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WAKEHAM LAKE AREA, SAGUENAY COUNTY

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PROVINCE OF QUEBEC, CANADA

Department of Mines

Honourable C. D. FRENCH, Minister A.-O. DUFRESNE, Deputy Minister

GEOLOGICAL SURVEYS BRANCH

I. W. JONES, *Chief*

GEOLOGICAL REPORT 37

WAKEHAM LAKE AREA

SAGUENAY COUNTY

by

Jacques Claveau

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WAKEHAM LAKE AREA

Saguenay County

by Jacques Claveau

INTRODUCTION

Location of Area

During the summer of 1943, the writer examined geologically an area of approximately one hundred and eighty-five square miles extending from longitude 63°00' W. to longitude 62°45' W., a distance of about eleven miles, and from latitude 50°45' N. to latitude 51°00' N., about seventeen miles. It lies immediately east of the Forget Lake Area, mapped by Longley[1] during the summer of 1942.

Wakeham lake, after which the present area is named, is near the southern margin of the map-sheet and is one of the large lakes of the region. Geographically, it lies in the uplands north of the north shore of the gulf of St-Lawrence, some forty miles north of Johan Beetz or fifty miles northeast of Havre St-Pierre. The latter, which is one of the main settlements along the gulf, is four hundred miles east of the city of Quebec and in the summer is served weekly by boats of the Clarke Steamship Company, sailing from Montreal and Quebec. Johan Beetz is a much smaller community, thirty-five miles east of Havre St-Pierre. Although lacking wharf facilities, it, also, is a regular port of call for the boats of the Clarke Steamship Company.

Means of Access

The area can be reached most easily by aeroplane from Havre St-Pierre. Most of the numerous large lakes that are fairly evenly distributed over the area afford ideal landing places. Some of them, however, as for example Blondin, Faucher, Cométique, and Stephenson lakes, are not suitable for this purpose, being either too shallow or encompassed by steeply rising, high cliffs.

The only other means of access to the area is by canoe. There are several possible canoe routes (see Figure 1). One leads from Havre St-Pierre to Longley lake, within the map-area, by way of Romaine and East Romaine rivers to Métivier lake, the eastern

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[1]LONGLEY, W.W., Forget Lake Area, Saguenay County; Que. Dept. Mines, Geol. Rept. 36, 1948.

end of which lies seven miles north of the southwest corner of the area. This route is not to be recommended, however, as it is long and arduous. Along some stretches, the Romaine is swift and often dangerous for canoes; along the East Romaine and the outlet of Métivier lake, the waters are shallow and turbulent, making navigation frequently impracticable; and between Métivier and Longley lakes, the portages are numerous, long, and rugged. The difficulties of the trip can be lessened somewhat by striking northeast from the east bay of Boucher lake (Figure 1) through a series of lakes and connecting portages leading to the southwest end of Métivier lake. This alternative avoids a part of the East Romaine and especially the rough travel along the Métivier Lake outlet.

The easiest routes known to the writer start from Johan Beetz or from Quetachou bay, three miles east of Johan Beetz (Figure 1). The region between Johan Beetz and the Wakeham Lake area is dotted with scores of lakes of all sizes and shapes, which afford easy and relatively safe travel by canoe. Indeed, the lakes are so numerous that it is difficult to describe any one route in particular. Portages are cut everywhere and the traveller is offered a rather wide choice.

The route between Wakeham lake and Johan Beetz followed by the writer in the fall of 1942 is indicated on the map accompanying preliminary report No.180[1]. In Figure 1, this route is shown as Nos.1 and 4, with other alternative routes which will be briefly described.

Starting from Quetachou bay instead of from Johan Beetz, the traveller can ascend Grand Piashti river for thirteen miles to Bellenger lake (route No.3) and enter its western inlet, which leads to Napoléon lake along the route described in report No.180. Or, he can ascend the river for about six miles, to the point where Cabane Brûlée lake empties into it (route No.2). Here, the lake overflows a rocky ledge, forming a beautiful fall along the west bank of the river. It is only a very short portage from the river below to the lake above, and from there the route continues to Napoléon lake as described in report No.180.

The three alternative routes from the shore of the gulf to Napoléon lake compare as follows in length and number of portages:

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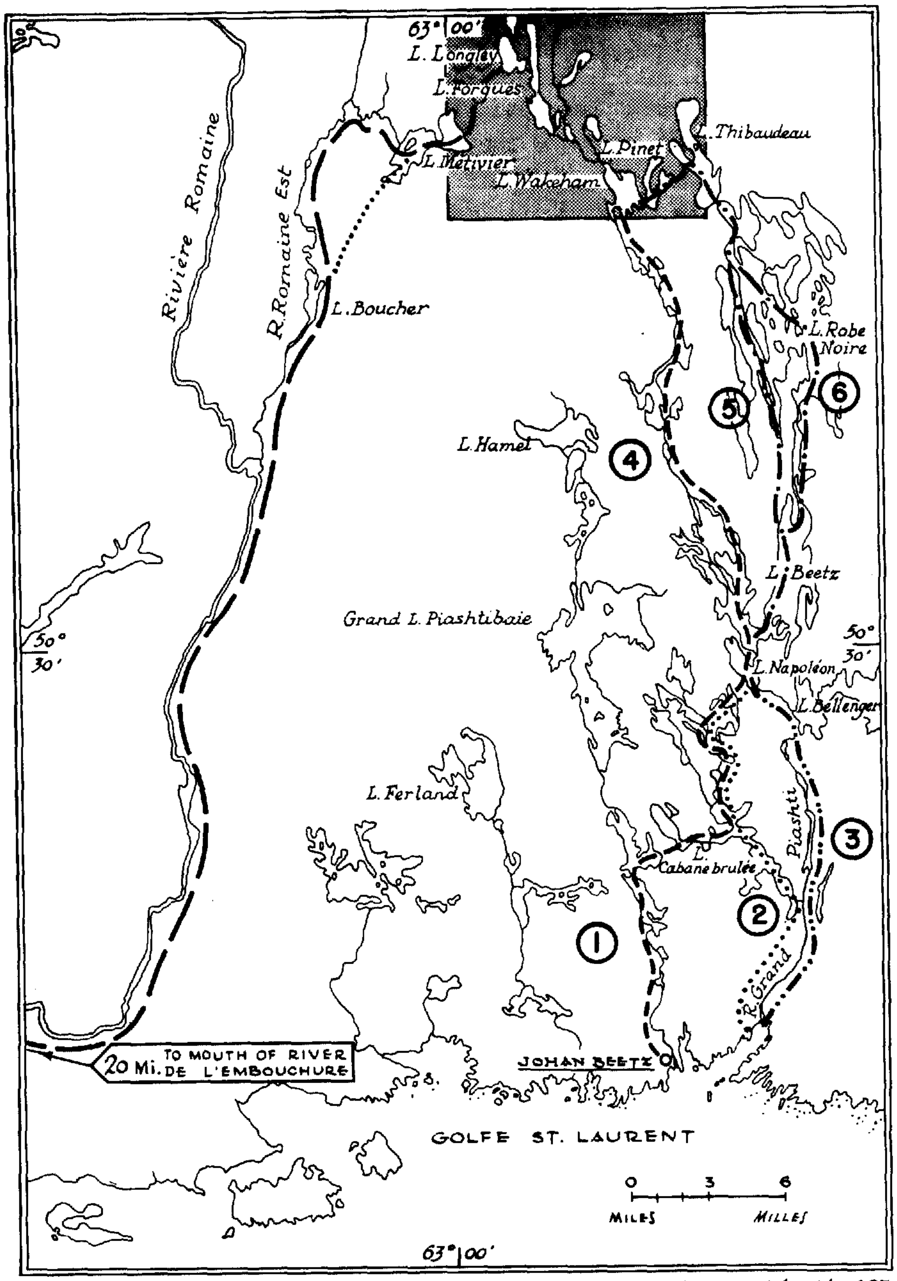
[1]CLAVEAU, Jacques, Special Report on the Area from Forgues Lake to Johan Beetz, North Shore of the St-Lawrence; Que. Dept. Mines, P.R. No.180, 1943.



M. M. Q. 1948 No. 683 FIG. I D. of M. Q. 1948, No. 683

Figure 1.—Canoe routes to the Wakeham lake area. Southern part of the area is shaded.

	Miles	Number of Portages
(1) Johan Beetz-Cabane Brûlée Lake-Napoléon Lake route (route of report No.180)	20	16
(2) Quetachou Bay-Grand Piashti River-Cabane Brûlée Lake-Napoléon Lake route	18.5	17
(3) Quetachou Bay-Grand Piashti River-Bellenger Lake-Napoléon Lake route	16	15

At the south end of Beetz lake, immediately north of Napoléon lake, the traveller has two options. He can enter the northwest arm of the V-shaped Beetz lake and follow the route of report No.180 (route No.4) or he can enter the northeast arm of the V and continue by way of Robe Noire lake to Thibaudeau lake, in the southeast corner of the map-area.

Two good routes branch from the northeast arm of Beetz lake to Robe Noire lake. One (route No.5) necessitates three portages and begins from the large falls which, four and a half miles north of the junction of the two main arms of Beetz lake, make a connecting link between the west side of the northeast arm of this lake and a long, narrow lake (unnamed) immediately to the west. In terms of travel time, this is the longer of the two routes, but it offers better shelter from the wind in the stretch between Beetz lake and Thibaudeau lake. The other route (No.6) leads from the end of the deep and narrow northeastern bay of Beetz lake and involves two portages only. Its disadvantage is that it enters Robe Noire lake in its broadest and least sheltered expanse, where even a moderate breeze renders travelling dangerous, if not impossible. The two routes meet at the northwest end of Robe Noire lake near the outlet from Thibaudeau lake.

From the latter to Wakeham lake, the distance is only six miles, but it includes long and strenuous portages which render the routes leading into the map-area by way of Thibaudeau lake not very advantageous. All the time gained in relatively rapid travelling through Beetz, Robe Noire, Thibaudeau, and intermediate lakes is lost in crossing from Thibaudeau to Wakeham lake. It requires approximately two days for a fully equipped party (3 to 3½ loads per man) to accomplish the crossing.

The longest portage leads from the inlet of the elongated lake immediately west of the middle part of Thibaudeau lake. The trail follows the stream for nearly a mile and a half to a small lake perched five hundred feet above the starting point. The portage actually ends in a shallow pond across which only very lightly loaded canoes can be dragged to the lake itself. Then, to pass from the pond to the lake, the canoes must be unloaded again and carried a distance of fifty feet over a gravel barrier.

The portage between the perched lake and Pinet lake is about half a mile long. The trail is flat and well beaten over most of its length, but near Pinet lake it runs into a steep downhill slope covered with large, angular blocks of quartzite through which walking with heavy loads is extremely precarious.

The routes between Napoléon lake (immediately south of Beetz lake) and Wakeham lake compare as follows:

	Miles	Number of Portages
(4) Napoléon Lake-Wakeham Lake (route of report No.180)	21	12
(5) Napoléon Lake-large falls of Beetz Lake (mentioned above)-Robe Noire Lake-Wakeham Lake route	24.5	10
(6) Napoléon Lake-Beetz Lake-Robe Noire Lake-Wakeham Lake route	26	9

After weighing all the advantages and disadvantages of the various routes just described between the St-Lawrence shore and Wakeham lake, it can be concluded that they are about equally good. Along certain of the routes, the wind may become a serious drawback on the large, open lakes. Other factors may also play an important rôle. Grand Piashti river, for instance, is probably preferable for downstream travel, although at low water many of the local people use this river for inland travel because the portages along it are very short. In May, when the river is swollen by waters resulting from the spring thaw, the current is very strong and the river turbulent in many places. It is then advisable to choose some other route.

Connecting the lakes and other waterways of the area are portages and numerous new trails, all of which are shown on the accompanying map. Some of the trails are rough, but 17-foot prospector canoes and light equipment were portaged over every one of them by the writer's party in the course of the field work.

Acknowledgments

The base-map used in the course of the work was compiled for the most part by the Quebec Department of Lands and Forests from aerial photographs and original land surveys. High praise must be expressed for this excellent compilation, which was made under the direction of Gérald Barrette. The strip within a mile and a half of the eastern boundary of the map-area was compiled by the writer from official survey plans, field sketches, and some aerial photographs.

Able assistance in the field was rendered by René Béland, a post-graduate student of Queen's University. The other members of the party were three canoemen — Paul Blondin of Senneterre, and Adelard and Georges Vigneault of Havre St-Pierre — and a cook, Albert Lebrun of Havre St-Pierre. Supplies were brought in at regular intervals from Johan Beetz by portagers under the direction of Odias Harvey of that place.

The portagers made three full trips in the course of the summer. Throughout the season, the average number of days required for a trip was between 12 to 15. Usually, two men using an 18-foot prospector canoe were sufficient to handle the load transported during each trip. The cost of this method of supply was about the same as if 'planes had been used, considering that the closest air base to the area is one hundred miles west of Havre St-Pierre. With an air base at the latter village, transportation of supplies would be less costly by air than by portagers.

All members of the party and the portagers discharged their respective duties in a most satisfacto.y manner.

Previous Work

The only geological work done in the area previous to the summer of 1943 was during a reconnaissance made by the writer[1] in the fall of 1942, through the southern part of the map-area. Proceeding from Métivier lake, and accompanied by Paul Blondin, he had travelled eastward to Longley and Forgues lakes, and then southward through Wakeham lake and various other lakes to Johan Beetz, on the shore of the gulf of St-Lawrence. In 1941, Retty[2] explored the Lower Romaine River area and made

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[1]CLAVEAU, Jacques, Op. cit.

[2]RETTY, J.A., Lower Romaine River Area, Saguenay County; Que. Dept. Mines, P.R. No.171, 1942, and Geol. Rept. 19, 1944.

a circuitous trip through the Forget Lake area. During the summer of 1942, Longley[1] mapped in detail an area (Forget Lake area) lying immediately west of the Wakeham Lake area and of about the same extent.

The writer, as geological assistant, participated in both the 1941 and 1942 expeditions.

Field Work

The field mapping of the area was done on a scale of two inches to one mile, from systematic traverses run at intervals of half to three-quarters of a mile. As the general regional trend of the formations is in a north-south direction, most traverses were run as east-west lines. In the Muriel and Davy Lakes region, where a plunging syncline emerges at the surface in a series of broad, semi-elliptical curves, the traverse lines were oriented in such a way as to cross the formations at right angles to their trend.

The rocks exposed around the shores of the larger lakes, and of many smaller, easily accessible ones, were examined in detail. The elevations of the important lakes and of high points encountered in the course of traversing were obtained by means of aneroid barometer reading taken on the spot and compared later with the readings of a similar, calibrated aneroid in camp. The cook was provided with prepared graph sheets and was instructed to read hourly the aneroid left in his care.

In order to obtain the elevation above sea of some points in the area, a calibrated aneroid was left at the seashore in the care of the chief portager, Odias Harvey, with instructions to record its readings four times daily for a period of ten days, beginning the day the party headed inland. As the writer and his assistant were equipped with similar calibrated aneroids, the elevation at any point along the route followed during these ten days could be obtained by a comparison of the readings at this point and the reading at sea level at the same hour.

The elevation of seven major lakes within the area was established in this manner and provided a reasonably accurate basis for the computation of the elevation above sea-level of all other points at which determinations were made in the course of the summer.

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[1]LONGLEY, W.W., Forget Lake Area, Saguenay County; Que. Dept. Mines, P.R. No.175, 1943, and Geol. Rept. 36, 1948.

A total of approximately seventy-five days was devoted to field mapping proper. The journey to, and out from, the area consumed much time. Nearly a month elapsed between departure from Quebec and arrival in the field, this including thirteen days spent in travelling from Havre St-Pierre to Cométique lake, which had been chosen as the site for the first base camp. Of the seventy-five days devoted to field work, many were lost through inclement weather or were spent in trail-cutting, moving, and other normal occupations.

PHYSIOGRAPHY

Topography

The topographical features of the area are a remarkably faithful reflection of its geological pattern, which includes sedimentary rocks that occupy nearly one-half of the area, very numerous dykes and sills of gabbro-diabase, and two granite stocks. The gabbro-diabase dykes and sills, being very resistant to erosion, form high hills and long north-south ridges, whereas the relatively softer sediments occupy the valleys. The granite, which also resists erosion fairly well, has perfectly developed, nearly horizontal jointing, which seems to explain why it is that the two stocks of granite form plateaus, one in the southwest corner of the map-area, the other along the northern boundary. Inclusions of gabbro in the granite generally stand out in relief as monadnocks, and consequently, where they are numerous and large, the topography is liable to be very rugged, with each inclusion, or parts of the same inclusion, rising abruptly above the surrounding granite. This variety of dissection is in sharp contrast (and generally diagnosed at a glance in the field or on aerial photographs) to the flat expanses or even the gently rolling, low-rounded hills of the granite plateau.

One of the outstanding monadnocks of the area is a gabbro inclusion in granite immediately east of Faucher lake. This large gabbro block rises about five hundred feet above the level of Faucher lake and from two to three hundred feet above the surrounding plateau to the northeast. A striking example of differential erosion is well displayed also across the lake from this inclusion, where the western edge of a large gabbro dyke, trending northerly along the median part of the map-area, ends abruptly against the northern granite stock (Plate I). Many other examples of the monadnock topography are found west and north of Pauline lake and north of Muriel lake. Where sediments constitute most of the country rock or occur as broad belts between bands of basic rocks, the hardest beds, such as quartzite, are likely to be left as hills or hogbacks (Plate II), elongated roughly north-south, parallel to the strike of the beds. Such is the case, for instance, around the shores, and north and northeast, of Pinet lake; north of Guénard lake; north of Harvey lake and west of Lebrun lake; and west of Cométique lake. But nowhere do the sediments form any striking, persistent, rugged and high ridges as do the sills and dykes of gabbro-diabase encountered in the country flanking the synclinal axis and, more generally speaking, in the whole eastern half of the area (Plates III, IV, V).

The western half of the map-area is much less rugged, except in and near the large gabbro mass immediately west of Cométique lake (Plate IV) and at a few other isolated points. The large body of gabbro between Béland and Bonnerme lakes, for instance, does not give rise anywhere along its course to any particular conditions of very accentuated ruggedness such as are encountered in the synclinal area. While many factors may be responsible for this lack of ruggedness, the writer believes it is primarily due to the degree of alteration the gabbro has undergone. Near the synclinal axis, and even in the large Davy Lake sill east of the northern granite stock, the gabbro is very fresh or only slightly altered, and is extremely hard. The gabbro of the Davy Lake sill is highly altered only at the immediate contact with the granite. In the western half of the map-area, the gabbro between the two granite stocks is, as a rule, intensely altered and hybridized, and habitually it is relatively soft. One exception is the large mass (Plate IV) immediately west of Cométique lake. The rock of this mass is unusually rich in feldspar, which is fresh, whereas the original ferromagnesian minerals have been changed to small flakes of secondary hornblende and biotite. The predominance of the large crystals of fairly fresh feldspar seems to explain why this rock has preserved its great hardness and resists erosion well.

The area, taken as a whole, slopes gently south and thus the highest elevations are found in the northern part. The highest point is believed to be the northern end of the gabbro ridge immediately west of Cométique lake, which stands 2,100 feet (Plate VI) above sea-level, and the lowest point is Thibaudeau lake in the southeast corner of the area, lying 530 feet above sea-level. The ridges near the southern margin of the map-area are from 800 to 1,000 feet above the sea. It is not uncommon to encounter gabbro cliffs rising almost sheerly to heights of 400 to 600 feet above neighbouring lakes. Such occurrences may be seen, for example, at Davy, Coumyn, Blondin, Stephenson, and Thibaudeau lakes and at many of the smaller, unnamed lakes throughout the region.

Quartzite, which borders many of the lakes, may locally form cliff-like escarpments, as along the northern shore of Pinet lake, where thick, massive beds of the rock rise about 500 feet above the level of the lake (Plate II). Such occurrences are rare, however, and lakes surrounded by quartzite are habitually characterized by low shores — that is, of the order of 20 to 50 feet above the water (Plate XVI).

The lakes occurring in areas underlain by granite are in broad, more or less rounded, basin-like depressions. Lying at the surface of a plateau, their shores are low and the rise from the beach of the lake to the highest parts of the plateau is generally gentle and long. An excellent example is Pauline lake, near the southwest corner of the area.

All the lakes in country underlain by sedimentary rocks or gabbro have striking shapes. They are long and narrow, paralleling the trend of the sediments. They occupy low portions of the trough-like, persistent depressions formed by differential erosion along the line of contact between gabbro and sediments.

No actual soundings were made, but it appears probable that most of the lakes are not very deep. Those in granite and quartzite basins possibly do not exceed 50 feet in depth. Presumably the deepest lakes are those filling trough-like depressions along gabbro-quartzite contacts, where the gabbro shore is frequently a sheer wall. Close to these walls, the depth, it is believed, might well be one hundred feet or more.

Besides the major lakes of the region, lying in the low portions of the main valleys or in the broad basins of the granite plateau, there are many small lakes or ponds filling depressions atop the large gabbro bodies or quartzite hills. Many of these have no permanent outlet. They are fed directly by precipitation, which is about balanced by evaporation.

Drainage

There is no well developed stream system in the area. In most cases, a lake overflows into the one next below in a short series of cascades or falls. Some short streams connecting large lakes have been called "rivers" on some survey plans and maps, but they scarcely merit this appellation. The largest of these is Plate river, which links Jobidon, Guénard, and Wakeham lakes. The stretch of this river between Jobidon and Guénard lakes is a lazy, meandering stream, well suited for travel by canoe; but on leaving Guénard lake, and until it reaches Wakeham lake, it rushes southward through an uninterrupted series of cascades, dropping 170 feet in two miles. Métivier river, along the western edge of the map-area, is navigable by canoe over a length of about two miles in its lower portion. This navigable stretch forms part of the route that leads from Métivier lake to Longley lake. The winding river forming the main inlet of Cométique lake can be ascended for a straight-line distance of two miles, beyond which, at least for the remaining quarter of a mile to the north boundary of the map-area, it continues as a succession of cascades. The northern inlet of Thibaudeau lake, a stream flowing from Nesmy lake, is navigable between short rapids over a length of about a mile and a quarter from its mouth.

All the drainage of the region is directed toward the gulf of St-Lawrence, through four main drainage basins:

(1) Métivier river, its tributaries, and all the lakes within three miles of the western border of the map-area (excepting Cométique and Pauline) belong to the Romaine River drainage basin.
(2) Pauline lake, in the southwestern part of the area, empties into the St-Lawrence through Corneille river, about midway between Havre St-Pierre and Johan Beetz.
(3) With the exception of the northeastern part, the remainder of the area, from Cométique lake in the north to Wakeham lake in the south and Thibaudeau lake in the southeast, is part of the basin which empties into the St-Lawrence at Quetachou bay by way of Beetz lake and Grand Piashti river. Plate river, in the central part of the map-area, belongs to this drainage system.
(4) Muriel, Davy, La Taille, and Coumyn lakes, in the northeastern part of the area, belong to the drainage basin of Grand Watsheshou river, reaching the St-Lawrence two miles east of Quetachou bay or five miles east of Johan Beetz.

Climate

Although, with the experience of only three summers in the district, the writer can say little concerning the average weather conditions, the following comments may be of interest. During June and most of July, the weather is very warm and precipitation is most frequent in the form of mid-day showers which last from half an hour to one hour. August is dry, moderately warm, and very pleasant. August, 1943, however, was exceptional. There was heavy rain on ten consecutive days and the level of such large lakes as Wakeham was raised as much as three feet above normal. Frosts commence early in September and by the end of the month, or the first days of October, canoe travel becomes precarious as some lakes have been known to freeze at this time, according to trappers who hunt in the region.

In the spring, it is likely that inland travel is possible by the middle of May, although there must, at that time, be a considerable amount of snow remaining in the depressions. In the season of 1942, some snow was still found in low ground in the middle of June. In the spring of 1943, which was marked by a rather late thaw throughout eastern Canada, snow on the shores of Cométique lake did not disappear until the last days of June. When the party headed inland on June 8th, the lakes had just thawed out. The snow along the portages did not hamper travelling, however, as it was tightly packed and provided better footing than the mud left where the thaw was complete.

NATURAL RESOURCES

Vegetation

Trees in the area are in general small and sparsely distributed. There are occasional hillsides where the stands are tall and thickly grown, but, since the soil cover is thin over most of the area, vegetation is proportionately meagre.

Timber is for the most part black spruce and balsam, but there is a minor amount of white birch. Tamarack may be found in the marshy areas, but generally it dies out at an early stage of its growth. Where trees are wanting, a thick growth of brush of the Labrador tea variety often takes their place. On many hilltops, the vegetation is dwarfed or completely lacking and bare rock is exposed.

Owing to its lean and thin soil cover, the region offers no agricultural possibilities.

Fish and Game

Fish and large game are not plentiful. Some large trout were caught in the outlet of Thibaudeau lake, and a small fish resembling the fresh-water smelt was seen in some of the lakes. Cariboo tracks were observed in many places, but only once was a cariboo seen.

Spruce partridge, rabbit, and porcupine are fairly abundant. Among the fur-bearing animals of economic value to the trapper, few were encountered in the course of the summer. Beaver and muskrat were seen, but they are not numerous.

Certain varieties of duck are found in small numbers on practically every lake.

GENERAL GEOLOGY

Table of Formations

QUATERNARY	Recent	Silt, sand and gravel
	Pleistocene	Glacial drift: morainic deposits, erratics
PRECAMBRIAN		Pegmatite and syenite dykes (not shown on map)
		Biotite granite: (a) Biotite-poor, medium- to coarse-grained pink granite (b) Biotite-rich, very coarse-grained, pink or grey granite, with occasional augen texture
		Intrusive Contact
		Hornblende syenite and lamprophyre dykes (not shown on map)
		Gabbro-diabase and massive (more rarely schistose) derivatives; in sills and to a minor extent in dykes: (a) Fresh, olivine-rich, hypersthene gabbro-diabase (b) Uralite gabbro-diabase, with relics of ophitic texture (c) Altered anorthositic gabbro (d) Amphibole and chlorite schist (e) Hybrid rocks of very diverse composition, mostly dioritic, commonly with relics of ophitic texture
		Intrusive Contact
		Calcareous and micaceous, light grey quartzite, and rare thin slaty bands and lenses
		Massive, fine-grained, grey to white quartzite
		Thin conglomeratic bed or lens; quartz-biotite-muscovite schists; arkosic quartzite; fine-grained, impure, dark to light grey quartzite

General Statement

All the consolidated rocks of the area are of Precambrian age. Sedimentary rocks occupy a little less than one-half of the area, gabbro slightly more than one-third, and granite approximately one-fifth. The gabbro is evenly distributed, occurring as numerous bands of varying sizes and intruded almost invariably along the bedding of the sediments. The granite forms two stocks, one along the northern boundary of the area, covering about fifteen square miles, the other in the southwestern corner, with surface outcrop of twenty square miles. Both continue beyond the limits of the present map-area. They are probably un-roofed outliers of a large batholith which is widely exposed throughout the adjacent Forget Lake area[1].

Sedimentary Rocks

The areal distribution of the sedimentary rocks permits of their being classified in three main groups. The first includes as its two typical members mica schists and impure quartzite and is found predominantly along and within three miles of the western limit of the area. The second group is the most widespread and is represented by a moderately pure, whitish, fine-grained quartzite. Interrupted by bands of gabbro, the quartzite is observed mostly in a north-south zone, five to six miles wide, extending through the central part of the area. Some is also present near the western margin of the area southwest of Bonnerme lake, and in the northeastern part, north and south of Davy lake. The third group, characterized by a calcareous quartzite and of limited occurrence, is found throughout the northern half of Thibaudeau lake, in the southeast corner of the map-area, and along the lower part of the large stream entering the lake at its north end. It is encountered again in the area one mile east of Nesmy lake.

This subdivision of the sedimentary rocks into three groups, based on areal distribution, does not, of course, mean that there was any break in sedimentation. Actually there is gradation from one group to another. As, in all three groups, the beds dip consistently to the east, except around the nose and along the eastern limb of the major synclinal fold of the area, and as there is no reason to believe them overturned, they become progressively younger eastward. Broadly speaking, the easternmost or calcareous group may thus be regarded as younger than the moderately pure quartzite group which, in turn, is younger than the impure quartzite and mica schists group.

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[1]LONGLEY, W.W., op. cit.

Cross-bedding and ripple marks observed in a few localities were found of little or no value in throwing light on the mode of origin or attitude of the beds. However, the high degree of sorting and the uniformity of the sediments over large areas indicate that they are of marine origin.

Impure Quartzite and Mica Schists

In this group fall a wide variety of types. These include a thin conglomeratic bed or lens; various kinds of quartz-mica schists; impure, fine- to medium- and more rarely coarse-grained dark to light grey quartzites, the colour varying with the proportion of impurities; rare garnetiferous bands; and arkosic quartzite.

From the limited number of outcrops of schist that were seen in traversing the area, it might be concluded that, in this group, schists are subordinate to quartzite. In numerous instances, however, the schists were found along the slopes of valleys and were seen to disappear beneath overburden. It is probable, therefore, that many of the drift covered valleys are floored by schists which have been eroded more easily to a lower level than the surrounding, harder quartzite.

Thin Conglomerate Bed or Lens.— This conglomerate was observed in only one locality, a mile and a half northwest of the western end of Cométique lake. It was found on a hillside as a single outcrop, 25 feet long and 15 feet across. The pebbles are very well rounded and range in size from a small fraction of an inch to two inches. Under the microscope, the matrix is seen to consist of recrystallized, moderately interlocking quartz grains, averaging 0.6 mm. in diameter, accompanied by up to 20 per cent of green biotite and epidote with minor amounts of sericitized feldspar, zoisite, muscovite, and chlorite. The pebbles are a practically pure quartzite of a slightly coarser grain than the matrix, with only traces of epidote, feldspar, chlorite, and muscovite.

Impure Quartzite.— The impure quartzite occurs in moderately thick beds and not infrequently in large, massive outcrops with no discernible bedding. It varies in grain between 3.0 and 0.1 mm., with average about 0.2 mm. Interbedded with schists, the rock is widespread throughout the area assigned above to this group of sediments. The type localities are one mile west of Longley lake; south of Béland lake; and a mile and a half west and northwest of Cométique lake, where there is a broad strip of these sediments. In certain occurrences, as for instance in the narrow quartzite lens between the gabbro and granite at the northern boundary of the map-area, due north of the western end of Cométique lake, a rude banding can be observed (Plate XV) in massive rock where bedding planes are absent. A thin section of this rock shows intimate interlocking of the quartz grains, indicating a high degree of metamorphism.

The predominant impurity in the quartzite is biotite. However, in a thin section from a specimen collected two and a half miles northwest of Cométique lake, as much as 10 per cent of green hornblende was found associated with 50 per cent of a greenish biotite. The micaceous impurities and hornblende (when present) generally form streaks parallel to the bedding, as a result of which the rock, on close examination, is seen to have a vaguely gneissoid character. Feldspar, in varying amount, is always present and occasionally is in excess of biotite. Other common constituents, present in very minor amount, include apatite, epidote, zircon, magnetite, ilmenite, and sphene.

Mica Schists.—The mica schists are well developed in the vicinity of Natel lake, two lobes of which project into the area on its western side, due west of Longley lake; along Métivier river; and between Vigneault and Bonnerme lakes.

A few hundred feet north of the point of outlet of Natel lake, a soft, friable, grey schist, in which large flakes of biotite and muscovite are conspicuous, occurs in limited outcrops. Under the microscope, it is found to contain 40 per cent quartz in small, equigranular, clear grains, 35 per cent biotite, and 25 per cent muscovite. The biotite flakes have parallel orientation, whereas those of muscovite are occasionally oriented in a very erratic fashion. In the thin section examined, three or four large crystals of epidote were observed in the groundmass.

The only bands of garnetiferous schist encountered in the area are about a quarter of a mile north of this occurrence.

The schists exposed along Métivier river and around Vigneault lake are in large part of the highly impure quartzite type. They differ from the impure massive quartzite in their fissile character and higher content of micaceous minerals. There usually is a gradation from schistose rocks in which the micas predominate to beds of more massive, impure quartzite. The intermediate type may be, for instance, a laminated rock consisting of layers of impure quartzite, averaging one-eighth of an inch in width, separated by layers of mica frequently less than one thirty-second of an inch in width.

A thin section of a finely laminated type in which mica predominates is illustrated in Plate VIII. This specimen, found interbedded with impure quartzites along Métivier river at a point a mile and a quarter due west of the southern end of Harvey lake, contains about 40 per cent quartz, 50 per cent biotite, and 10 per cent muscovite. The lamination, which is plainly discernible in the thin section, is produced by the alternation of layers, half a millimeter or more in width, rich in mica, and rich in quartz. The latter layers are also characterized by quartz grains of larger size than in the mica-rich layers. It will be noted in Plate VIII that the laminated effect is heightened by diversity in orientation of the mica flakes from layer to layer. This shifting orientation of the mica follows a symmetrical pattern which can be represented, as indicated schematically in Figure 2, by a sinusoidal curve with abscissa approximately at

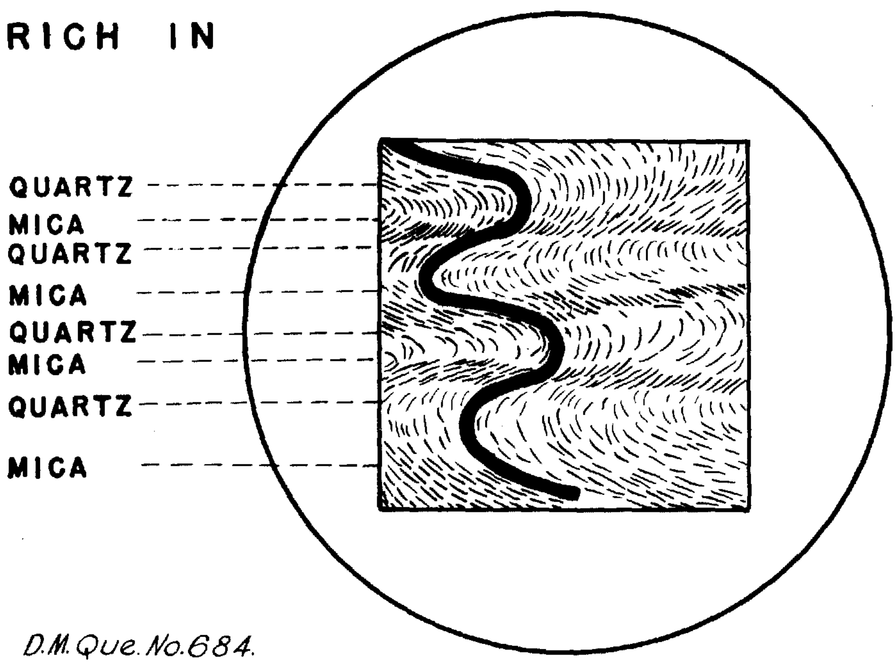

Figure 2.—Schematic reproduction of the changing orientation of the mica flakes in the thin section of Plate VIII. The orientation varies according to a sinusoidal rhythm, as shown by the heavy line.

right angles to the lamination. The crests and troughs occur in alternate quartz-rich layers, whereas the part of the curve between a crest and a trough and the part between a trough and crest occur in alternate mica-rich layers. The rhythmic pattern is thus complete in each set of four adjacent laminae. The curve illustrating the changing orientation of the mica flakes forms a peak in a quartz-rich layer; then, passing through the adjacent mica-rich layer, goes to form a trough in the alternate quartz-rich layer; and finally passes upward through the next succeeding mica-rich layer. The pattern is then repeated indefinitely, with the same period along the imaginary abscissa. The overall effect is that of strongly curved mica flakes tending to be at right angles to the lamination in the quartz layers, and straight flakes lying at an angle of 45 degrees or less to the plane of lamination in the mica layers (Figure 2). In the four-laminae set that goes to form the symmetrical pattern, the mica flakes show opposite curvature in the two alternate quartz-rich layers and reverse inclined orientation in the two alternate mica-rich layers.

This unusual structure is interpreted as the result of an acting couple with external stresses tangential to the lamination forming one part of the couple, and friction along the lamination planes forming the other part. This particular rock, owing to its high mica content, clearly yielded as a semi-plastic medium, which explains the flowage effect that is rendered so conspicuous by the sinusoidal arrangement of the mica flakes.

In some of the laminated types, such as occur around the shores of Vigneault lake, the rock has a much lighter than average colour and muscovite is the predominant mica.

Arkosic Quartzite.- This name has been applied to a medium-grained, light grey rock found near the gabbro about one-third of a mile northwest of the northern end of Vigneault lake. Little is known of its field relations as it was seen only at this point and moss had to be stripped to examine the outcrop. Normal quartzite occurs a few hundred feet away on either side. In thin section, the arkosic rock is seen to contain equal amounts of highly altered feldspar (andesine) and fresh quartz together with lemon-yellow epidote (15 per cent) and biotite (10 per cent). The quartz grains range in diameter from 0.1 to 0.2 mm. and those of feldspar from 0.2 to 0.6 mm. The rock is undoubtedly sedimentary in nature. It is distinctly gneissoid and, in addition to the minerals mentioned, contains minor amounts of apatite, sphene, muscovite, and magnetite. The high percentage of epidote may indicate that the original sediment was of a calcareous nature.

Massive, Fine-grained, Whitish Quartzite

This quartzite is essentially the same as that of the first group, but generally it is purer and, consequently, lighter in colour. Also — and this is the chief distinguishing feature between the two groups — interbedded schists are not present in appreciable amount and, as a result, the beds are apt to be thicker and more massive (Plate XVI), and to resist erosion better, than those of the first group.

The type localities for this group are north of Pinet lake; around Wakeham lake; along the shores, and west and north, of Lebrun lake; and north and south of Davy lake. The quartzite is fine-grained (0.2 mm. average) and occurs in beds with a range in thickness from 3 inches to 2 feet. The rock breaks with a conchoidal fracture when moderately pure. At the surface and for a few millimeters immediately below it is pure white due to the leaching out of iron oxide impurities, which have been carried off in solution and re-deposited lower down as limonite. The original iron oxide, magnetite, is finely disseminated throughout the rock. Other impurities always present at least in "traces" are feldspar, carbonate, and white mica (muscovite or sericite). Rarely, feldspar forms as much as 10 per cent of the rock. In a thin section of a specimen from immediately south of Coumyn lake, a secondary growth of oriented silica over the original quartz grains was observed. This particular specimen is surprisingly unmetamorphosed, as shown by the loose, unlocked grains (Plate IX-A). It is probable that most of the sedimentary rocks within the synclinal trough are very little metamorphosed.

Calcareous Quartzite

This group constitutes a rather well defined lithological unit, although thus far its occurrence is restricted to a zone adjacent to the eastern boundary in the southern half of the map-area — around the shores of the northern part of Thibaudeau lake and in the area beyond the easternmost gabbro body, due east of Nesmy lake. The rock is a very fine-grained (Plate IX-B) quartzite (0.02 mm. average) with a fairly constant (up to 10 per cent) content of carbonate and white mica. The beds may be only a fraction of an inch thick but the general range is from a few inches to one foot. The weathered surface in some exposures is pitted. The pits have been formed through the solution of streaks of pink calcite, three-quarters of an inch or less in length. These calcite streaks are of somewhat rare occurrence, however, and where they are not present weathered surfaces of the rock are not pitted. Wherever tested with hydrochloric acid, the quartzite was found to effervesce strongly and acid digestion of three specimens from various localities revealed between 7 and 11 per cent carbonate. The white mica occurs as very finely divided interstitial sericite or as flakes of muscovite the size of the quartz or calcite grains. The flakes are often greenish, imparting a similar tinge to the rock.

Associated with the quartzite of this group are thin slaty beds which pinch and swell along their strike and frequently break into discrete lenses. They are very local in occurrence but were seen in exposures a mile and a quarter east of the southern end of Nesmy lake and near the southern tip of the large island in Thibaudeau lake. Because of overburden, they could not be followed for more than twenty to twenty-five feet. Locally, portions of the slaty bands have been ruptured into a great number of small and thin, shell-like, fragments (Plate XIV) embedded in the calcareous quartzite. This occurrence illustrates well the high degree of plasticity assumed under the influence of differential pressure by this originally shaly interbed within massive quartzites. Under the microscope, evidence may be gathered on a small scale of the rupture of these originally shaly bands and of their flowage and constricted attitude between obstacles such as neighbouring quartz crystals.

Thin sections of the calcareous quartzite reveal a white mica content averaging between 5 and 10 per cent, but in particularly schistose bands it may be as high as 50 per cent, owing to the fact that, in highly metamorphosed beds with lenses which were formerly slaty, the latter consist of long, twisted flakes of muscovite with subordinate biotite. Carbonate forms about 10 per cent of the average rock, but in beds containing calcite streaks it may reach 25 per cent. Among minor accessories in the rock are feldspar, chlorite, sphene, and magnetite. At the surface of the outcrops, supergene leaching of the calcite has proceeded to a depth of about half an inch, leaving the rock slightly porous.

Crystalline Limestone

Although no beds of crystalline limestone were found in the area, blocks of the rock included in gabbro were seen in two localities — at the southeast corner of the small lake a mile and a half northwest of the west end of Cométique lake, and along the east shore of Wakeham lake where it almost closes to form the northern narrows. At both localities, blocks of the very coarsely crystalline limestone, six inches or less in diameter, are enclosed in the gabbro at its contact with quartzite. This seems to indicate that the beds of the sedimentary series, along which some at least of the gabbro sills were intruded, were limestone beds.

A large erratic of cream-coloured, coarsely crystalline limestone, three feet in diameter, was seen along the northwest shore of Forgues lake, resting on quartzite. It must have been carried there by the ice.

Origin of the Sedimentary Rocks

Assuming no repetition of beds by large-scale strike faults, a conservative estimate of the minimum thickness of the sedimentary series in the area, as measured along latitude 50°50', would be 25,000 feet. In the writer's opinion, it is extremely unlikely that the true thickness approaches such a figure, which leads him to conclude that the above assumption is unjustified. It is true that no large-scale strike faults have been positively recognized, but their possible presence along many of the numerous north-south, deep and narrow valleys of the region is entirely plausible.

Even if the true stratigraphic thickness is only a few thousands of feet, the sedimentary series is still a comparatively prominent assemblage. It consists of well-sorted, fine-grained sediments composed mainly of quartz, with some feldspar, mica, and locally, calcite or other carbonate, and presupposes a long period of continuous erosion of a predominantly granitic land mass. The universal fine grain suggests that the land mass was of low relief or was very remote from this particular site of deposition. The decreasing fineness of grain upward in the series, that is from west to east in the area, as shown by 0.02 mm. in the calcareous quartzite and 0.20 mm. in the massive quartzite, may indicate a gradual deepening of the sea or a lowering in relief of the land mass.

A very interesting feature of the series is that its folding has a north-northwest trend. Information concerning the major structures of the general region lying north of the gulf of St-Lawrence is still far from complete, but it has generally been assumed that the folds are Laurentian in age and that they have northeasterly trends. North-northwest fold systems are known in the region lying north and northwest of the Laurentian mountain folds, as in the Labrador trough in central Ungava, and in the north-trending Belcher Islands trough in Hudson Bay, but such systems date from Late Precambrian (Huronian) time. What, then, is the explanation of the north-northwest folding trend which occurs in the present area, south of, or almost within, the region of northeast Laurentian folding?

There is no basis at present for regarding these folds, or this minor fold system, as Huronian in age. The folds are intruded by gabbro which, in turn, is cut by granite, both presumably Early Precambrian. In all probability, the Wakeham Lake fold is interrupted a short distance north of the map-area by a large mass of anorthosite (see Map No.680, in pocket) which is thought to be older than the gabbro.

Two possibilities may be considered. Is the Wakeham Lake fold a cross fold of the Laurentian system, or does it represent folding that occurred in post-Laurentian, but pre-Huronian, time?

Under the first hypothesis, the sediments would be equivalent to the Grenville in age and sould have been involved in the Laurentian folding. If so, one would expect them to be highly metamorphosed and complexly folded, which is not the case. True, the rocks of the Bristol series or facies of Bristol township[1], in southwestern Quebec, which is usually considered as the uppermost part of the Grenville, are less altered and less strongly folded than are the average Grenville rocks, and the sedimentary series of the present area might be assumed to represent another example of a similar case. However, the Bristol sediments are very limited in occurrence and they are clearly folded with the neighbouring Grenville rocks, whereas here the sediments form an extensive series and their folding trend lies at right angles to the Laurentian trends.

Admittedly, there is some very serious doubt as to the possible equivalence of the Wakeham Lake sediments to even the uppermost part of the Grenville series. Any hypothesis involving the assumption that the Wakeham Lake sediments are pre-Laurentian and that the folding represents cross folds formed before, during, or after the Laurentian revolution, meets with the apparently unsolvable difficulty of explaining the relatively mild metamorphism and folding of the series.

The second hypothesis implies the existence or creation of north-northwest troughs in post-Laurentian but pre-Huronian time, and the extensive accumulation of sediments and subsequent folding along north-northwest axes, accompanied or followed by the emplacement of anorthosite, by the intrusion of gabbro, and later of granite.

The distribution of north-northwest trending sediments in and about the Wakeham Lake area may provide some clues as to the extent of a trough that possibly existed in pre-Huronian time, especially since those sediments were not subjected to intense

[1]WILSON, M.E., Arnprior-Quyon and Maniwaki Areas, Ontario and Quebec; G.S.C., Mem. 136, 1924, pp. 23-25.

folding and metamorphism. In its present extent, the Wakeham Lake trough has Romaine river as its approximate western boundary. Its eastern limit lies in unmapped territory but it can be appraised from a study of topographical maps, since the north-trending sediments are strikingly reflected in the drainage pattern. On the basis of such observations, the eastern limit of the trough can be placed some fifteen miles east of the eastern boundary of the map-area. This would give the trough a present width of approximately thirty miles or less, but varying considerably from place to place. It has been followed without interruption along its length from the north boundary of the Wakeham Lake area to the shore of the gulf of St-Lawrence (see Map No.672, in pocket), a distance of fifty miles, and obviously a somewhat greater length may be assumed. In its present state, the trough consists of a major syncline and anticline, presumably complicated by strike faulting. From the dimensions of the present trough and the absence of evidence of very severe folding, it may be postulated that the original trough of deposition was of a relatively modest size.

That such, probably minor, troughs, exemplified by the Wakeham Lake trough, may have come into existence in pre-Huronian time, very likely as forerunners of the later, major Huronian troughs occurring north of the Laurentian mountain folds, is suggested by the fact that the postulated Wakeham Lake trough lies along the same trend as — that is, in line with — the Labrador trough, whose southern end is about 240 miles north-northwest of the Wakeham Lake area. This alignment is likely more than accidental; rather, it seems to indicate that, long before Huronian time, there existed within the earth's crust a zone of weakness with north-northwest orientation passing through the Wakeham Lake region and probably extending, even at that time, to and beyond what is now the Labrador trough. Indeed, it is possible that a minor Labrador trough came into existence at the same time as the Wakeham Lake trough, although this remains to be proved, for all the observed sediments of the present Labrador trough are presumed to be of Huronian age.

It is therefore tentatively suggested that the sediments of the Wakeham Lake series were laid down in a north-northwest minor trough that came into existence in post-Laurentian but pre-Huronian time. Also that this minor trough, and probably other similar ones which, the writer suspects, will be found in the North Shore region as geological work progresses, was created by precursory stresses of the great forces that were to build, north and northwest of the Laurentian mountain folds, in Huronian time, the major Labrador and other similar troughs. The Wakeham Lake trough is structurally related to the Labrador trough in particular. Although it is obviously older, and more than two hundred miles to the south, it lies along the same north-northwest lineament of weakness in the earth's crust.

Correlation of the Wakeham Lake sediments with similar sediments of better known regions is not advisable at present. However, to fix ideas, one may consider the possibility of regarding them as equivalent to the Hastings series of Ontario. Here, again, some difficulties arise from the fact that the folding trends of the Wakeham Lake sediments do not coincide with those of the Laurentian folds. The Hastings series, on the other hand, is separated from the Grenville series by an erosion period, but the two series are parallel and were folded together[1].

Obviously, not until considerably more work has been done in the North Shore region will it be possible to find a satisfactory solution to the various problems pertaining to the Wakeham Lake sedimentary series.

Gabbro-diabase and Derivatives

General Statement

The oldest intrusive rocks known in the region consist of a series of sheet-like bodies of gabbro-diabase which have intruded the Wakeham Lake sediments. This basic rock is of special interest as it appears to have exerted a structural control on the mineralization so far encountered in areas where it occurs. The gabbro complex is well developed in the Wakeham Lake area and in the part of Forget Lake area east of East Romaine river[2]. The larger sheets range in width from a quarter of a mile to one mile. Some of them pinch out within the limits of the map-area, but the greater number extend beyond its boundaries. In the reconnaissance work of 1942, the writer[3] established that, southward, they extend as far as the St-Lawrence shore, a distance of more than fifty miles from the northern boundary of the Wakeham Lake map-area (see Map No.680, in pocket).

Although most of the sheets have, as a rule, a remarkably constant width, large masses northeast and east of Nesmy and Thibaudeau lakes present rather irregular outlines. However, even these irregular masses have a general elongation along the axial plane of the syncline, suggesting that they were intruded along

[1]WILSON, M.E., The Grenville Pre-Cambrian Sub-Province; Jour. of Geol., Vol.33, 1925, pp.394-395.

[2]LONGLEY, W.W., op. cit.

[3]CLAVEAU, Jacques, op. cit.

a plane of weakness coinciding with the axial plane of the fold. Thus it seems logical to offer as a tentative hypothesis that this plane of weakness localized the main intrusive body. At a certain stage during the intrusion, relief became easier in a lateral direction, that is, along the bedding planes of the sediments, and thus numerous sheets branched out at various horizons from the main mass, wedging their way between the quartzite beds.

With this hypothesis in mind, the intrusion could appropriately be termed a system of multiple sills, since the sheets of gabbro-diabase must tend to be horizontal where they are connected at depth to the central mass, that is, in the vicinity of the axial plane of the fold. At the surface, however, the sheets are in general steeply dipping (although, in some places, the present dip is probably not the original dip, as will be shown in the discussion of the structure), and one may prefer to call them concordant dykes. This is actually an intermediate case between concordant dykes, and sills, and both terms are acceptable, although the writer prefers the term sill. Discordant dykes, that is, sheets cutting across the bedding, are not entirely absent, but they are negligible in comparison to the great number of sills, or concordant dykes.

The rock has the composition and appearance of gabbro. However, examination in thin section under the microscope shows that it possesses, almost invariably, a very pronounced ophitic texture, and this is sometimes visible to the naked eye. To reconcile these various features and describe the rock adequately, the term gabbro-diabase is applied, indicating that the rock is more or less a transition type between gabbro and diabase[1]. Throughout the discussion, however, the term diabase is often omitted and the rock is referred to as gabbro.

In the description that follows, and on the accompanying map, five types of the rock are distinguished, on the basis, primarily, of the degree of alteration of the original ferromagnesian minerals. In the synclinal area, the rock is generally very fresh. It becomes more altered westward, passing to uralite gabbro-diabase and to very highly altered and often partly hybridized types between the two granite stocks of Wakeham Lake area and in the part of Forget Lake area where these gabbro intrusions occur. The types distinguished are:

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[1]KEMP, F.K., A Handbook of Rocks, pp.77 and 210; D. Van Nostrand Company, New York, 1922.

(1) Fresh olivine gabbro-diabase
(2) Uralite gabbro-diabase
(3) Altered anorthositic gabbro
(4) Amphibole and chlorite schists
(5) Hybrid rocks, mostly dioritic

Type 3, in addition to being altered, is of a somewhat anorthositic nature, that is, it contains a higher percentage of feldspar than the average rock. The localities in which each type prevails have been indicated on the accompanying map.

The age relations of the gabbro and granite are well established. Contact zones where the granite projects into the gabbro in tongues, dykes, and stringers, and numerous altered, and some partly digested, inclusions of gabbro in granite, provide ample proof that the gabbro is the older rock.

<u>Fresh Olivine Gabbro-diabase</u>

The freshest representatives of the basic intrusive are found around, and south and southwest of, Blondin lake (Plate V); in the vicinity of Stephenson lake; and in parts of the large Davy Lake sill.

The rock is extremely hard, medium-grained, and dark grey in colour. Its composition varies rather widely and abruptly. The average of six specimens of the perfectly fresh rock shows 60 per cent plagioclase (calcic labradorite), 15 per cent augite, 5 per cent hypersthene, 17 per cent olivine, and 3 per cent magnetite-ilmenite. The plagioclase content is fairly constant, whereas the other constituents may very widely. One of the thin sections examined contains about 30 per cent olivine and almost no pyroxene. In another, augite is very subordinate to hypersthene. The texture is always ophitic (Plate X-A) and the pyroxene clusters exhibit characteristic angular boundaries which serve as a very helpful criterion in reconstructing the nature of the changes that have taken place in the moderately altered and partly hybridized types.

The pyroxenes surround the olivine and contain fine, blade-like inclusions of a probable iron mineral. Hypersthene is earlier than augite and is diagnosed by its strong pink pleochroism and parallel extinction. Augite is commonly faint green or colourless, and may exhibit a weak purplish pleochroism. The magnetite-ilmenite crystallized late. Apatite is very rare.

<u>Davy Lake Breccia</u>.—Along the eastern shore of Davy lake, and at the point of outlet of a small lake a mile and a half northwest of it, blocks of gabbro in a matrix of gabbro were

Plate I — Monadnock of gabbro on the west shore of Faucher lake. The high gabbro cliff ends abruptly against granite outcropping at water level.

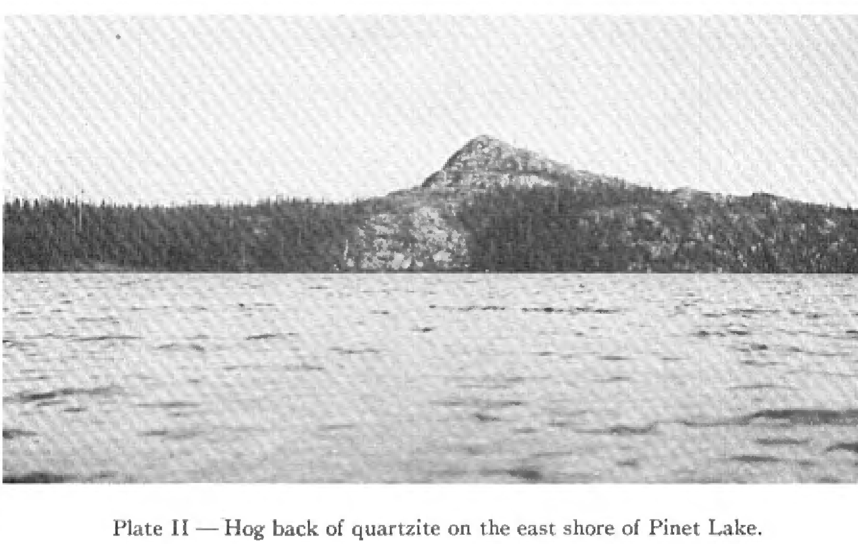

Plate II — Hog back of quartzite on the east shore of Pinet Lake.

Plate III — Gabbro sill bordering the east shore of Stephenson lake. As viewed from the outlet of Blondin lake.

Plate IV — View of Cométique lake taken from the east end of the lake, looking west. On the horizon is the high ridge of anorthositic gabbro.

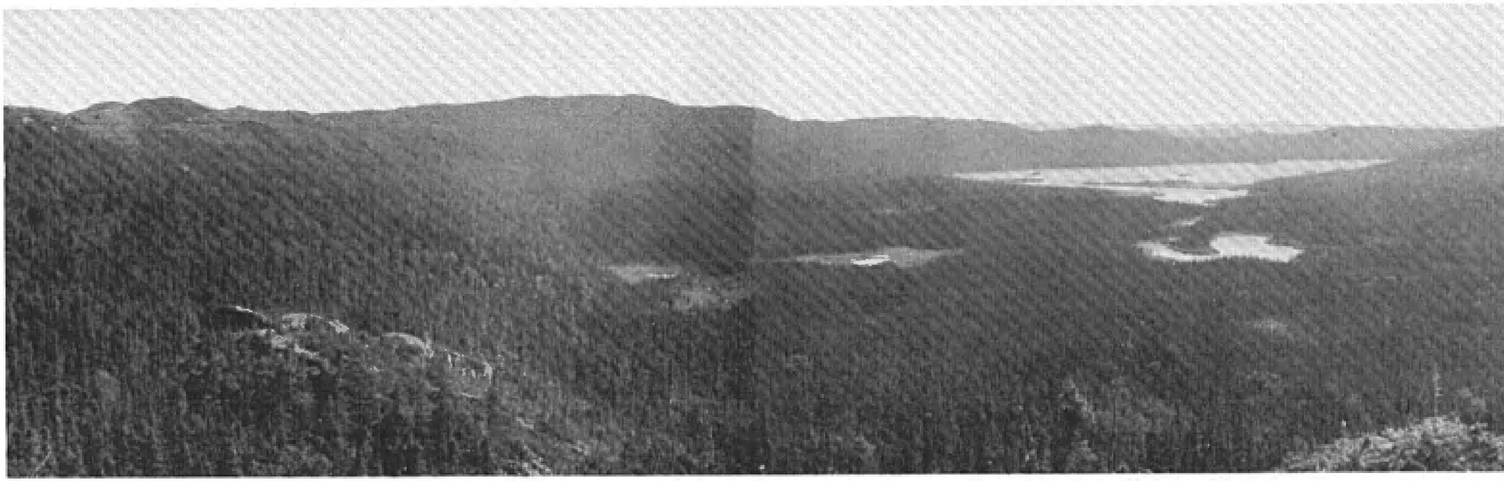

Plate V — Panoramic view looking slightly north of east of the northern part of the synclinal basin. Taken from the top of the gabbro sill (seen in plate III) bordering the east shore of Stephenson lake. Large lake is the northern part of Blondin lake.

Plate VI — View looking south south-east from the highest point in the area (2100 foot summit along northern border of area, due north of west end of Cométique lake) Cométique lake in upper right hand corner. Note glacial drift.

Plate VII — Broad glacial valley in the hills northwest of Stephenson lake. Looking northeast.

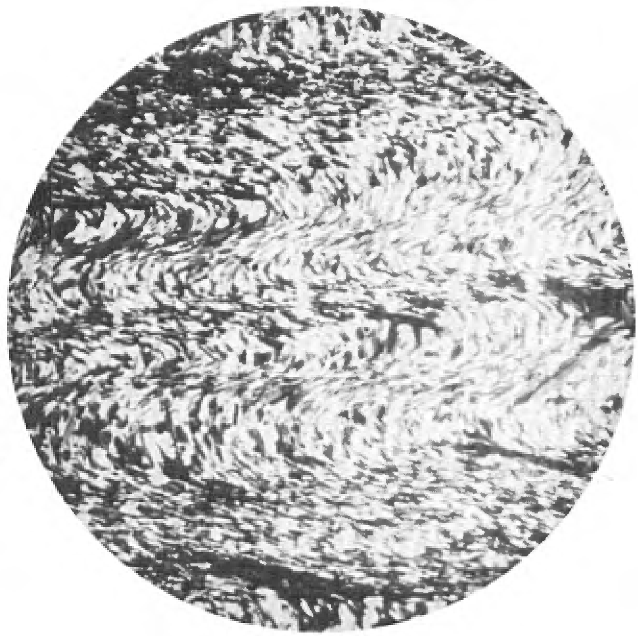

Plate VIII — Photomicrograph of mica-quartz schist from Métivier river. Note the unusual effects of stress on the mica flakes (see text and fig. 2, p. 22a) (x19). Natural light.

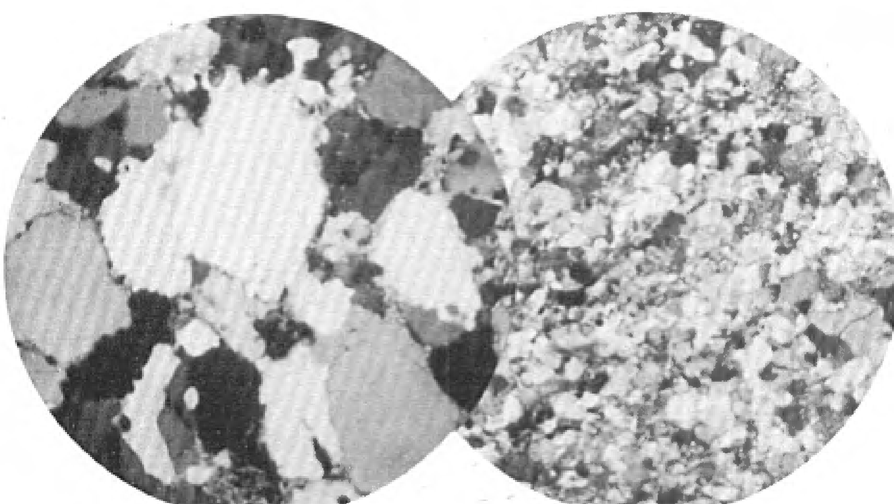

Plate IX — A—Photomicrograph of a thin section of quartzite from Coumyn lake. Note relatively unmetamorphosed state. Note also secondary growth of quartz around upper edge of largest quartz grain in south-east quadrant. (x50). Nicols crossed.
B—Photomicrograph of a thin section of calcareous quartzite from Thibaudeau lake. Note fine grain. (x50). Nicols crossed.

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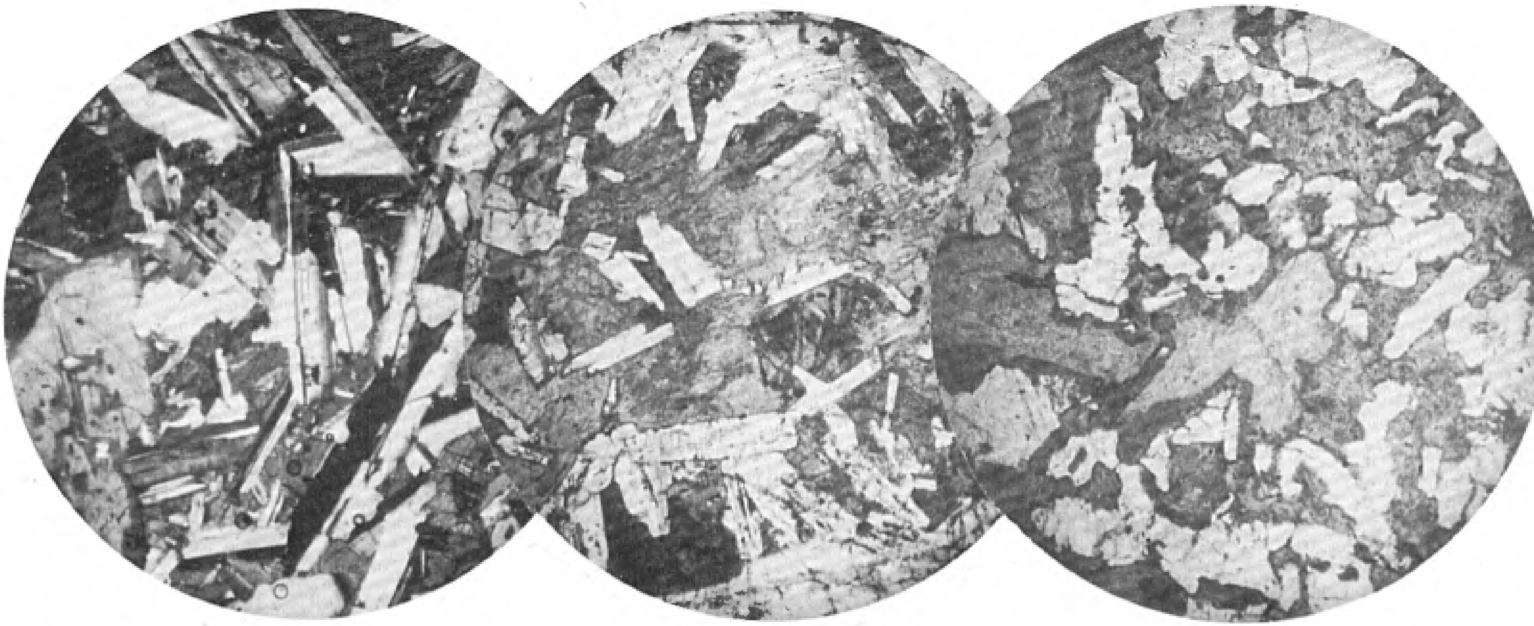

Plate X — A—Thin section of fresh gabbro-diabase from 1½ miles SE of Blondin lake. Nicols crossed. x19
B—Gabbro-diabase in advance stage of uralitization. NE of Thibaudeau lake. Several crystals of pyroxene still remain intact. Ophitic texture preserved. Natural light. x19
C—Gabbro-diabase completely uralitized. Southwest part of Jobidon lake. Note darker rims around uralite areas. Feldspar largely intact except for cracks filled with ferromagnesian minerals. Natural light. x19

Plate XI — A—Partly uralitized gabbro in which the uralite areas are surrounded by a hairy fringe made up of tiny amphibole needles projecting into the adjacent feldspars. Northwest of Muriel lake. Natural light. x19
B—Advanced alteration of the gabbro. Uralite is largely recrystallized to dark green hornblende which is strongly corroded in sieve-like fashion by small grains of secondary albite. Ophitic texture still discernible. Western edge of anorthositic sill west of Cométique lake. Natural light. x19
C—Gabbro recrystallized to a granoblastic aggregate. Some feldspar laths have escaped complete obliteration. Inclusion west of Pauline lake. Natural light. x50

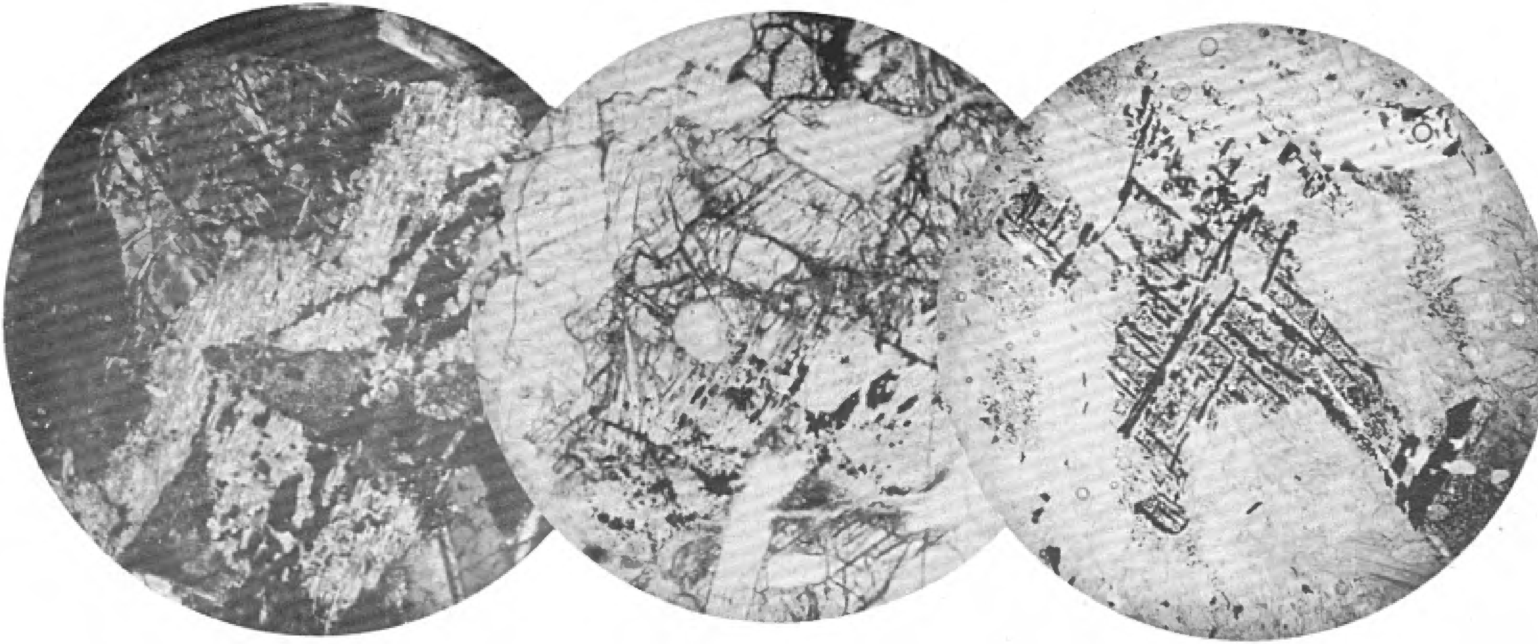

Plate XII — A—Olivine being replaced by tremolite in parallel fibers. Note rejection of abundant iron in long trains in tremolite. Gabbro from southeast of Stephenson lake. Nicols crossed. x50

B—Same specimen as in A. Olivine and pyronene are replaced by tremolite fibers in erratic orientation. Note again rejection of iron during replacement. Natural light. x50

C—Skeletal magnetite in highly altered gabbro. From a point 2.5 miles north of Béland lake. Natural light. x19

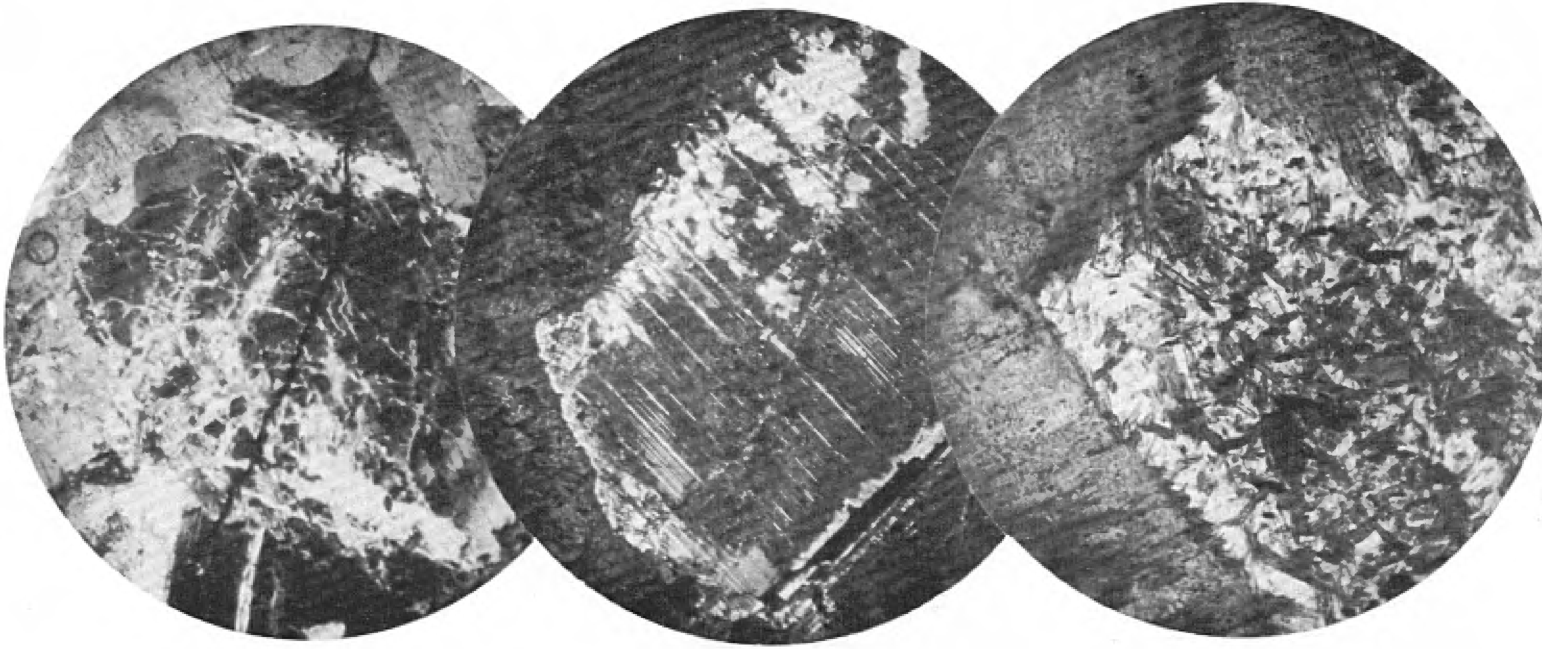

Plate XIII — A—Albite replacing a large crystal of calcic andesine along large and small fracture in gabbro northwest of Cométique lake. Nicols crossed. x19
B—Albite replacing a large crystal of calcic obligoclase in dioritic gabbro from the east shore of Béland lake. Nicols crosses. x19.
C—Swarms of tiny needles of bluish green hornblende in a large plagioclase crystal in the gabbro of the southwestern shore of Pinet lake. The hornblende needles are interpreted as recrystallized ferromagnesian material that migrated into the feldspar during alteration. Large crystals of amphibole surrounding the feldspar are pale green and uralitic in character. Natural light. x50.

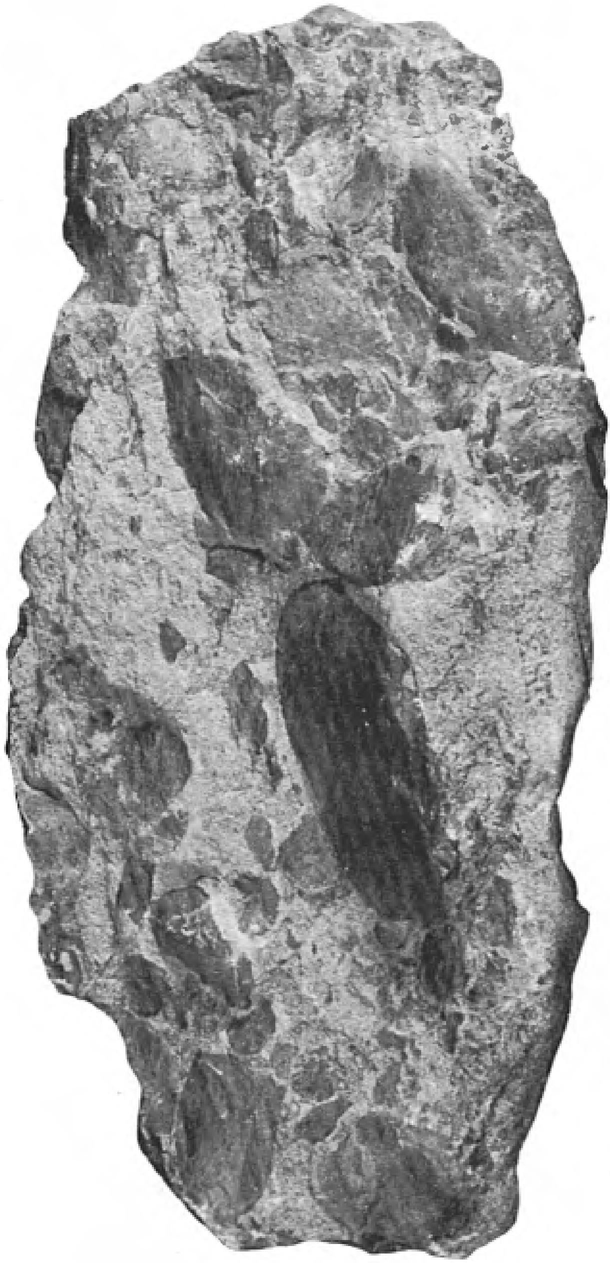

Plate XIV — Rounded shaly fragments in calcareous quartzite from east of Nesmy lake. Reduced about one third.

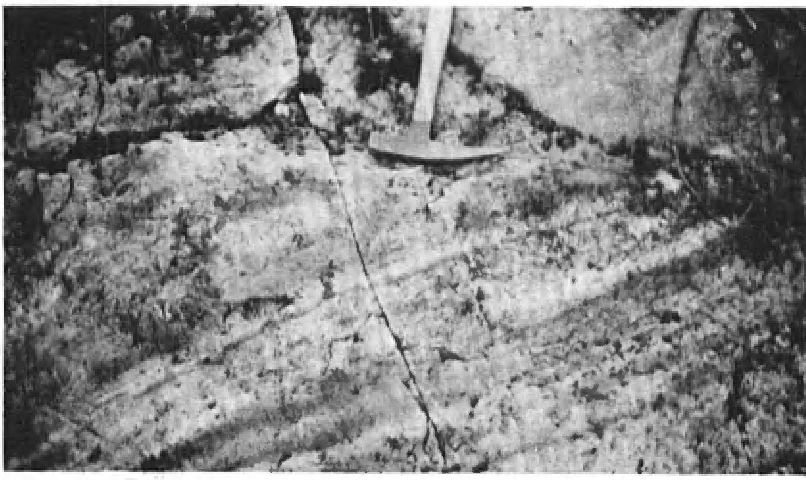

Plate XV — Highly recrystallized quartzite near the granite, north of Cométique lake. Actual bedding planes have been obliterated but the stratified character of the rock still persists in the nature of strong banding.

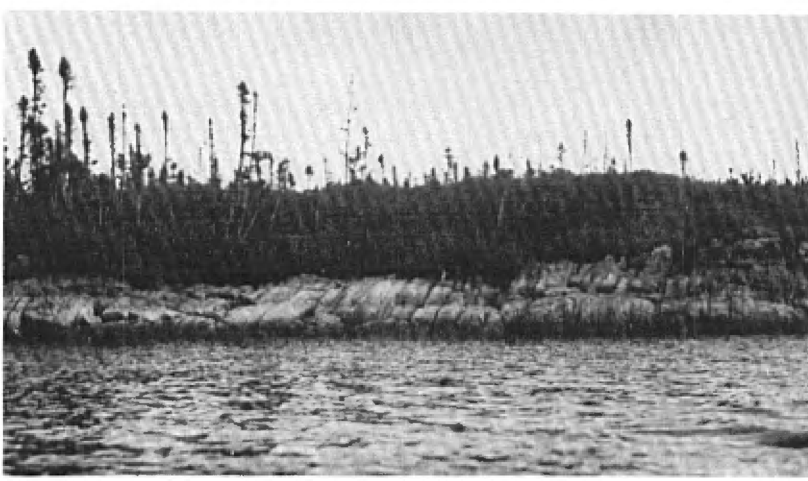

Plate XVI — Bedded quartzite around the southern shore of Wakeham lake.

Plate XVII — Pitted weathering of gabbro along the east shore of Lebrun lake.

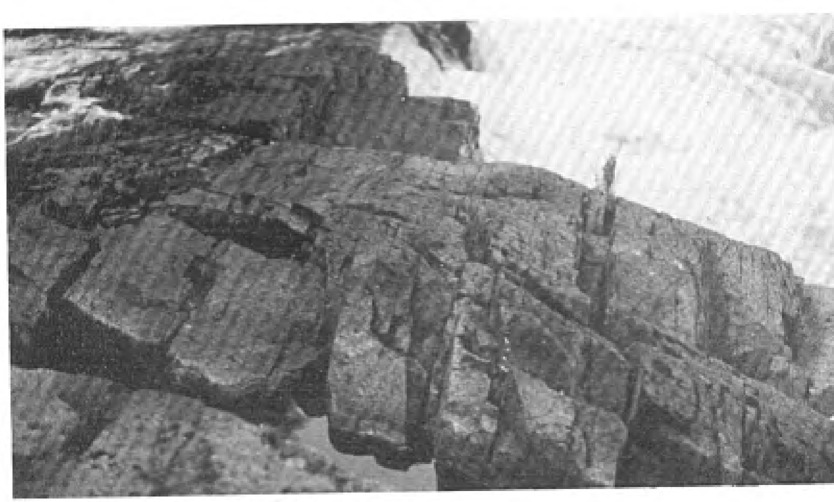

Plate XVIII — Schistose gabbro at the outlet of Thibaudeau lake.

encountered. Many of the blocks have vague boundaries, but some are sharply defined. Blocks as small as one foot in diameter were observed, but generally they are much larger than this and only partially exposed. They are sub-rounded to angular and may be very slightly darker-coloured than the matrix. In thin section, however, the blocks and matrix are seen to have much the same composition, except that the feldspar of the latter is slightly more sodic than that of the blocks. This may be a result of the partial alteration which characterizes the gabbro of the matrix.

Both occurrences are at the same horizon in the same sill and are thought to represent a mild type of brecciation during the consolidation of the sill, and influx of new gabbroic magma either from the sill itself or from the central reservoir that gave rise to the sill.

The Davy Lake breccia may be analogous to the " block structure"[1] of the Adirondacks, where anorthosite or gabbroic anorthosite contains inclusions of anorthosite, or vice versa. Alling[2] notes that, in some thin sections he examined, the inclusions carry a slightly more basic plagioclase than the host.

Introduction to the Altered Types

No rigid line of demarcation can be drawn between types 1 and 2, or, for that matter, between any of the types. The change from the fresh rock to uralite-gabbro, in which the ophitic texture is still intact, and from this to schists and finally to hybrid rocks in which the ophitic texture is partially or completely obliterated, is very gradual. All stages (Plates X and XI) of the alteration of the gabbro have been traced under the microscope in thin sections of specimens from all over the region where the gabbro occurs.

In the discussion of type 1, no alteration has been mentioned, although many of the rocks shown on the map as belonging to this type (designated type 1a) are, in fact, partially uralitized or saussuritized.

The granite is most likely responsible for the alteration of the gabbro. The prevailing medium to fine grain, the frequently chiller facies against the quartzite, the absence of coronas around the olivine crystals, all indicate that the gab-

[1]BUDDINGTON, A.F., Adirondack Igneous Rocks and Their Metamorphism; G.S.A., Mem. 7, 1939, p.27.

[2]ALLING, H.L., The Adirondack Anorthosite and Its Problems; Jour. Geol., Vol. 40, 1932, p.210.

bro masses cooled very rapidly. Very coarse, or even medium-coarse, facies occur only in the central part of some of the large sills, as for instance in the anorthositic gabbro west of Cométique lake and in the gabbro immediately east of Béland lake. Being an undersaturated (olivine-bearing) magma that congealed very rapidly, the gabbro was not accompanied by abundant emanations of volatiles nor did it produce marked heat effects in the intruded rocks. The degree of recrystallization of the sediments is only moderate (Plate IX) and no high-temperature minerals, such as diopside and wollastonite, are found in the calcareous quartzite at its contact with the gabbro. Where blocks of limestone occur in gabbro, they show a texture of coarsely crystalline calcite grains among which no common metamorphic minerals such as apatite, diopside, vesuvianite, and wollastonite are present. Following the same train of reasoning, it appears highly improbable that the alteration of the gabbro occurred as a late magmatic or deuteric effect. It seems, therefore, relatively safe to turn to the granite for the cause of the alteration of the gabbro.

One of the characteristic secondary minerals occurring in the altered gabbro is albite, or albite-oligoclase. From this it may be concluded that the solutions which produced the alteration were sodic in nature — and the granite is known to be a sodic type. Other common secondary minerals are quartz, epidote, apatite, and, in places, abundant calcite — minerals which, like the albite, are absent, or almost entirely absent, from the fresh gabbro but (with the exception of the calcite) are present in the granite. It is true that the epidote and calcite, and possibly some of the albite, may have been produced by direct alteration of the plagioclase of the gabbro, but there is definite evidence, as will appear from the descriptions of thin sections of the various types of altered gabbro, that the alteration was effected by solutions that were introduced into the gabbro from some outside source and supplied the material necessary for the formation of the secondary minerals.

As noted earlier, the granite stocks exposed along the north boundary of the map-area and in its southwest corner are composed of similar rock, and both are believed to be outliers of the large granite batholith occurring in the Forget Lake area, adjacent on the west. It is reasonable to assume that, throughout this general region of granite outcrop, the gabbro and sediments are underlain at a relatively shallow depth by granite, but that this is not the case in the eastern half of the Wakeham Lake area, where no granite appears at the surface. Supporting this assumption is the fact that the sediments and gabbro are more disturbed throughout the Forget Lake area and the western half of the Wakeham Lake area than in the eastern part of the latter. It would, of course, be expected that, where the gabbro is underlain by granite, it would be more altered than the gabbro in the syncline, away from the granite and shielded by the enveloping quartzite.

Field and microscopic evidence disclose that all the gabbro-diabase west of the large sill that extends from north to south and along the west shore of Wakeham lake is highly altered and locally hybridized, whereas practically all the gabbro east of this sill is only partially uralitized or even perfectly fresh. It would thus appear that the Wakeham Lake sill lies vertically above the eastern limit (at reasonable depth) of the granite batholith, in which case it might be said that in a westward direction from, say, Nesmy lake, the gabbro becomes progressively more altered as the granite is approached and that from Wakeham lake westward, throughout the area underlain at moderate depth by the batholith, it is highly, and more or less uniformly, altered.

The distribution of the various types can now be pictured more clearly. Types 1 and 2, that is, the fresh rock and the partly or completely uralitized gabbro, occur east of, and within, the Wakeham Lake sill, whereas the anorthositic gabbro (type 3), which is now largely dioritic in composition, the schists (type 4), and hybrid (dioritic) rocks (type 5), occur west of the sill. Although this is a true generalization of the distribution of the several types of gabbro, the detailed picture is much more complex and representatives of the various types can be found locally in what may seem erratic positions. Alteration by solutions, however, is often of a capricious nature and rarely follows a rigid course.

Uralite Gabbro-diabase

The completely uralitized gabbro-diabase is best represented in the large Wakeham Lake sill. The rock is dark greenish, and it appears more compact and finer-grained than the fresh gabbro. The secondary amphiboles — hornblende, actinolite, and tremolite — can be observed as short needles or forming glistening surfaces on exposures of the rock. Weathering occasionally produces deeply pitted outcrops (Plate XVII), good examples of which may be seen along the shore of the lake.

The plagioclase in this "uralite" type of the gabbro-diabase is generally more or less saussuritized, but in many of the thin sections examined some clear, unaltered grains of the mineral were seen. The olivine has been converted to serpentine or has been replaced by tremolite. The sections show that the hypersthene was readily altered, and that augite was the last ferromagnesian mineral to be attacked. The alteration proceeded capriciously. The olivine and pyroxene crystals were generally attacked from the periphery inward and replaced by a confused mass of tremolite-actinolite needles (Plate XII-B); by serpentine and amphibole; by serpentine alone; by fibrous or compact light green or bluish hornblende; by compact tremolite in parallel orientation (Plate XII-A); or by a combination of any of these. Most prominent, however, are the amphiboles replacing pyroxene, for which reason the term "uralite" is used here to designate this general type of alteration. In some of the sections, the uralitized grains of pyroxene are surrounded by a narrow rim of bluish-green amphibole (Plate X-C) or by a narrow, hair-like fringe of minute amphibole needles (Plate XI-A). Fine blebs of magnetite are scattered through the rock, and larger patches of associated magnetite-ilmenite and sphene become abundant with increasing degree of uralitization.

The relatively fresh feldspar grains, that is, those with only slight cloudiness and little or no saussurite, have the composition of acid labradorite, but as the products of saussuritization (chiefly zoisite and epidote) increase, the feldspar tends to become more sodic or to lose its lime. Evidently, the solutions that produced the alteration were rich in soda and this entered the plagioclase molecule, displacing an equivalent amount of lime. The latter either went to form calcite, or, more commonly, was used up in the formation of zoisite and epidote. Other secondary minerals usually present in the rock include sericite, numerous small needles of green to bluish-green hornblende, flakes of chlorite, and, more rarely, calcite and scapolite.

The rock thus presents various degrees of alteration up to and including types in which replacement of all the original constituents of the gabbro-diabase has proceeded to completion. It is noteworthy, however, that no matter how complete the alteration, the rock retains perfectly the ophitic texture that is characteristic of the gabbro-diabase (Plates X-B, X-C).

An exposure at a point two and a half miles due west of Cométique lake affords an excellent example of completely altered rock which still retains ophitic texture. It consists now of aggregates of tiny tremolite and sericite needles, representing original plagioclase laths, in a groundmass of serpentine, through which is dispersed a large amount of magnetite in skeletal crystals.

Altered Anorthositic Gabbro

A large sill of anorthositic gabbro borders the granite stock west of Cométique lake. It enters the map-area from the north, rises to an elevation of 2,100 feet, and terminates near the southwest end of the lake. The designation "anorthositic" has reference to the generally high feldspar (andesine-labradorite) content of the rock, which averages 70 to 75 per cent in the central part of the sill but is lower than this toward the borders. Similarly, the grain, which over most of the body is very coarse, with the laths of feldspar commonly more than half an inch in length, is finer at the margins, as is the case in many of the sills of the area[1]. The rock has a distinctive purplish and green colour, the purple tone imparted by the plagioclase and the green by the compact matrix of fine needles, or more rarely large crystals, of hornblende, in which are embedded large, skeletal crystals of magnetite.

The automorphism of the plagioclase crystals is well marked in spite of the coarseness of the grain. Although many crystals are stout, a great number are small and lath-like, and the tendency toward an ophitic texture, a feature of the gabbro as a whole, is clearly recognizable. The sill-like nature of the mass, its ophitic tendencies, its similarity in composition with the dioritic rocks of type 5, leave no doubt that it belongs genetically, and in age, to the gabbro complex of the region.

When examined in thin section, the rock is seen to contain many large crystals of compact hornblende, undoubtedly representing original pyroxene or olivine, in which are included skeletal grains of magnetite. For the most part, however, the ferromagnesian content of the rock consists now of aggregates of tiny crystals and "needles" of bluish-green amphibole, with minor biotite and chlorite. It is to be noted that the secondary amphibole occurring in the altered gabbro-diabase of the area commonly has this bluish tint, which is characteristic of the soda-bearing amphiboles[2]. This lends further support to the belief that the solutions responsible for the alteration of the rock were sodic in composition.

The plagioclase of this rock has a composition within the range andesine-labradorite and is relatively fresh. It contains occasional actinolite needles and patches of calcite. A striking feature of the rock as seen in thin section is the

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[1]Some sills in the region show chilled borders of such fine grain that they can be resolved only with difficulty under the highest magnification.

[2]IDDINGS, J.P., Rock Minerals, p.364; John Wiley and Sons, N.Y., 1906.

presence in relatively large amount of sodic plagioclase, of composition near albite-oligoclase, which has been introduced into the rock as such. The secondary plagioclase replaces the original basic plagioclase in homogenous patches and veinlets (Plate XIII-A) or in mosaic of small crystals. In the hornblende, it occurs in small clear crystals in the usual poikilitic fashion.

The mass of anorthositic gabbro bears evidence of the dynamic effects of the intrusion of the adjacent granite. In addition to the irregular fracturing of many feldspar crystals, the sill as a whole shows a set of closely spaced discontinuous fractures oriented transverse to the elongation of the mass. The fractures obviously provided ideal avenues for the solutions from the granite. They show slight offset and are filled with grains of albite-oligoclase and needles of hornblende, chlorite, and biotite.

Apatite is present in the rock in moderate amount and some quartz may be associated with the albite.

Amphibole and Chlorite Schists

Representatives of this group are few and occur principally in the northwest corner of the map-area along a zone four miles long, paralleling the western, deformed edge of the Béland-Bonnerme Lakes sill. Of two thin sections examined, one consists of aggregates of actinolite and tremolite, compact hornblende, chlorite, much magnetite, apatite, and zircon, the last included in flakes of chlorite. The outlines of a few brown patches suggest pyroxene relics. The other section contains chlorite, magnetite, and a little apatite. The magnetite is abundant and assumes a striking pattern of skeletal crystals consisting of criss-crossing blades, between which are scattered clouds of small blebs of the same mineral (Plate XII-C).

The rocks of this type have been termed schists, but they do not everywhere possess a true, well developed schistosity. They are compact aggregates of fibrous, needle-like, or flaky minerals which, as a rule, are oriented in rudely parallel planes. The deformation of the sill along its edge is attributed to shearing movement along its contact plane with the sediments during the disturbance created by the granite intrusion.

Hybrid Rocks, Mostly Dioritic

In the course of examining nearly fifty thin sections of gabbro from various points in the area, it was found that practically all the specimens from the gabbro lying in the western half of the map-sheet, between the two granite stocks, had suffered changes similar to those undergone by the gabbro found as inclusions in granite. In the case of the latter, the changes have unquestionably been effected by the enclosing granite. It is, then, logical to assume that granitic solutions which permeated the rocks in this portion of the map-area were responsible for the partial to complete obliteration of the original features of the gabbro-diabase.

The alteration has not progressed to a uniform degree of intensity. In a few localities, the gabbro has escaped with only limited changes, and sufficient clues are left for positive recognition of the original character of the rock.

The diagnostic ophitic texture characteristic of the rocks of types 1 and 2 can still be discerned in its various stages of obliteration (Plate XI-B, XI-C). In fact, it has been completely destroyed in only a few of the thin sections studied.

The rocks of the group as a whole may be said to have been "hybridized". New constituents were added which in part were taken from the gabbro itself and redistributed, and in part were present in the solutions from the granite. As seen in the field, the resulting rocks resemble altered diorite. In thin section under the microscope, also, many are seen to be more or less dioritic in composition, but many others are metamorphic types to which no rigid name can be applied.

In its several occurrences, the rock exhibits a wide range of grain size. Generally, it is fine- to medium-grained, but very coarse facies, with crystals up to several inches in length, are encountered. To a large extent, the grain size determines the colour, or shade of colour, and the general aspect of the rock. Thus, the whitish feldspar is more conspicuous in coarse than in fine grained rock, and the latter appears quite dark. In the moderately coarse-grained varieties, the plagioclase occasionally has a reddish tinge due to a fine, red dust clouding the crystals. Some types of the rock contain a great abundance of magnetite grains. These hybrid rocks are rarely strongly gneissoid, but in some occurrences a rough alignment of the dark minerals suggests an incipient stage in the development of schistosity.

Depending on the degree and nature of the alteration, these hybrid rocks contain any or all of four types of amphibole: pale green hornblende, dark green hornblende, bluish-green sodic amphibole, and tremolite-actinolite - the colours mentioned being those seen in thin section.

The pale green hornblende is habitually associated with tremolite-actinolite, serpentine, or chlorite. The crystals, or groups of crystals, some of them twinned, either have frayed margins or are surrounded by a rim of bluish-green sodic amphibole. Numerous needles of the latter are also distributed throughout the rock, both in the pale green hornblende and in the plagioclase (Plate XIII-C). The dark green hornblende is found in the more highly altered and completely recrystallized rock, in which it forms large sieve-like crystals, or small poorly to well developed crystals.

The pale green hornblende is unquestionably uralitic, representing original pyroxene, and is comparable to that in the type of gabbro-diabase that has here been designated "uralite gabbro-diabase". In the case of these dioritic rocks, it would seem that, as alteration progressed to higher stages, the uralitic material was gradually recrystallized to form either rather compact crystals of dark green hornblende or swarms of small crystals of bluish-green sodic amphibole. The distribution of these latter all through the rock shows that they must have migrated to their present positions, and certainly their abundance in the feldspar, in many of the thin sections examined, precludes the possibility of their having been derived from the alteration of that mineral (Plate XIII-C).

The rock contains biotite, but rarely in large amount. It is invariably associated with hornblende, from which, for the most part, it has been derived.

Magnetite and ilmenite in large skeletal crystals rimmed with sphene (leucoxene), or in clouds of fine "blebs", occur in or with the hornblende.

With the exception of secondary albite or albite-oligoclase, the feldspar in these dioritic rocks is highly saussuritized, but optical determination indicates that it is fairly high in soda (oligoclase), with gradation to more calcic types where the rock is less highly altered and approaches gabbro in composition. It is believed, however, that the feldspar now present has resulted from degradation of original more highly calcic feldspar, largely or entirely through loss of calcium and other constituents in the process of saussuritization, to form zoisite, epidote, actinolite, hornblende, and sericite. In addition, albite or albite-oligoclase has been introduced into the rock from outside sources, and this is clear and unaltered. It occurs in homogeneous patches replacing the original feldspar (Plate XIII-B), as a mosaic of grains along junctions between feldspar laths and replacing them, and also replacing hornblende, the crystals of which then have a characteristic sieve-like, corroded appearance (Plate XI-B).

Other constituents of the rock are quartz and calcite, veining and replacing the feldspar and hornblende, and apatite, which generally is in moderate abundance. These minerals, as well as the albite and sodic amphibole, are absent from the fresh gabbro. They are too abundant to be explained entirely as a rearrangement of the constituents of the rock, and it is safe to conclude that the material to form them has in large part at least been introduced.

The effects of the northern granite on the gabbro are well seen in outcrops at the northern end of a lake about 1,000 feet northeast of Muriel lake. One specimen of the gabbro, taken at a point ten feet from the granite, has the composition and general character of the rock here designated "dioritic". In thin section, it is seen that the feldspar laths have been forced into parallel orientation. A few of them are broken, bent, or strained, but the majority show no deformation. The original texture has been obliterated and the olivine and pyroxene have disappeared, giving place to pale green hornblende in which are left brown patches (possibly pyroxene relics). The feldspar has been saussuritized and its present composition is sodic andesine, an obvious result of albitization. In another sample from this locality, taken at a point twenty-five feet from the granite, although the feldspar has been albitized (to oligoclase), the rock still retains the ophitic texture and it belongs to the "uralite" type. In both rocks, calcite has been abundantly introduced, and, in lesser amount, quartz, epidote, and albite. In the same sill, less than a mile due east of this occurrence, the rock is fresh olivine gabbro containing calcic labradorite.

Hybrid types, not as closely allied as those discussed above to rocks of dioritic composition, are observed locally. A thin section of a dark, massive, fine-grained specimen taken at a point one mile northwest of the northern end of Auberive lake shows a matrix of clear quartz and plagioclase grains, innumerable granules of epidote, abundant biotite, subordinate skeletal hornblende, calcite, zoisite, and sphene.

Along the western shore of Thibaudeau lake, one mile due south of the large island, a moderately coarse-grained rock in which pale pink feldspar predominates consists of microcline, sodic feldspar, olive-green biotite, rare skeletal hornblende, secondary quartz, and calcite, magnetite, sphene, epidote, and apatite. No satisfactory conclusion has been reached regarding the origin of this rock. It may be the result of contamination of the gabbro by the granite, or it may be an acid differentiate of the gabbro. Overburden concealing the larger part of the outcrop hindered the study of its relation to the adjacent normal gabbro.

Light coloured, almost pure white, feldspar-rich facies of the gabbro were noticed in a few places. A section of such a rock, from the east shore of the narrow lake half a mile west of Wakeham lake, near the southern boundary of the map-area, discloses large crystals of acid oligoclase in a matrix of finely granular, clear albite which penetrates along fractures in the oligoclase. Hornblende is rare, occurring in long, radiating sheaves of yellowish-green crystals. Apatite is fairly abundant and magnetite is present in irregular patches and tongues. These light-coloured facies appear to be portions of the gabbro that are pegmatitic or aplitic in nature.

Inclusions of Gabbro in Granite

Some of the inclusions of gabbro in granite present certain features which deserve brief mention. In general, they are of one or other of the types already discussed, most of them of the "dioritic" type.

Three thin sections of specimens from a long, narrow inclusion west of Pauline lake exhibit marked variety in composition. One, taken from the northern end of the inclusion, contains hypersthene, augite, biotite, and minor hornblende in a matrix of andesine-labradorite. The hypersthene is strongly pleochroic in pink tones and is partially altered to serpentine. Some pseudomorphous patches of the latter may be after olivine. The augite is clear, abundant, and distinctly replaced by small amounts of compact green hornblende. The biotite, brown in thin section, is in large flakes and segregated in pockets, and is accompanied by rare flakes of muscovite. The plagioclase crystals are strained, fractured, and moderately sericitized. The rock has suffered intense fracturing and the fissures are filled with quartz, carbonate, epidote, serpentine, and chlorite. The texture is granular and moderately coarse.

A section of a specimen taken a few feet away from that just described shows completely sericitized and saussuritized feldspars, a large proportion of brownish epidote, pale and deep green hornblende, abundant chlorite, apatite, and sphene, and quartz in veinlets.

Near the south end of the inclusion, the rock is a granoblastic diorite well advanced toward the state of complete recrystallization, with deep green, equigranular hornblende, and andesine-labradorite feldspar, occasionally in lath-shaped crystals (Plate XI-C).

That the rock of the northern part of the inclusion should be a relatively fresh gabbro whereas that of the remainder is strongly altered, is somewhat puzzling. The fresh rock may be original gabbro which has escaped metamorphism. If so, its lack of ophitic texture is most unusual, considering the universal occurrence of such a texture in the fresh gabbro of the region. It is possible, therefore, that the rock is not original gabbro that has been preserved, but that, on the contrary, it has been produced by local high-grade metamorphism whereby the original rock was completely recrystallized and lost its texture - that is, the original gabbro was first degraded to the amphibole-bearing or dioritic type, and then, at a later stage of the granite intrusion, was recrystallized into its present form.

In thin sections of two inclusions of "gabbro" from the northern granite stock, the rock was seen to have a dioritic composition. In one of these sections, the ophitic texture is still discernible in places. Where it has disappeared, the feldspars are recrystallized in a mosaic of clear grains. Hornblende assumes a poikilitic habit and houses numerous small crystals of secondary feldspar.

Hornblende Syenite and Lamprophyre Dykes

Narrow dykes which appear to be late differentiates of the gabbro were found cutting gabbro sills at two localities: along the eastern shore of Lebrun lake, three-quarters of a mile south of the portage leading to Faucher lake; and along the eastern shore of Davy lake, near the eastern boundary of the map-area. The dykes are too small to be shown on the map, being only four to six inches wide and exposed for lengths not exceeding ten feet. They have a vertical attitude and cut the sills in a roughly transverse fashion.

At Lebrun lake there is only one of these dykes. It is a light grey, fine-grained, granular rock having the composition of hornblende syenite, with 60 per cent microcline, 20 per cent albite, and 15 per cent hornblende. Accessories include epidote, zoisite, calcite and, in very minor amount, chlorite, magnetite, sphene, and apatite.

At the Davy Lake locality, there are two or three dykes of lamprophyric composition. The rock is extremely fine-grained, dark greenish, and breaks with a conchoidal fracture. It consists of hornblende (75 per cent) and albite (20 per cent), with finely scattered magnetite and sphene, and small amounts of carbonate, zircon, epidote, and tourmaline.

Origin of the Gabbro

The probable mode of intrusion of the gabbro has already been mentioned, but may be re-stated at this point. It is believed that an elongated mass of gabbro was emplaced along a vertical plane of weakness, trending in a general north-northwest direction and coinciding with the axial plane of the Wakeham Lake area syncline. The reasons for this belief are the irregular outlines of the gabbro masses along the synclinal axis, south of Blondin lake and around Thibaudeau lake, and the symmetrical arrangement of the intrusive sheets of the area about the synclinal axis. Obviously, a similar symmetry could result if flat-lying sills were folded contemporaneously with flat-lying sediments enclosing them. However, as shown later in the discussion of the structure, there is not sufficient general deformation of the sills to suggest that they were folded with the sediments.

During intrusion of this central elongated mass along a plane of weakness coinciding with the synclinal axial plane, relief became easier laterally along the bedding planes of the sediments, and sheets branched out from the main mass and wedged their way laterally along the sediments, following the planes of easiest relief. It is possible that, after the initial intrusion of the central mass, a short period of quiescence, during which its upper part congealed, was followed by a recrudescence of igneous activity. But as the upper part of the initial mass was already solidified, relief was now found easier laterally, and most of the sills may date from this resurgence of the gabbroic magma. The Davy Lake breccia may be a result of this recrudescence of igneous activity, that is, of a forceful intrusion of magma along an already partly solidified sill.

The close vicinity of the gabbro masses to large bodies of anorthosite occurring northwest and southwest of the map-area (see map No.680, in pocket) warrants consideration of the hypothesis that the gabbro may be derived from, or at least genetically related to, the anorthosite.

Buddington[1], in his study of the origin of the Adirondack anorthosite and its various gabbroic facies, discusses at

[1]BUDDINGTON, A.F., op. cit., pp.217, 236.

length the possible modes of derivation of such facies from the parent anorthosite mass. Two hypotheses have particular bearing on the present case. The gabbros may be of the nature of residual liquid from crystallization fractionation during cooling or they may be interpreted as the product of partial melting of primordial gabbroic or noritic anorthosite horizons of primordial layers. According to the first hypothesis, the plagioclase of the gabbro should be less calcic than that of the anorthosite, whereas according to the second hypothesis it should be more calcic. In the anorthosite west of the Wakeham Lake area, the plagioclase ranges from calcic andesine to sodic labradorite; in the present map-area, the plagioclase of the fresh gabbro is calcic labradorite. The second hypothesis, therefore, would be applicable to the origin of the Wakeham Lake gabbro.

The mode of derivation of the mafic magma is conceived as follows by Buddington[1]:

> "... the deep-seated anorthosite horizon might perhaps be banded with layers of noritic, troctolitic, or gabbroic anorthosite. Such more mafic bands might be completely molten at the same temperature at which the anorthosite was only partly melted to yield the magma of assumed composition. Such more mafic liquids would, however, be of higher density than the less mafic magma and would tend to settle out as units from it and not necessarily appear as a contemporaneous facies. Daly[2] observes that, in general, "the femic pole which would settle at the bottom would remain there invisible until a later eruptive effort forces it up through the anorthosite or country rock".

That the many gabbro masses of the Wakeham Lake area were derived from deep, appropriate horizons of the westerly anorthosite bodies in the manner suggested by Buddington and Daly is obviously quite possible. It is incontrovertible that the gabbro is closely related in time to the anorthosite. As far as is known at present, there is no intervening intrusive event in the time-scale between the anorthosite and gabbro. Their mutual relationship is unknown, but the gabbro is thought to be the younger of the two intrusives. Whether or not the present hypothesis of derivation of the gabbro is correct, it is certain that the two rocks are genetically related.

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[1]BUDDINGTON, A.F., op. cit., p.220.

[2]DALY, R.A., Igneous Rocks and Their Origin (1914), McGraw-Hill, p.327.

Biotite Granite

General Statement

Granite occurs in the area as two stocks, one occupying about 15 square miles in the region of Cométique and Muriel lakes, near the northern boundary of the map-area, the other exposed over an area of about 20 square miles in the region of Pauline lake, in the southwestern corner. Both masses extend beyond the limits of the map-area. In both stocks, the typical rock is a pink biotite granite, but it is coarser grained and contains more biotite and sodic plagioclase in the southern than in the northern body. It is believed, however, that the two stocks are contemporaneous and genetically related, and the alteration suffered by the gabbro-sediments complex lying between them suggests that they join to form one body at moderate depth below the complex.

Northern Granite Stock

The northern granite is medium-grained. The typical rock, as seen in thin section, contains potassic feldspar (predominantly microcline), 40 per cent or more; sodic feldspar, 25 per cent; and quartz, 20 to 25 per cent. Biotite is green and never exceeds 10 per cent. Accessory minerals include epidote, calcite, magnetite, ilmenite, sphene, muscovite, zircon, apatite, and, in one section, euhedral crystals of an isotropic mineral, probably garnet. The proportion of sodic feldspar (oligoclase) is likely to be under estimated under the microscope, as much of it is intergrown with the microcline, forming microcline-microperthite. To a lesser extent, it is intergrown also with quartz. Staining tests on polished hand specimens (staining the potash feldspar yellow and leaving the oligoclase unaffected) reveals a larger proportion of soda feldspar than was estimated in the thin sections.

The plagioclase is commonly in zoned crystals, with the central cores more altered than the rims to sericite and saussurite. The microcline is slightly altered to kaolin and sericite, and the biotite to chlorite. Many of the quartz grains display undulatory extinction.

An unusual facies of the granite occurs along the western contact between the gabbro and granite north of the western end of Cométique lake. As seen in hand specimen, the rock is dark greenish, medium-grained, and shows a large mica content in glistening flakes. A thin section reveals a highly altered rock in which potash feldspar (orthoclase) is present in insignificant amount. The main constituents are plagioclase (50 per cent), biotite (20 per cent), and quartz (15 per cent). The plagioclase appears to be oligoclase with clear rims of more sodic composition. Actually, there is little left of the oligoclase as it is considerably altered to muscovite in small oriented flakes, epidote and zoisite granules, and calcite patches. Epidote is also present in the rock as large lemon-yellow crystals associated with apatite and sphene. As in the normal granite, the biotite is green in thin section.

Southern Granite Stock

The rock of the southern granite stock is very coarse-grained, with feldspar crystals averaging between half an inch and one inch in diameter. Although usually pink in colour, the rock occurring in the southwest corner of the area is grey, and it has an apparent porphyritic texture which is interpreted as the incipient stage in the formation of an augen gneiss and not as a true porphyritic character.

The rock is rather loosely compacted, and as a result the preparation of thin sections is difficult and from some specimens is impossible. Staining tests and microscopic study indicate that, in this rock, plagioclase commonly exceeds potash feldspar. Quartz and plagioclase are present in approximately equal amount. The average composition can be roughly expressed as 30 to 35 per cent plagioclase, 25 to 30 per cent potash feldspar, 30 per cent quartz, and 15 per cent biotite. The biotite is dark brown. Microperthitic intergrowths of the two feldspars are frequent. The plagioclase is zoned and habitually sericitized to a moderate extent. Accessories include apatite, zircon, epidote, muscovite, and magnetite.

All the original minerals of the rock are intensely fractured. No gneissic banding was observed, but the mica has a tendency to be segregated and wrapped around large crystals of feldspar or areas of quartz and feldspar.

In some smaller bodies of granite between the southern stock and Wakeham lake the rock is fine-grained and closely allied in appearance to that of the northern stock. The same is true of the small granite dykes (not shown on the map) encountered in a few other localities. There is no reason to doubt, however, that all the granites are of the same age.

Pegmatite and Syenite Dykes

A limited number of pegmatite (and more rarely aplite) dykes were seen in the area. They are restricted to the vicinity of the large granite masses and unquestionably represent late differentiates of the magma that gave rise to these. They are medium- to coarse-grained rocks in which pink feldspar is preponderant.

Only one syenite dyke was observed. It cuts the gabbro near its contact with granite at the north end of the small lake whose outlet is about 1,000 feet northeast of Muriel lake. The rock is pinkish to red and coarse grained, consisting of orthoclase, plagioclase, and microperthitic intergrowths of the two. Following deformation of the dyke, quartz and epidote have been introduced, the latter forming more than 5 per cent of the rock, accompanied by minor biotite, magnetite, and hematite.

Pleistocene and Recent

There is clear evidence throughout the area of continental glaciation. Glacial striae, large erratics, and morainic débris are found on practically every high hill (Plate VI), as well as in the valleys. How intensive the glaciation was is a question that cannot be fully answered until a great deal more work has been done in the region. It is certain that most of the erosional pattern is of pre-glacial origin, and that the work of the ice consisted of scouring and cleaning an already deeply incised area. The main result was the rounding of the valley bottoms and smoothening of their walls (Plate VII). Erosion has encroached considerably in some places upon the edges of some gabbro dykes and sills and has brought them at or near the level of the valley floors, an operation which certainly cannot be attributed to the abrasive action of the ice alone. It can be better explained by picturing the pre-glacial valley slopes as consisting of lofty gabbro bodies, the edges and sides of which were gradually being carved and indented by weathering. The large glaciers followed the valley channels (since all glacial striae indicate that the ice moved parallel to the trend of the sedimentary rocks and the valleys) and removed all the soft, crumbling indentations along their sides, rounding and scouring the floor at the same time. It is quite conceivable that the ice, being constricted between narrow gabbro walls, had a great abrasive power, a condition which would explain the effective scouring of most of the valleys.

The glaciers have left only a thin cover of drift over the region, and in many places the bed-rock has been swept clean. Commonly, the débris has been piled thickest at the foot of the high cliffs where it unfortunately hides such critical features as contacts between gabbro and sedimentary formations. Apart from re-working, sorting, and transporting of the thin drift blanket by streams that cut their beds through it, little erosional work has proceeded in the region since glaciation.

The unconsolidated sediments of Pleistocene age consist of glacial drift, such as erratics and morainic débris, left over the area in relatively thin patches. The small rivers and streams have re-worked the glacial deposits in Recent time, effecting an appreciable amount of sorting and accumulating the finer material at and near their mouths.

The main concentrations of sand and gravel have been indicated on the map, but for the most part these deposits are too coarse to be of any use. Limited reserves of sand and fine gravel suitable for road-building or other purposes lie along, and at the mouth of, the main inlet stream of Cométique lake; along Plate river near Guénard lake; and at the northeast end of Pauline lake.

STRUCTURAL GEOLOGY

Folding

The sedimentary rocks of the area were folded, prior to intrusion of the various igneous masses, in a broad symmetrical syncline plunging in a southeasterly direction. A short portion of the axis of the fold is shown on the accompanying map in its approximate position. It trends north-northwest and, if produced at either end, would cross the northern boundary of the map at a point about half a mile east of the eastern edge of the granite stock, and, in the south, after passing along the centre of the large gabbro body forming the eastern shore of Thibaudeau lake, would leave the map-area at a point about four and a quarter miles north of the southeast corner. Most of the area, therefore, lies on the western limb of this fold. The angle of plunge of the syncline was not ascertained but is probably between 25 and 40 degrees.

The areal structure was inferred from the attitude of the sedimentary beds and gabbro sills. No positive evidence of overturning of the beds was found. Where ripple-marks and cross-bedding were observed in the sedimentary rocks, they offered no reliable criteria but suggested vaguely that the beds are in a normal position. Thus, for purposes of determining the structure, it seemed reasonably safe to rely on the dip of the formations.

A total of 240 strike and dip observations were recorded in the sedimentary rocks. Some 210 were made in the area west of the axial plane of the fold. Of these, 75 per cent indicate an easterly dip and 20 per cent a vertical attitude. Of the observations made east of the synclinal axis, approximately 80 per cent indicate a westerly dip and 10 per cent a vertical attitude. The plunging nature of the fold is reflected in the elliptical curving in the trend of the sedimentary beds in the region of Stephenson, Blondin, La Taille, Davy, and Coumyn lakes and is made strikingly apparent on the aerial photographs by the attitude of the high, rugged gabbro sills.

Near the axis, both limbs of the fold dip at 40 to 50 degrees. Little more is known of the eastern limb, as only a short portion appears within the boundaries of the map. The beds of the western limb show no close uniformity in their angle of dip. Along an east-west line through the centre of the area, the dips change abruptly and erratically, with range between 50 and 80 degrees east. Nearly all the dips in the southeastern quarter of the area and in the neighbourhood of Forgues lake are steep (70 to 90 degrees), which seems to indicate that the southern granite stock tilted the beds on edge in an eastward direction during intrusion. The anomalous northward dipping beds near the axis of the truncated southerly-plunging syncline, a mile and two miles west of the western extremity of Davy lake, seem to be another example of local disturbance created by the intrusion of the granite.

The forceful intrusion of the gabbro sills along the beds probably accounts in a large measure for many of the minor local irregularities of dip.

Except near the synclinal axis, the strike of the formations is remarkably uniform throughout the area, the general trend of the sedimentary rocks and the gabbro sills and dykes being consistently between north-south and a few degrees west of north.

Jointing and Shearing

The sedimentary rocks are commonly traversed by joint planes which have various trends, with no regular pattern. Their origin is obscure and probably dates for the greater part from the period of regional folding. In the schists, the schistosity is developed parallel to the bedding. It may date from the period of regional folding, but also may in part be the result of differential movement along the bedding planes due to the eastward push that the granite must have exerted against the western limb of the syncline during intrusion.

The gabbro-diabase shows regular jointing, especially well developed in the anorthositic mass west of Cométique lake. The joints were best observed at the summit of the mass (elevation 2,100 feet), near the northern boundary of the area. There are two sets: one vertical and about paralleling the elongation of the mass, the other with trend S.75°W. and dip 80 degrees to the north. Numerous minor fractures, so closely spaced as to give the rock a schistose appearance, parallel the second set and are filled with secondary ferromagnesian minerals. The joints may have originated through contraction of the rock as it cooled, but the minor fractures, which approach the nature of a shear cleavage, are obviously a direct effect of the intrusion of the adjacent northern granite stock.

Aerial photographs of the portion of the sill immediately east of Stephenson lake show regular joints traversing the rock, but these were not clearly discernible in the field. They strike S.70°E. and dip very steeply south. They may be a result of cooling or an effect of the intrusion of the nearby northern granite stock. They are too local in occurrence to be interpreted as a result of folding and thus cannot be used as an argument to assign to the gabbro intrusion a pre-folding age.

Between Béland lake and the northern boundary of the map-area, schistosity was observed at three points along the western margin of the large gabbro sill in the northwestern corner of the area. As shown on the accompanying map, the trend of the schistosity at these three localities is erratic. Along its western margin, the rock of the sill is generally altered to a chlorite or amphibole schist in which the strike of the schistosity is not always easily ascertained. The deformation of the sill along its edge may be attributed to shearing movement along its contact plane with the sediments during the disturbance created by the granite intrusion.

A quarter of a mile northeast of Métivier lake, the gabbro is strongly schistose. The schistosity parallels roughly the western edge of the sill and is seen in thin section to be the result of recrystallization of the rock under conditions favouring the alignment of crystals of poikilitic hornblende and of the few remaining feldspar laths. The schistosity could thus be termed a flow cleavage. There seems to be little doubt that it is a direct effect of the intrusion of the adjacent southern stock of granite.

Along the southwestern shore of Wakeham lake, the gabbro exhibits schistosity parallel to the elongation of the sill. It appears to be related to a fault cutting the gabbro at that point. The fault, in turn, is believed to be a result of the emplacement of the southern granite stock.

Just beyond the southeast corner of the Wakeham Lake map-area, a well developed schistosity (Plate XVIII) was observed in the gabbro along the outlet of Thibaudeau lake. This adjoining area has not yet been geologically mapped and the occurrence was not closely investigated by the writer.

The foregoing discussion emphasizes the absence of a regional pattern of fracturing in the gabbro and strengthens the belief that the gabbro was intruded after the sediments had been folded. There is no uniform schistosity developed over large areas. The fracturing is of a strictly local character. It is found in the immediate or relatively close neighbourhood of the granite stocks. Its origin may therefore be logically ascribed to the effects of the emplacement of the granite.

In many localities in this general region, the granite displays three sets of well developed joints. These are particularly well exhibited in the stocks of the Wakeham Lake area. One set strikes N.10°E. and is steeply dipping; another, also steeply dipping, strikes nearly at right angles to the first; and the third approaches a flat-lying position. They are probably the result of contraction of the rock upon cooling, although the flat set occasionally has the appearance of "sheeting", such as, in some areas[1], has been ascribed to the after-effects of the last continental glaciation: that is, the relief of pressure consequent on the melting of the ice is believed to have been sufficient for the development of large-scale horizontal fractures or "sheeting".

No gneisses were seen in the area. In certain parts of the southern granite stock, the mica flakes have a tendency to be wrapped around large feldspar crystals or around mixtures of quartz and feldspar crystals. This feature is interpreted as the incipient stage in the formation of an augen gneiss. The quartz and feldspar crystals are intensely fractured.

Faulting

The faults indicated on the map were for the greater part inferred from coincidence of abrupt change in the rock outcrops as encountered in the field with fracture lines appearing on the aerial photographs. The strike separation of the faulted blocks can be obtained from a study of the map; beyond this, little is known of the faults. As seen in the field, they lie along V-shaped valleys which generally are occupied by streams and partly filled with huge angular boulders derived from the faulted blocks. The tops of the hanging-wall and footwall sides stand at about the same level in most cases, indicating either thorough erosion since faulting or relatively small vertical displacement during faulting.

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[1] JAHNS, R.H., Sheet Structure in Granites; Jour. Geol. Vol. 51, 1943, p.71.

West of Cométique lake, a short fault is indicated by a narrow gap, walled on one side by quartzite and on the other by gabbro. The gap is heavily obstructed and is lost eastward among a ramified system of similar ravines. Few outcrops occur except high up the walls of the gap, where no shearing is found in either quartzite or gabbro. The strike separation is about 1,200 feet.

The fault shown east of Vigneault lake was not recognized in the field, but aerial photographs show a distinct break indicating an offsetting of the gabbro, which, also, is suggested by the observed outcrops.

The La Taille Lake fault was inferred from the distinct break shown on the aerial photographs, and by a deep ravine filled with large angular boulders along its assumed course. It appears to have no appreciable horizontal component of displacement but a vertical component alone. Being undoubtedly a result of the emplacement of the northern granite stock, one may assume that the west block has been raised.

The remaining faults indicated on the map are in the southeast quarter of the area and consist of a group of northeasterly fractures arranged in an <u>en échelon</u> pattern. The break south of Nesmy lake was perhaps the best recognized in the field. The southern block constitutes a sheer cliff dipping very steeply north. At its only accessible point, the cliff is covered by overburden and the rock poorly exposed. It was possible to recognize, however, that the gabbro has been sheared, because it has disintegrated into thin slabs which blanket the steep hillside. The fault plane is nearly vertical or slightly north-dipping and, since the southern block is somewhat higher than the northern block, the fault may be regarded as of the gravity type with a strike separation of half a mile.

Around and north of Wakeham lake, the lofty sills show local faulting with strike separations ranging from 300 to 1,000 feet. The offset of the ridges is clearly evident from a short distance away, but, on the spot, the fault planes are lost under the common accumulations of large angular boulders. Well defined schistosity was recognized near the fault plane along the southwestern shore of Wakeham lake.

Various other large-scale fractures are apparent on the aerial photographs. The field evidence failed to show any appreciable strike separation along them, however, and they have been neglected for the time being.

Except perhaps for local wrapping of the sediments around some of the large gabbro masses of the synclinal area, as for example east of Nesmy lake, evidence of any major structural disturbance that may have accompanied the emplacement of the gabbro has been completely, or almost completely, destroyed by the superimposition of the later, strong disturbances ascribed to the granite intrusion.

Effects of the Emplacement of the Granite

A study of the map will demonstrate more effectively than a detailed discussion the large-scale effects of the emplacement of the granite stocks.

The Pauline Lake stock has strikingly forced a large portion of the gabbro-sediments complex aside, pushing it northward and eastward. The northward push is well illustrated in the shape of the sills and sedimentary beds which terminate against the northern border of the stock, and the eastward push by the deflection of the numerous sills and the abnormally steep dips east of the stock.

The effects of the Cométique Lake stock are self-evident. There was a westward push, well shown in the attitude of the gabbro-sediments complex west of the stock. In the east, the granite appears to have split open part of the Davy Lake sill and to have exerted a strong southeastward push, displayed by the convex deflection of the complex toward the synclinal axis and by the reverse dips of the sediments immediately south of the Davy Lake sill in the area between Muriel and Davy lakes. As previously pointed out, the La Taille Lake fault probably is a result of this disturbance.

The kinks in some of the sills - as east of Guénard lake, southwest of Nesmy lake, and at the south end of Lebrun lake - are interpreted as the combined result of the north and northeast, and south and southeast, push of the southern and northern granite stocks, respectively. In other words, they appear to be the expression of the compressive stress imposed upon this part of the region by the emplacement of the northern and southern granite stocks.

Among small-scale effects of the forceful emplacement of the granite are the local schistosity and shearing already discussed, and, on a microscopic scale, as seen in thin sections of the gabbro, the parallel alignment of plagioclase laths and the frequent occurrence of fractures filled by secondary minerals, particularly in specimens taken in the vicinity of the granite masses.

It seems clear from the above discussion that the granite was of the rapid injection type. Also confirming this view are the facts that the granite has a fairly uniform composition, shows sharp contacts, holds relatively few inclusions, and shows little evidence of assimilation. The intrusive masses have therefore pushed the obstacles aside rather than assimilated them.

If the granite stocks of the Forget Lake area[1] are taken into consideration and all the stocks of that and the Wakeham Lake area are regarded as connected together at shallow depth to form a single batholith, it can be shown[2] that this large mass of granite could not have been forcefully emplaced without pushing the pre-existing rocks apart, that is, without tilting the gabbro-sediments complex in an easterly direction and similarly crowding the sediments west of the batholith in a westerly direction.

The result in the Wakeham Lake area is that the dip of the gabbro-sediments complex of the western limb of the syncline is very different from the original dip, which probably was relatively gentle. Allowing for the numerous local irregularities, the present dip is generally well above 60° — commonly between 70° and 80°. The original dip, if similar to that of the relatively unaffected parts of the syncline, would have been between 40° and 50°.

In résumé, the sediments were folded in a gentle syncline and intruded by gabbro, which apparently created little disturbance. The subsequent emplacement of the granite batholith and of its projecting stocks seems responsible for most of the local complexity found in the structure of the area. Among the predominant effects were the tilting in an eastward direction of the western limb of the syncline as a whole, minor complex folding, local faulting and shearing, and smaller-scale effects.

The incipient formation of an augen gneiss in the southern granite stock, undulatory extinction in quartz, and fracturing of a late syenite dyke, are features that indicate a mild deformation of a regional character later than the granite. The

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[1]LONGLEY, W.W., op. cit.

[2]CLAVEAU, Jacques, The Geology of the Wakeham-Forget Lakes Region; Ph.D. Thesis (unpublished), University of Toronto, 1944.

age of this deformation is not known. It may represent local disturbance created by the uptilting of the Shield in late Tertiary time or by its isostatic movements during advance and withdrawal of the Pleistocene ice sheets.

ECONOMIC GEOLOGY

Copper, in the form of chalcopyrite, was found at several widely separated points within the area investigated - always along or near contacts between sedimentary rocks and gabbro. Descriptions of the most interesting occurrences follow in the order in which they are shown (in circles) from north to south on the accompanying map.

Northwest of Cométique Lake. Pyrite, with a minor amount of associated chalcopyrite, was observed at the southeast corner of a small lake which lies a mile and a half northwest of Cométique lake. The sulphides occur in altered gabbro cut by quartz veinlets and containing small inclusions of coarsely crystalline limestone.

Lebrun Lake. Small veinlets of quartz carrying massive chalcopyrite occur in the gabbro near the water level on the east side of the lake, about 500 feet north of its southern end.

West of Harvey Lake. Slightly over two miles due west of the southwestern corner of Harvey lake, feldspathized gabbro contains disseminated mineralization including pyrite, ilmenite, chalcopyrite, and pyrrhotite. The mineralized portion of the rock appears almost white, with large amounts of introduced sodic feldspar replacing the original constituents of the gabbro.

Southeast of Guénard Lake. Chalcopyrite occurs in, and at the walls of, a tiny chlorite-filled fracture in the gabbro, one mile southeast of Guénard lake or nearly a mile and a half north of the northern end of Wakeham lake.

Forgues Lake. Fractures in fine-grained gabbro, which is associated with granitic dykes and quartzite, are filled with finely divided chalcopyrite, quartz, and epidote. This occurrence is about 1,700 feet northwest of the southernmost tip of the lake.

Wakeham Lake, Northern Portion. Chalcopyrite, in veinlets and stringers, occurs in the gabbro and also in quartz introduced along the quartzite-gabbro contact. Besides filling fractures in these rocks, the quartz replaces remnants of coarsely crystalline limestone. This occurrence, which has been described previously[1], is on the east side of the lake, about a mile and a quarter from its northern end, at the north end of the "narrows" which joins the wider northern and southern portions of the lake.

This showing was not re-examined during the summer of 1943 as it was under water at the time. Field mapping of this part of the area coincided with heavy rainfall which raised the level of Wakeham lake three feet above normal.

An assay of a grab sample collected during the 1942 reconnaissance gave the following result:

Copper .... 3.74 per cent
Gold .... 0.040 oz. per ton
Silver .... 1.685 oz. per ton

Wakeham Lake, Southern Portion. Along the western shore of the lake near the water level, a few hundred feet north of the southern boundary of the map-area, a quartz vein, partly in quartzite and partly along the gabbro-quartzite contact, was traced over a length of 175 feet. The vein strikes N.25°W. and stands vertically. Both to the north and south it disappears beneath overburden. The land exposure of the vein is interrupted in two places by narrow embayments of the lake, so that it is in three segments which, from north to south, are 30, 8, and 90 feet long. In the northern segment, the vein is five inches wide and barren of sulphide mineralization. In the central section it has a width of nine inches and is traversed throughout its length of eight feet by two parallel veinlets of solid chalcopyrite, three to four inches apart and each ranging from a quarter of an inch to one inch in width. Here and there, stringers from these veinlets run off into the quartz wall-rock. In the southern segment of the vein, the quartz contains only "traces" of chalcopyrite.

Grab samples from the central section of the vein were mixed together for purposes of assay and were found to contain:

Copper .... 5.29 per cent
Gold .... 0.010 oz. per ton
Silver .... 1.154 oz. per ton

Pinet Lake. Disseminated chalcopyrite and pyrrhotite occur in altered dioritic gabbro along the western shore of Pinet lake, near its southern end. Assay of the gabbro to ascertain the possible nickel content of the pyrrhotite gave negative results. The rock averages 0.06 per cent copper.

[1]CLAVEAU, Jacques, Que. Dept. Mines, P.R. Nº 180, 1943, p.15.

Mineralized Erratic of Limestone. A large, angular boulder of cream-coloured, coarsely crystalline limestone, criss-crossed with veins and lenses of quartz that contain abundant chalcopyrite, pyrrhotite, and pyrite, was found along the western shore of the northern part of Forgues lake. The source of the boulder was not determined. Assays of grab samples gave negative results for nickel and 0.17 per cent copper.

RECOMMENDATIONS

As noted above, copper mineralization was found at widely scattered points in the course of the 1943 field work. The richest mineralization observed — along the shore of Wakeham lake — is close to the southern granite and it is not unlikely that the Wakeham Lake main fault and the schistose character of the sill in the vicinity of the fault had much to do in providing avenues of access for the mineralizing solutions. The remaining occurrences are localized in gabbro which, as a whole, has undergone moderate to intense alteration. In the localities west of Harvey lake, at the south end of Forgues lake, and west of Cométique lake, the mineralization appears clearly as the last stage in the alteration of the rock by the sodic solutions from the granite magma.

The channels followed by these mineralizing solutions appear to have been the same as those that guided the slightly earlier solutions that effected the alteration of the gabbro. Although the altered gabbro is not everywhere mineralized, it is along such zones of alteration that prospecting should be concentrated. The structural control appears to have been rather simple. The solutions followed faults or, more commonly, contacts between the sills and the sedimentary strata, and possibly they migrated across the trend of the structure along fault planes or fractures running transverse to the strike of the sediments and gabbro sills.

The structural channels may have been far too numerous to allow appreciable local concentrations, and may, instead, have effected a widespread dispersion of the mineralization. There remains the possibility, however, that, in some places, favourable factors, such as the replacement of large inclusions of limestone in the gabbro by quartz and copper and other sulphide minerals, permitted the formation of deposits of economic importance. The prospector, therefore, should devote special attention to gabbro-sediments contacts that are located near faults or other fractures. The faults themselves should be thoroughly investigated because they do not appear to be very persistent. They are rather of the scale that might favour localization instead of dispersion of solutions.

The occurrence of gold and notable amounts of silver with the chalcopyrite is interesting, especially in view of the fact that the mineralization is believed to be genetically related to the sodic granite of the area. If the theories that have been proposed regarding the association of gold and albite in the gold fields of northwestern Quebec are valid, then they could be tentatively applied to the present area and prospecting for gold and silver should be encouraged accordingly.

The Wakeham Lake area is of particularly easy access. The field season lasts from the middle of May to the end of September. Overburden is heavy in certain localities, but this is not the general rule, and stripping should be relatively easy.

ALPHABETICAL INDEX