river and beyond which any further progress downstream by canoe was deemed impossible.

Figure III—Piles of large boulders covered by short growth through which portaging was found impossible on the north side of falls shown in figure II.

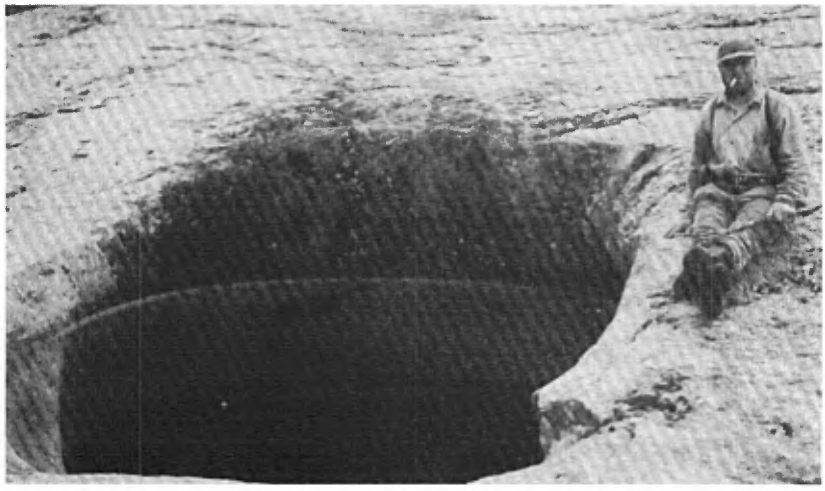

Figure IV—Giant pot-hole in anorthosite on north side of falls shown in figure II.

Figure V—Upper gorges of Romaine river immediately above the falls two miles above Glapion river, looking upstream.

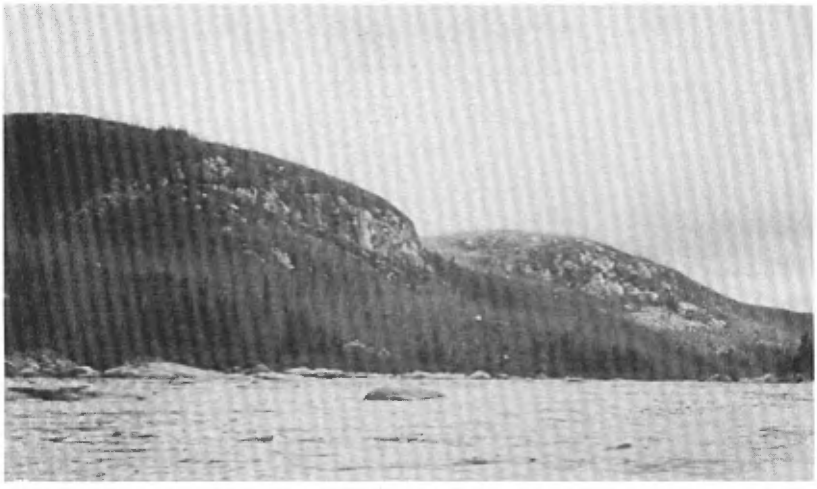

Figure VI—Upper gorges four miles above Glapion river looking downstream. Note rugged hills of anorthosite and talus.

Figure VII—Precarious maneuvring through the rapids of the upper gorges. Three miles above Glapion river.

Figure VIII—Travelling upstream through the ten-mile stretch of milder rapids above the upper gorge. Note the low shores and absence of high hills. View looking upstream.

Figure IX—Rougemont lake, looking north.

Figure X—Gently rolling hills and scant vegetation in the region immediately south of Moyen lake. View looking north.

Figure XI—Looking west from a low hill at the south end of Rougemont lake, showing the scant vegetation and gentle hills.

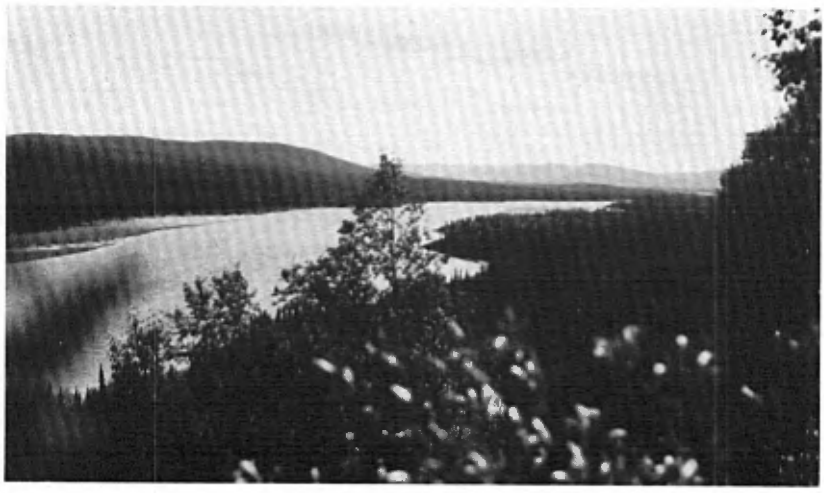

Figure XII—Romaine river, looking south from a point near the mouth of river aux Touladis.

Figure XIII—Party travelling up Romaine river. View looking south from a point ten miles above river aux Touladis.

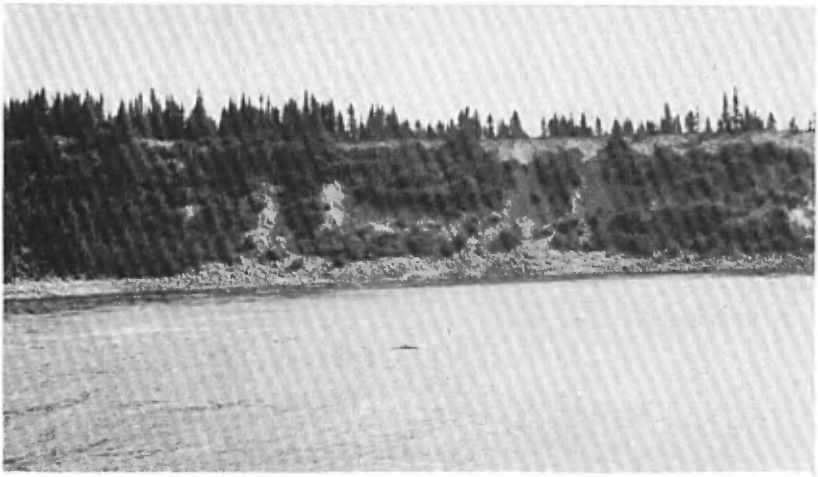

Figure XIV—Romaine river cutting through moderately coarse till at the first rapids below the mouth of river aux Sauterelles.

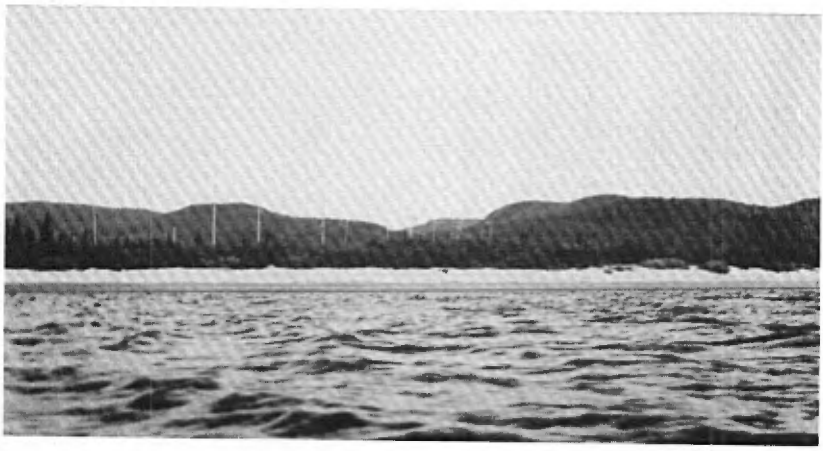

Figure XV—Hills of gabbro in the large body of olivine gabbro north of the mouth of river aux Touladis.

Figure XVI—Gneissic granite in the rapids along Romaine river fifteen miles above river aux Touladis.

Figure XVII—Romaine river flowing over a bed of coarse boulders as it issues from Lozeau lake.

Figure XVIII—Looking southeast from a point six miles southeast of Norman lake.

Figure XIX—The outlet of Garnier lake meandering through thick deposits of fine-bedded and cross-bedded sands near its point of junction with Romaine river.

Figure XX—Thick deposits of fine-bedded and cross-bedded sands along river aux Sauterelles.

part of West Garneau river, its northern margin swings southward to cut through Rougemont lake and around the west side of Garnier lake, touches Romaine river where the outlet stream from those lakes joins it, and then swings sharply eastward toward Legendre lake. It is not known whether or not the small mass is connected at the surface with the larger body in the region north of the upper gorges on Romaine river.

Typical Anorthosite

The typical anorthosite is a coarse- to medium-grained rock, white to grey or pale bluish-grey in colour. In the bluish-grey facies, the bluish shade is due to a play of colours exhibited by the labradorite of which the rock is composed. Very beautiful colour effects in azure-blue, greenish-blue, green, and, more rarely, reddish and pink tones are to be seen in some specimens or exposures. They are best displayed on naturally polished and preferably wet surfaces of the coarse grained rock exposed around the shores of Garnier lake and in the upper gorges two miles below Baubert river.

The labradorite has a composition between An_{50} and An_{55}. It is generally fresh, with only occasional incipient alteration to white mica or to saussurite. Dark minerals are present in very small amount or mere 'traces'

A specimen from the long lake one mile east of Rougemont lake has a somewhat porphyritic aspect, with large labradorite crystals distributed through a groundmass of fine to medium grain. The large crystals exhibit a bluish play of colour which is only faintly displayed in the groundmass, probably because of the small size of the labradorite crystals in the latter. The large crystals are bent or fractured and show a ragged contact line with the granular plagioclase of the groundmass. They are disposed erratically through the groundmass and lack any relation to the faint foliation suggested by the tendency to alignment of the few flakes of hornblende and biotite present.

Two specimens of the coarse-grained facies of the rock, one from the south end of Garnier lake and the other from a point four miles below Baubert river, in the upper gorges on Romaine river, were found on examination to have almost identical characteristics, despite the fact that they were from such widely separated localities and are from the small and the other from the large anorthosite mass. The feldspar, in grains over two millimeters in diameter, is fresh but shows pronounced strain effects such as bent twinning lamellae and undulatory extinction. The dark minerals present are biotite, hornblende, and ilmenite, all in very small amount and erratically distributed. In the specimen from Garnier lake there is slight alteration of the plagioclase grains along their edges to saussurite and white mica. Some quartz is present in grains, in blebs, and as small irregular patches in the feldspar (myrmekite). Many regular blade-like intergrowths in the labradorite are probably orthoclase (antiperthite). In the specimen from the upper gorges, there is, in addition to the antiperthite, a feathery micrographic intergrowth of quartz and feldspar replacing some of the labradorite crystals.

In the anorthosite outcropping along the portage route between Garnier and Rougemont lakes, segregations are encountered which take the form of pockets or drawn-out lenses and streaks of large pyroxene crystals – up to several inches in length – and of minor clusters of ilmenite grains.

Ilmenite is an erratic accessory mineral of the anorthosite. It is frequently disseminated throughout the rock or it occurs locally in small streaks and lenses. Appreciable concentrations were observed in only one locality, at the falls two miles above Glapion river.

Anorthosite Gneisses

These rocks are, more strictly speaking, gabbroic anorthosite with a strong gneissic banding, since they are characterized by a large content of dark minerals (up to 30 per cent). They are found as a contact facies around the borders of both anorthosite masses, and also in the midst of the larger mass. They are regarded as primary gneisses, that is, dating in origin from the emplacement and consolidation of the rock.

In the gneiss of the border facies, the plagioclase appears to be slightly more sodic (An_{45-50}) than in the typical anorthosite, and the dark minerals include, in addition to ilmenite and small amounts of hypersthene and diopside, biotite and green hornblende. In the gneiss found well within the larger mass, biotite and hornblende are lacking or in very minor amount. It seems, therefore, that greater amounts of the mineralizers necessary for the formation of these two minerals were available near the borders of the masses than elsewhere. Evidence of granulation is also more marked in the border facies by the presence of zones of finely granular plagioclase between the dark bands.

In the large anorthosite mass, the passage from the normal white, coarse-grained facies to the gabbroic type is gradual. In the upper gorges, the change begins in the hills south of the falls two miles above Glapion river with the appearance of large granules of ilmenite and conspicuous amounts of pyroxene. The latter increases in abundance southward until, in the neighbourhood of Glapion river, the rock is a strongly gneissic gabbroic anorthosite with more than 30 per cent dark minerals. Under the microscope, the dark bands are seen to consist of large crystals of olivine surrounded by hypersthene and minor amounts of brown and pale green hornblende. The pyroxene and amphibole commonly occur in feathery micrographic intergrowths. The plagioclase is labradorite (An_{50}) and occasionally the crystals are slightly bent. The dark minerals, and more particularly the olivine, all show intense fracturing, but all are fresh.

In a specimen of a finer-grained facies of the same gneiss, collected half a mile above the last, olivine is absent and hornblende is somewhat more abundant, rimming or replacing hypersthene.

Anorthosite Dykes

At the mouth of Glapion river, the gabbroic anorthosite is cut by a few dykes of dark purplish medium-grained, pure anorthosite. They are only a few inches wide and generally follow the gneissic banding, but one was observed cutting across it. The plagioclase of the dykes is andesine (An_{45}). It is cloudy but shows little or no strain effects. The rock contains also some later interstitial plagioclase, and very minor amounts of pyroxene and ilmenite.

Primary or Protoclastic Textures and Structures of the Anorthosite

There is little doubt that the Glapion River gabbroic anorthosite is a primary gneiss. Olivine would scarcely be expected to have survived the intense deformation necessary to produce such a pronounced banded structure if it were of secondary origin. It is likely that the gneisses of the border facies also date from the consolidation of the magma. In other words, the gneissic or foliated facies of the anorthosite seems to be a direct result of magmatic flowage and concomitant stresses. Early crystallized dark constituents lying in a plagioclase mush were forced into parallel arrangement under flowage during the final stages of the emplacement of the anorthosite. Flowage and stress during the last stages of consolidation explain as well the shape of the flat, pinching and swelling lenses of ilmenite occurring conformably in zones of well foliated anorthosite. Here, however, it is also possible that, in the case of large segregations, the ilmenite was squeezed along favourable structures from neighbouring parts of the mass.

In the porphyritic anorthosite occurring east of Rougemont lake and elsewhere, in which large crystals are distributed through a fine grained groundmass, the texture is more probably protoclastic than the result of later deformation. A somewhat similar texture considered as protoclastic is reported by Balk (1) in the Adirondack anorthosite.

Age Relations

It has been previously mentioned that the anorthosite is thought to be younger than the syenite gneiss which surrounds the small mass and appears as a belt between it and the large body to the south. On the other hand, it is probably older than the olivine gabbro and the northern granite. The coarse-grained anorthosite of the upper gorges is cut at a point three and a half miles below Baubert river by a dyke of altered diorite or metagabbro, which probably is genetically related to the gabbro. Many small

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(1) Buddington, A.F., Adirondack Igneous Rocks and Their Metamorphism; Geol. Soc. Am., Mem. 7, 1939, p.24.

bodies and dykes of pegmatite and granite which are considered to be related to the northern granite cut the anorthosite of both the large and the small masses in several localities.

Gabbro, Diorite, and Altered Derivatives

Gabbro and diorite constitute an important intrusive series of the region. They are thought to be a late basic differentiate of the magma that gave birth to the anorthosite. Similar conclusions were reached by the writer (1) for an extensive series of gabbroic rocks occurring in the Wakeham Lake Area, twenty-five miles southeast of the present map-area. Fresh, normal diorite is rare in comparison to fresh gabbro. Although there probably exist true diorites representing a less basic facies of the gabbroic differentiate, some unusual dioritic types of the area could plausibly be regarded as the result of assimilation of the invaded gneisses by gabbro. In addition to these, there is a 'spotted' diorite facies which is found in close association with the fresh gabbro or in isolated outcrops. A similar facies was encountered in the Wakeham Lake area where it was clearly the product of thermal alteration of pre-existing gabbro either during the late magmatic stages of the intrusion or during subsequent intrusions in the vicinity.

Under the term 'altered derivatives' are included amphibolites, plagioclase amphibolites, and chloritic gneisses and schists known or suspected to be metamorphic derivatives of the gabbro or diorite and which in some cases may be regarded as the more advanced metamorphic stages of the spotted dioritic facies.

Distribution and Petrography

The best known body of gabbro occupies a circular area exceeding twenty square miles between Romaine river and the lower part of Aux Touladis rivers just north of their point of junction. The map shows clearly that this plug of gabbro, which forms resistant, rugged hills (Figure 15), had a marked deviating influence on the courses of both rivers. The results were an easterly bulge around the plug in the course of Romaine river and a pronounced westerly bulge in the course of river aux Touladis.

No sharp contact was seen between this gabbro and the surrounding rocks. Along the lower part of river aux Touladis, various types of 'mixed' rocks consisting of granitic gneiss with considerable amounts of amphibolitic and chloritic material indicate that the contact with the older gneiss is possibly gradual rather than sharp. Farther up the same river, where the gabbro comes in contact with the younger northern granite, somewhat similar

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(1) Claveau, Jacques, Wakeham Lake Area, Saguenay Co.; Que. Dept. Mines, Geol. Rept. 37, 1948.

mixed rocks are encountered which here, however, must be regarded as the result of partial assimilation, or mixing, of the gabbro with the later granitic intrusive.

The gabbro of the plug is a medium-grained, dark, massive rock. From a rigid petrographic standpoint, it should be termed norite, as its characteristic pyroxene is hypersthene. But it also contains diallage and for that reason, as well as for purposes of correlation with other areas, the term gabbro is preferred.

In the fresh rock, the texture varies from granular to ocellar and diabasic. The latter is seldom very marked whereas the ocellar texture is common and is due to the presence of reaction rims around olivine. The rock consists of olivine, hypersthene, diallage, garnet, hornblende, biotite, plagioclase, magnetite, and apatite. These are present in somewhat variable amount with the exception of the hypersthene and garnet, which seem to be consistent in occurrence and abundance. In the ocellar texture, nuclei of olivine are rimmed by successive zones of hypersthene, green hornblende, and small garnets. Where diallage is present it is usually in large individual crystals. Although the garnets may occur in irregular distribution, they are characteristically found along boundaries between the ferro-magnesian minerals and plagioclase. The hornblende with associated magnetite is brown whereas that accompanying pyroxene is the green variety. The plagioclase is labradorite (An_{50}), occurring as laths where the texture is diabasic and in equidimensional grains where it is granular or ocellar. It forms only a small percentage of the total constituents of the rock and shows moderate alteration to saussurite and white mica.

The 'spotted' dioritic facies mentioned earlier is seen here and there within the gabbro plug. The characteristic texture of this facies — which is regarded as probably the result of late magmatic alteration — is rudely eye-shaped nests of finely acicular amphibole in a groundmass of plagioclase. These nests may be arranged in a vague alignment and locally, may even become sufficiently flattened and elongated to produce banding.

Other occurrences of gabbro are at the north end of Rougemont lake, where a small island is formed of this rock, and a small dyke-like mass in the granitic gneiss outcropping along the first tributary south of river aux Touladis. The gabbro at Rougemont lake is particularly rich in olivine and plagioclase. The latter, which is labradorite (An_{50}), makes up more than 40 per cent of the rock and exhibits undulatory extinction and occasional bending of the twin lamellae. The olivine is in large grains surrounded by delicate rims of hypersthene and bluish-green amphibole. Other minerals present include brown hornblende, biotite, apatite, and rare calcite. The gabbro south of river aux Touladis also contains olivine and hypersthene.

The olivine and hypersthene content of these rocks strongly suggests a genetic relation with the anorthosite, which often carries hypersthene locally and whose gabbroic facies, encountered along the upper gorges, carries both olivine and hypersthene. Except for its greater content of plagioclase, the gabbro facies of the anorthosite differs

very little indeed from the gabbro of the individual masses intruded in the gneiss surrounding the anorthosite.

'Spotted' and other types of diorite of the gabbroic series outcrop in places in the vicinity of the anorthosite. Spotted diorite, cut by granite and abundant pegmatite, is found as a prominent hill that rises at the northwestern end of the lake lying immediately northeast of Rougemont lake, and also forming a small island at the north end of Moyen lake. An isolated outcrop of diorite was seen at the top of the low ridge on the west side of Garnier lake. The rock is a medium-grained, massive aggregate of yellowish-grey plagioclase and subordinate dark minerals. Diorite also forms an isolated hill on the south side of the lake upstream along the first western tributary of the Romaine above river Petite Romaine. The rock here is somewhat more compact than that at Garnier lake and it contains occasional crystals of pink orthoclase. Although on freshly broken surfaces it has all the appearance of a typical diorite, it is particularly misleading on the weathered surface, which is whitish-pink and resembles granite. The rock possesses a mild foliation and is rather low in dark minerals. It may be a product of assimilation in situ of the invaded gneiss by the gabbro.

In the northern part of the map-area, members of the gabbroic series constitute the larger part of several groups of outcrops encountered within the area of outcrop of the northern granite mass. Those outcrops can be tentatively regarded from their field distribution as forming two north-south-trending bands included in the granite.

The more westerly of these bands appears to have a width of more than four miles at its widest part, with tapering toward both ends. From south to north, the outcrops encountered are as follows: altered gabbro and sedimentary rocks at the head of the first rapids below the mouth of Aux Sauterelles river; a high hill of plagioclase amphibolite just east of the mouth of this river; a prominent ridge two miles farther north in which practically all the rocks of the region are found in an intricate assemblage; and typical gabbro and diorite along the outlet stream from Norman lake. From the first named locality, high hills which, owing to lack of time, were not examined, can be seen rising sharply in the west at two or three miles from the river. Their ruggedness and dark colour are suggestive of the rocks of the gabbroic series and it is thus probable that they form part of this westerly band.

Specimens of a particularly fresh-looking and homogeneous coarse diorite collected on the prominent ridge along the east side of Romaine river four miles above the mouth of river aux Sauterelles, and similar rock encountered along the stream flowing from Norman lake, seem to indicate that some at least of the diorite in the gabbroic series was intruded as such, and is not a metamorphic derivative of the gabbro or a product of assimilation of country rock by the gabbro magma, as are the dioritic rocks so far considered.

In some outcrops, this intrusive diorite is massive; in others it is strongly gneissic. A thin section of the latter shows advanced alteration of large, poikilitic crystals, of hornblende to chlorite and the presence of zones of

granulation which have been invaded by large, colloform patches of quartz. It is quite clear that the quartz has been introduced from the northern granite, which occurs in close association with the diorite. The feldspar, which constitutes over 50 per cent of the rock, is acid to intermediate andesine; it is generally fresh and, unless crushed, the grains are of medium size. Minor constituents are biotite, occasional muscovite, apatite, magnetite, and calcite. Except for the presence of later quartz, this rock is a perfectly normal intrusive with the composition of an average diorite.

The other band of basic rocks within the area of outcrop of the northern granite is a mile and a half east of that just described. Some three miles in width, its western boundary trends slightly west of north through the middle of Norman lake. The main outcrops are found in hills bordering the southwestern shore of the lake and in a series of north-south ridges at its southeast end. It is through a gap across these ridges that a large stream flowing from the southeast empties into Norman lake. The southerly extent of the band beyond this stream is unknown. To the north, altered gabbro in association with relics of sedimentary rocks and granitic gneiss outcrops along the portage route to Anderson lake. As the present work was not carried beyond Anderson lake, the northward continuation of the band remains undefined. It may be noted, however, that the only exposure found by Low (1) between Burnt lake and the foot of Lozeau lake was an outcrop of dark-green hornblende schist at the outlet of Lavoie lake, which is the lake emptying into Anderson lake from the north. There is little doubt that this schist is a metamorphic derivative of gabbro. As the outcrop lies along the projected trend of the Norman Lake gabbroic band, it can be safely assumed that this band extends north as far as, and probably beyond, Lavoie lake.

The gabbro of the ridges at the southeast end of Norman lake appears to be representative of the band. The rock tends to display a vague schistosity which parallels the long axis of the band. It shows a typical pitted weathering on the surface and a purplish tinge on the fresh fracture. Fairly fresh and highly altered types alternate repeatedly and rather abruptly, making it difficult to decide which is more representative of the rock as a whole. A feature of particular interest at the lower falls along the stream emptying into Norman lake is the presence of irregular, small bodies of fine-grained diabase cutting the gabbro. At one point, the diabase carries angular blocks of the latter. Under the microscope, the gabbro itself is seen to have a strong diabasic texture. It is medium-grained, with diallage as the main dark constituent. Pale green amphibole (a product of incipient uralitization) fringes the pyroxene. Some patches of magnetite dust, and irregular serpentine-filled 'cracks' occupying areas among pyroxene crystals, may be relics of original olivine. The rock contains a minor amount of hypersthene in small crystals, and rare grains of garnet. Besides occurring as dusty particles, magnetite is also present in solid patches and in reaction rims

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(1) Low, A.P., op. cit., p.235L.

consisting of small biotite flakes surrounded by green hornblende. The feldspar is labradorite (An_{65}) in fresh, beautifully zoned, crystals. It forms about 40 per cent of the volume of the rock.

Dyke Rocks Related to the Gabbroic Series

Reference has already been made to a dyke of altered gabbro or diorite cutting the anorthosite of the upper gorges. The dyke pinches and swells to some extent, but averages two feet in width. It could be an inclusion, or 'pseudo-dyke', but there is little evidence that this is the case. It is much more probable that it is a dyke of the gabbro series, owing its deformation to movement subsequent to its intrusion. The gabbro being regarded as an intrusive closely related to the anorthosite genetically as well as in time, it would be expected that any forces producing deformation in the anorthosite would remain active during and after the intrusion of the gabbro. The rock is fine-grained, and, though somewhat altered, has the composition of normal diorite. It consists of green hornblende in skeletal crystals, subordinate biotite, and calcic oligoclase. Accessories include magnetite, apatite, zircon, and, in very minor amount, pyrite. Usually, there is a little secondary calcite.

Dykes of two types were found cutting the gabbro of the map-area: diabase dykes, already referred to, at the southeast end of Norman lake; and garnetiferous lamprophyre dykes, which cut the gabbro of the aux Touladis-Romaine River plug at the base of a high cliff on Romaine river, five miles above the mouth of river aux Touladis. As neither diabase nor lamprophyre dykes were seen cutting the northern granite, these occurrences are regarded as late minor differentiates of the gabbroic series and older than the granite.

Age Relations

The presence of a dyke of diorite cutting the anorthosite, and the satellitic distribution of gabbro and diorite in large and small masses around the anorthosite, suggest that the gabbroic series is younger than the anorthosite but that there is a close relationship between the two is indicated by the presence in the anorthosite of a gradational olivine-hypersthene gabbroic facies similar in composition to the average rock of the gabbro series.

On the other hand, it is definitely established that the gabbro is older than the northern granite. Dykes and irregular masses of granite or pegmatite were seen cutting the gabbro and diorite in most of the outcrops of these rocks and are particularly numerous in those along the stream below Norman lake.

Granite

Distribution

The northern part of the map-area is occupied by granite, part of a great batholith of still largely undefined extent. Where the batholith enters the present area from the west, in the lower part of river aux Tou-

ladis, its south margin has a northeast trend. It follows the western side of the large gabbro plug and, continuing northeastward, crosses Romaine river at a point somewhere along the heavily overburdened area in the lower part of the long rapids midway between rivers aux Touladis and aux Sauterelles. It must continue beyond this point, possibly with the same northeastward trend, through the unexamined area between Moyen lake, where syenite gneiss prevails, and Norman lake, to the north, which is underlain by granite with large inclusions of older rocks.

The most prominent exposures of the granite are found along rivers aux Touladis and aux Sauterelles, along Romaine river opposite the mouth of the Norman lake outlet and also four miles farther north, and four miles southeast of Norman lake.

Petrography

The typical granite is a coarse-grained, pink rock containing abundant microcline, subordinate plagioclase, and relatively little quartz and dark minerals. It varies little in appearance and grain throughout the vast area it underlies. Except along its contact zones with other rocks, it possesses only a mild to negligible foliation. In large outcrops, it is seldom free of inclusions, which are commonly biotitic gneiss; some, however, are identifiable as impure quartzite. Where the rock is foliated, the inclusions are generally elongated parallel to the foliation. They seldom exceed a few tens of feet in length and one foot in width. In the unfoliated granite, the inclusions are more apt to be block-like.

Three specimens of the granite examined in thin section reveal a highly variable quartz content. Two of the sections contain less than 15 per cent quartz and the third 40 per cent. In general, however, the tendency is for the quartz content to be low, and not infrequently the rock could be termed a quartz syenite. In one place at least, along the southwest shore of Norman lake, the rock is actually a syenite. On the other hand, the granite of the high hill opposite the mouth of Norman lake outlet is very rich in quartz. It is very coarse-grained and consists almost entirely of pink potash feldspar and large grains of opalescent quartz.

The average granite is moderately fresh. Its microcline content approximates 70 per cent, and plagioclase (oligoclase) ranges from 10 to 15 per cent. The microcline occasionally carries blades of plagioclase (microperthite) and many of the oligoclase crystals have intergrowths of vermicular quartz (myrmekite). Both feldspars show incipient to moderate alteration to white mica and, as a rule, such alteration is more pronounced in the plagioclase. The dark constituents seldom exceed 5 to 10 per cent and consist chiefly of biotite and hornblende. Brownish-yellow epidote is an important accessory and may exceed biotite and hornblende in amount. Other minor accessories include apatite, zircon, sphene, and magnetite.

The granite exposed along the rapids on Romaine river between rivers aux Touladis and aux Sauterelles shows a strong foliation. It also contains a larger percentage

of dark constituents than the average granite and is so deformed in places that it could be termed an augen gneiss. Another feature of the rock is the unusually large number of foreign inclusions, either in the form of schlieren or well-defined bands of gneiss. It may be noted that the granite here is in contact, at the head of the rapids, with the southeast margin of the more westerly of the two bands of gabbroic rock described on an earlier page, and, a few miles farther south, with the northern margin of a body of granitic gneiss. Presumably, therefore, the peculiar character of the rock is the result of contact metamorphism. The 'augen' structure, however, was probably the result of deformation subsequent to the consolidation of the batholith. It is quite conceivable that in this locality, where the granite has the form of a rather narrow neck between the gabbro and the syenite gneiss, the rock was exceptionally vulnerable to any later regional forces of deformation.

Dyke Rocks Related to the Granite

Small masses and dykes of fine-grained granite, aplitic granite, coarse pegmatitic granite, and pegmatite, found cutting the granite and all the other rocks of the area, are regarded as the final differentiation products of the main granite magma. They also mark, as far as is known, the close of recognizable igneous activity in the area.

Pleistocene and Recent

In the part of the area underlain by the southern anorthosite mass, the unconsolidated sediments are coarse, thin, and patchy, whereas in the whole area to the north they are thick and consist largely of fine bedded material, especially at the lower levels. It is likely that, in early post-glacial time, the upper gorges of Romaine river were largely closed by debris left by the retreating ice sheet. The water derived from the melting ice, dammed as it was by the clogged gorges and the elevated front of the southern anorthosite mass, attained, in the valleys of Romaine river and its tributaries, a level well above the present water mark. As the ice retreated, there probably came into existence between the upper gorges and Lozeau lake (and undoubtedly also farther north, beyond the limits of the map-area), a series of lakes, separated by barriers of coarse drift and spilling into one another. These constituted the initial post-glacial drainage along the Romaine River valley. In them were accumulated fine bedded sediments which were later cut through by the river as the drainage became better established through reduction of the drift barriers.

Thus deposits of bedded sands are encountered at successively higher levels up Romaine river. Areas along Romaine River valley where at one time particularly large lakes appear to have existed, due to favourable conditions of extensive low relief, are all in the lower part of the river, around the mouth of the Petite Romaine, east of Moyen lake, and more especially in the upper one-third of the map-area. While no serious attempt at generalization should be made at present, one may speculate on the possibility that river aux Sauterelles, the whole Romaine river

from twelve miles below river aux Sauterelles to Lozeau lake, and Norman lake and the lakes to the southeast of it, were all at one time part of one single, large, irregular and deeply embayed lake.

Unconsolidated sediments are most abundantly developed along the valleys of Romaine river and river aux Sauterelles. They persist for some distance up most of the minor tributaries of Romaine river, but become thinner in the region of the uplands. As is to be expected, also, the deposits of the higher levels are generally very coarse and of no economic value, since all the finer material has been washed down toward the Romaine valley.

Along the Romaine valley, the deposits form a strip from one to two miles wide extending from Baubert river in the south, at the border of the larger anorthosite mass, to Lozeau lake, at the upper limit of the map-area. It is interrupted for less than one mile at one point only, the upper part of the first rapids below the mouth of Aux Sauterelles river.

Along the river aux Sauterelles Valley, the lateral extent of the drift is impressive (Figure 20). The deposits are very thick and visual inspection from a vantage point near the mouth of the first tributary of the river revealed that, apparently, similar conditions prevail for a considerable distance up that tributary.

The unconsolidated sediments of the area are predominantly sand and very fine grav: in thinly bedded and cross-bedded layers which are very well exposed along the banks of Romaine river and river aux Sauterelles and in the lower parts of the smaller tributaries (Figure 19). The bed and beaches of Romaine river, however, consist of moderately coarse till at several points, generally where the current is strong. Many such points probably mark positions where, in the initial post-glacial drainage, there were drift barriers, above which lakes formed and fine sediments were deposited.

One outstanding instance where the river has cut an unusually deep channel — as much as fifty feet deep — through moderately coarse till is along the lower half of the rapids south of the mouth of river aux Sauterelles. (Figure 14). The impact of the water falling tumultuously from the granite ledges at the head of the rapids accounts for this strong degradation.

Clay is very rarely seen in the area. A fairly extensive deposit of clay of a somewhat sandy character was observed along some small streams flowing into Romaine river north of the outlet of Norman lake.

An outcrop of a partly consolidated sediment, emerging from beneath looser sand and gravel, was seen along Romaine river three miles above the mouth of the Petite Romaine. It consists of bedded, dark brown, rusty, coarse sand carrying small rounded pebbles.

STRUCTURAL GEOLOGY

The various structural features observed in the area are more clearly related to the local intrusives than to a regional pattern.

The gneisses close to the anorthosite masses show a 'wrapping' effect that is obviously controlled by the shape of the intrusive bodies and thus lends support to the belief that the gneisses are older than the anorthosite. In the anorthosite masses, as already noted, a narrow marginal zone marked by the presence in unusual abundance of dark minerals, has a gneissoid structure due to the concentration of these minerals in series of parallel bands whose trend at any point corresponds with that of the margin of the mass. This, however, is a primary structure produced by flowage and stress during the emplacement of the anorthosite. Along the northwestern margin of the smaller anorthosite mass, it was possible to obtain several reliable measurements of the dip of the banding in both the gneisses and the anorthosite. Most of these measurements show an average northwestward dip of 55 degrees, indicating that this part of the anorthosite mass is dome-shaped, that is, it plunges under the gneiss at about 55 degrees.

Elsewhere, no clues were obtained regarding the shape of the masses. In the bands of gneiss between the two anorthosite masses, the foliation is usually linear and, where its attitude can be ascertained satisfactorily, the only information it furnishes is that the foliation is conformable to the border of the southern anorthosite mass.

A strong zone of foliation which trends between east and southeast across the anorthosite of the upper gorges and dips north (40 to 70 degrees) seems to constitute a major structure of this mass. The upper limit of the zone is roughly parallel to the northern margin of the anorthosite and crosses the upper gorges at a point five miles above the mouth of Glapion river. At Glapion river, the foliation is still very strong and shows no sign of weakening. This structure appears to date from the last stages in the emplacement of the anorthosite and it may have considerable importance in view of the fact that the only notable concentration of ilmenite observed in the area occurs within this zone of foliation.

All strike measurements obtained in the gneisses in the vicinity of the Touladis-Romaine gabbro plug show that the general tendency is for the surrounding gneisses to be wrapped around the plug.

Along the rapids on Romaine river between rivers aux Touladis and aux Sauterelles, the trend of the gneissic granite, and also that of the gabbroic gneisses and sedimentary rocks it intrudes, parallels the contact between these rocks, and the dip indicates that the granite plunges steeply beneath the northern band of older rocks. In the granite southward from this contact, the strike remains the same but the dip changes from northwest to southeast. It is thus likely that the contact of the granite with the southern gneisses is parallel to the northern contact, and that here again the granite plunges steeply beneath the gneisses.

Little can be said about the structure in the remainder of the area, north of these rapids. The granite seldom shows appreciable or measurable foliation. The few determinations of strike that were made in the gneisses along the two bands of these rocks lying within the granite indicate that their gneissic trend or schistosity conforms to the long axes of the bands.

Jointing is well developed in several of the rock types of the area. In the anorthosite, two steep to vertical sets of joints meet at an angle of 120 degrees. In the gneisses, the joints are most prominent parallel to the plane of foliation. The granite displays a remarkably well developed horizontal jointing, which locally has the characteristics of sheeting.

Certain outstanding microstructures and textures, such as the protoclastic texture of the anorthosite and the thorough granulation of the syenite gneiss, have been discussed in the sections of the report dealing with these rocks.

Small-scale drag-folding and crumpling were observed locally, especially in the sedimentary rocks. In the anorthosite, folding and crumbling of elongated segregations of dark minerals were noted which may be attributed to local flowage under stress during the emplacement of the partly consolidated anorthosite.

ECONOMIC GEOLOGY

Ilmenite

Appreciable concentrations of ilmenite were discovered in the anorthosite on Romaine river at the falls two miles above the mouth of Glapion river. They occur on the north side of the upper fall, in a zone some 75 feet wide and 120 feet in uncovered length, striking N.60°W., that is, directly across the river. The zone disappears under overburden at its eastern end and under the swirling waters of the fall at its western end. It was not picked up again across the river, although small exposures of anorthosite, through which the zone should pass, occur near the water level.

The zone itself consists of one major, central, vein-like body of ilmenite surrounded by irregular splashes and disseminations which fade out rapidly with distance from the centre of the zone.

The central body is a vein of very irregular width, striking N.60°W. and dipping northward at 65° to 75°. For a few feet before it disappears beneath the water of the fall, it is a massive sheet, 18 inches wide. Eastward from here it is narrower. It may swell in width to as much as 12 inches and then pinch to a mere line. Near the fall, both the vein and the enclosing anorthosite are cut by a dyke of pegmatite. Some patches of ilmenite scattered through the rock close to the southern border of the vein, although they convey the impression of being important concentrations, must be only very thin and superficial, because a dip-needle survey indicates a magnetic peak for the zone a few feet north of the vein.

The following tabulation gives the dip-needle readings taken at 25-foot intervals across the strike of the zone and indicates also the relative abundance and type of ilmenite outcropping.

SOUTH ← → NORTH

Footage	0	25	50	75	100	125	150	175
Reading	+7	+17	+26	+67	+60	+33	+16	+10
Ilmenite (Surface outcrop)		Disseminated	Disseminated	Disseminated Massive	Massive (Central Vein) ←	Disseminated →		

As will be noted, the peak indicated by the dip needle does not coincide with the abundance of surface outcrops of ilmenite. Instead, the maximum reading and other related high readings were obtained north of the central vein, indicating that the main concentration lies at depth, north of the vein. Since the vein dips at 65°-70° to the north, it is likely that its downward prolongation, and possibly rich occasional swelling, create the strong anomaly recorded north of the point of emergence of the vein at the surface.

CONCLUSIONS

The ilmenite concentrations encountered thus far in the anorthosite are obviously not as important in commercial value as in structural significance. The notable concentrations at the falls near Glapion river lie in a zone of strongly foliated or even schistose anorthosite and are oriented parallel to that foliation. In the northern mass of anorthosite, small concentrations of ilmenite were observed between Garnier and Rougemont lakes at points where the anorthosite shows signs of local deformation. And, as a rule, elsewhere throughout the anorthosite masses, where ilmenite is present and no deformation apparent, it is always in small, sparsely disseminated granules.

Thus it seems evident that the foliated or otherwise deformed anorthosite has exerted some influence on the localization of the ilmenite. And it follows, as a corollary, that, if ilmenite is to be found in appreciable quantity, it will be along zones of deformation of the anorthosite.

The zone which contains the ilmenite at the falls near Glapion river may extend east and west of Romaine river, parallel to the border of the anorthosite. In addition, there are probably other similar zones within the larger anorthosite mass. The smaller northern mass, which was traversed much more extensively than the southern mass, does not seem to hold favourable possibilities for ilmenite,

and for that reason the main search should be concentrated on the larger mass.

Very little can be offered in the way of suggestions for the search for deposits of other economic minerals in the area. Structures favourable for the occurrence of such deposits were not observed, possibly because they are hidden by the thick overburden. More detailed work might furnish more encouraging results, but in the course of the present reconnaissance work nothing of more interest than occasional specks of pyrite and chalcopyrite was observed.

ALPHABETICAL INDEX