CANADA
DEPARTMENT OF MINES
GEOLOGICAL SURVEY BRANCH
HON. W. TEMPLEMAN, MINISTER; A. P. LOW, DEPUTY MINISTER;
R. W. BROCK, DIRECTOR

GEOLOGY

OF AN

AREA ADJOINING THE EAST SIDE

OF

LAKE TIMISKAMING

QUEBEC

BY

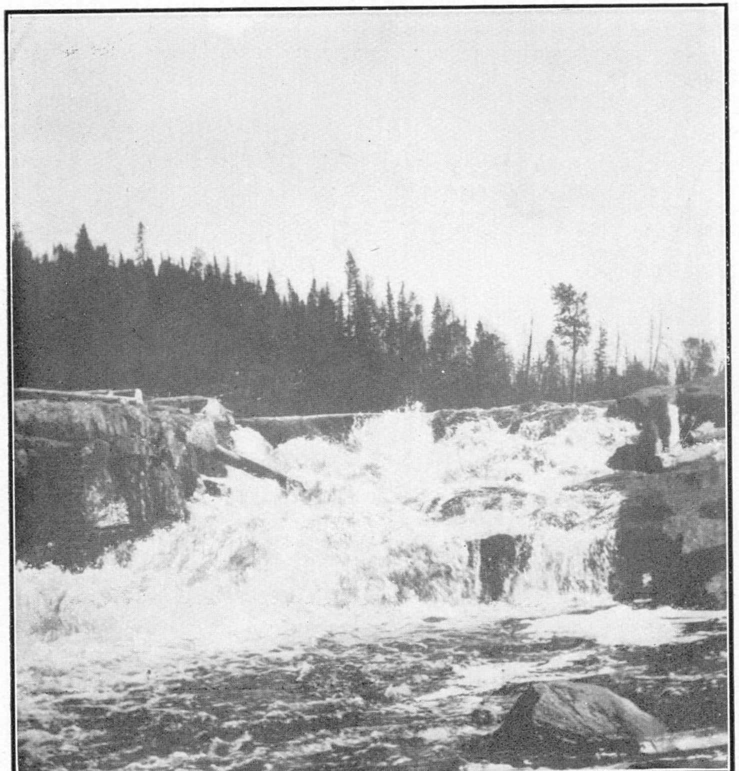
MORLEY E. WILSON.

OTTAWA
GOVERNMENT PRINTING BUREAU
1910

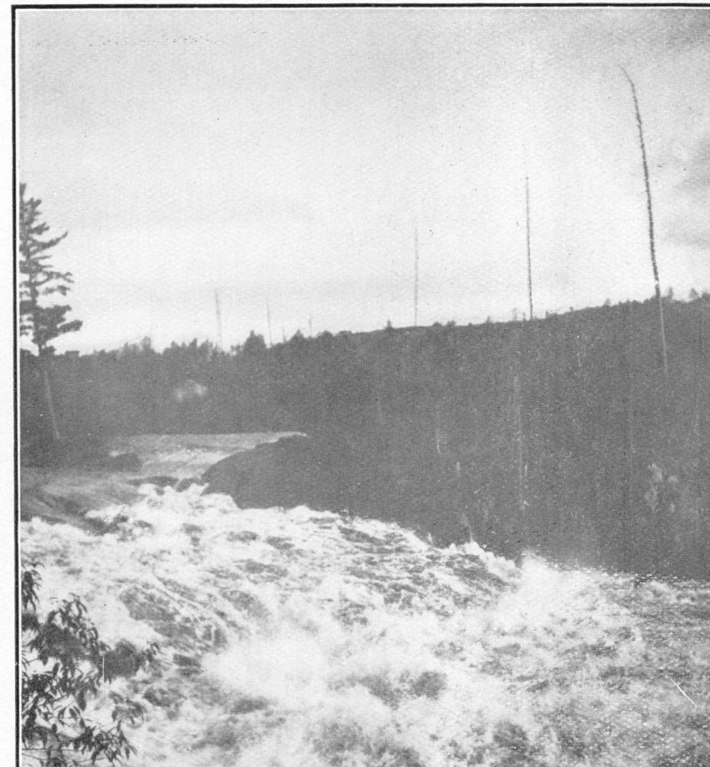
No. 1064

Frontispiece.

6487



Third Rapids, Rivière des Quinze.



Burnt Island Rapid, Rivière des Quinze.

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To R. W. BROCK,

Director Geological Survey,

Department of Mines.

SIR,—I herewith beg to submit a report on the geology of an area adjoining the east side of Lake Timiskaming, to be accompanied by a geological map of the Lake Timiskaming Mining Region.

I have the honour to be, sir,

Your obedient servant,

(Signed) MORLEY E. WILSON.

OTTAWA, May 19, 1908.

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OF

AN AREA ADJOINING THE EAST SIDE OF LAKE TIMISKAMING, QUE.

BY

MORLEY E. WILSON.

INTRODUCTION.

As stated in the Summary Reports of 1906 and 1907, the geological examination of the district adjoining the east side of Lake Timiskaming was undertaken for the purpose of determining the extent easterly of those geological formations which in Ontario have been found to contain cobalt-silver-nickel ores, and of delimiting the various geological boundaries in greater detail than had hitherto been attempted.

The present report, with the accompanying geological map, represents the result of two seasons' field-work, viz., that of 1906, and 1907. During 1906 the field operations were under the direction of Dr. A. E. Barlow, but owing to his absence from the field during a great part of the summer, and his subsequent retirement from the staff of the Survey, the work devolved upon the writer as his assistant. The area examined comprises about 600 square miles, extending from Lake Timiskaming to Lake Kipawa and Lac des Quinze, and from Rivière des Quinze to the south end of Fabre township.

In the preparation of the map, surveys were made of roads, trails, creeks, lakes, etc., using the Rochon micrometer and surveyor's compass. These, while necessary adjuncts for a correct topographical map, were also utilized for locating geological boundaries. In those portions of the area surveyed into townships the lot posts, which occur on the range lines at intervals of thirteen chains, were employed for the same purpose.

Geological descriptions of parts of the area have appeared from time to time in the publications of the Geological Survey. In 1845, Sir Wm. Logan undertook the examination of the Ottawa river, continuing his investigations as far as the third rapid on Rivière des Quinze. His report contains a brief outline of the geology of the east side of Lake Timiskaming.[1] In 1872, Mr. Walter McOuat was engaged in making a geological examination of a 'portion of the country on the Ottawa to the northward and eastward of Lake Timiskaming.' This undertaking included an examination of Rivière and Lac des Quinze, the geology of which is very accurately described in the report of his field-work for that season.[2] A detailed account of the geology of Lake Timiskaming, and Rivière des Quinze, together with an appendix by Dr. Ami on the fossils of the Silurian outlier of the Timiskaming district, is given by Dr. Barlow in his report on the geology and natural resources of the area included in his Nipissing and Timiskaming map sheets. This report, which was a resumé of observations extending through several seasons, was published in 1897.[3]

Prof. Miller's report on the cobalt-nickel arsenides and silver deposits of Timiskaming, issued in 1905, contains several references to the geology of the east shore of Lake Timiskaming, and more particularly to the deposit of argentiferous galena occurring at Wright mines.[4]

In the report of the Department of Mines of Quebec, for 1906, Mr. Obalski mentions the mining developments being carried on in this region, which he had visited during the previous summer in the course of a reconnaissance through the western part of Pontiac county.[5]

Physical Features.

The topography of the country east of Lake Timiskaming, while possessing in part those characteristics common to the Archæan peneplain, has been greatly modified by extensive deposits of post-glacial materials. These consist largely of stratified clays, which have filled in the depressions in the uneven rocky surface, producing flat, almost plain-like areas, which differ strikingly from the more rocky portions of the district. It is probable that many of the higher rock exposures, which project through the clay as knobs,

[1] Report of Progress, Geo. Surv. Can., 1845-6.
[2] Report of Progress, Geo. Sur. Can., 1872-3.
[3] Annual Report, Geo. Surv. Can., Vol. X.
[4] Report of Bureau of Mines, Pt. 2, 1905.
[5] Report of Department of Mines, Que., 1906.

hills, or ridges, played the part of islands in the huge post-glacial lake which covered the northern part of the Timiskaming area, and from which the bedded clays were laid down.

Of the physical features which distinguish the rocky areas from those in which clay predominates, the most prominent are those associated with the hydrography of the region. In the former areas lakes are abundant, while in the latter they seldom occur; and the streams, which in the rocky areas are rapid and without definite channels, in the clay areas meander slowly between high banks of stratified clay. With the exception of the Galt-St. Amant-Morin chain of lakes, which have their outlet into Lake Kipawa, the drainage of the region is almost exclusively into Lake Timiskaming; and that the above series of lakes flow into Lake Kipawa is not due so much to the general slope of the surface as to the way in which the drift has obstructed the long, narrow depressions in which they occur. The greater part of the drainage into Lake Timiskaming is by way of the Otter river, the remainder being distributed between Little river, Young and Lavallée creeks. All of these have their sources in the interior lake country, passing through the clay flats in the lower part of their course.

Although the surface of the country on the whole is somewhat rugged, yet, as is generally found throughout the Archæan plateau, extreme differences of elevation do not occur, a hill rising over 200 feet above the surrounding country being a somewhat striking topographical feature. The most prominent elevations in the district are a series of hills and ridges which parallel the east side of Lake Timiskaming from Lavallée bay to Apika creek. These, while not having an altitude of more than 400 feet above the lake, are rendered very conspicuous by contact with the flat clay areas enclosing them. The interior rocky areas have either the monotonous, mammillated surface characteristic of the glaciated granite and gneiss, or the still more pronounced low relief of the Keewatin. The highest elevation in the whole area occurs a short distance north of Lavallée lake, the altitude being nearly 1,200 feet above sea-level, or 600 feet above the level of Lake Timiskaming.

The close relationship between the topography and the underlying geological conditions, which have been frequently noted as characteristic of the Archæan, is well exemplified in this region. The low relief of the Keewatin, the monotonous roche moutonne surface of the granite and gneiss, the low clay covered areas of greywacké, and the abrupt rocky hills of quartzite have each their own typical surface features, which are directly related to the nature and structure of the rocks themselves. Lakes, which occur in massive rocks having no lines of weakness along which decay and erosion could act, possess irregular outlines, while those which occur in schists or gneisses have elongated trough-like basins, corresponding in direction to the foliation of the enclosing rock.

There are, however, a number of lake basins which have no apparent relationship to geological conditions. This is best exemplified by those which occupy the long rocky depressions extending from Galt to Otter lake. This valley, while on a much more limited scale, is precisely similar to that of Lake Timiskaming in direction and general character, and probably resulted from the same cause, or set of causes, to which the latter owes its origin. The remarkable parallelism in the watercourses of the Timiskaming area has been noted by Prof. Miller,[1] which, he supposes, has been brought about by regional disturbances in post-middle Huronian times. The very ancient, probably pre-Palæozoic existence of the Timiskaming valley, is proved by the Silurian outlier which occurs at the north end of the lake, and, while the attitude of the rocks both on Timiskaming and on the Galt-Otter series of lakes seems to prove that these depressions are not due to folding, their linear and parallel character would suggest that extensive faulting had possibly determined their direction. But whether they originated primarily from regional movements or not, the latter alone would not be sufficient to account for the existence of such deep rocky gorges. It would, therefore, seem more probable that aqueous erosion has played the important part in giving these parallel depressions—of which the Timiskaming cañon is the most conspicuous member—their present physiographic character.

Geology.

The geology of the district differs but slightly from that described elsewhere in the Timagami-Timiskaming area, presenting rocks of the same varieties, and in the same stratigraphical relationship. The various formations, with their equivalents, as found on the Ontario side of Lake Timiskaming, are as follows:—

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1 Report of Ontario Bureau of Mines, Part II, 1905.

QUEBEC.	ONTARIO.
PLEISTOCENE.	PLEISTOCENE.
Post-glacial—	Post-glacial—
Stratified clay and sand.	Stratified clay and sand.
Glacial—	Glacial—
Gravel, sand and boulder clay.	Gravel, sand and boulder clay.
Unconformity.	*Unconformity.*
PALAEOZOIC.	PALAEOZOIC.
Silurian—	Silurian—
Clinton and Niagara limestone, sandstone and conglomerate.	Clinton and Niagara limestone, sandstone and conglomerate.
Unconformity.	*Unconformity.*
PRE-CAMBRIAN.	PRE-CAMBRIAN.
Huronian—	Huronian, middle—
Conglomerate.	Lorrain arkose,
Quartzite and arkose.	quartzite and conglomerate.
No apparent unconformity.	*Unconformity.*
	Huronian, lower—
	Cobalt series:
Greywacké.	Greywacké, quartzite, conglomerate, etc.
Conglomerate.	
Unconformity.	*Unconformity.*
Keewatin—	Keewatin—
Quartz-porphyrite.	Quartz-porphyries, greenstone, etc.
Iron formation.	
Serpentine, hornblende-schist, diabase.	
INTRUSIVES.	INTRUSIVES.
Post-Huronian—	Post-Huronian—
Diabase and gabbro.	Diabase and gabbro.
Granite.	
Post-Keewatin—	Post-Keewatin—
Granite and gneiss.	Granite.

It will be observed that the Huronian here differs from that of the Cobalt area in the absence of any evidence of unconformity between the conglomerate and greywacké, and the overlying quartzite and arkose. The presence of a post-Huronian acid intrusive, as far as known, is also a distinguishing feature. But in other respects the two areas, from a geological standpoint, are practically identical. There are, however, some differences in the extent of the members comprising the various formations. Thus, while on the Quebec side of the lake quartz-porphyry,[1] or porphyrite, is an important Keewatin rock, on the Ontario side this occurs only in dikes; but in the case of the post-Huronian diabase, the conditions are reversed, these rocks being very prominent in Ontario, and of minor extent in Quebec.

The early history of the pre-Cambrian of the district, of which there is a distinct record, is largely that of a succession of igneous

[1] Report of Bureau of Mines, Pt. II, p. 42, 1905.

intrusions, with accompanying dynamic action, which resulted in the formation of schists and other metamorphic rocks. The oldest members of this complex consist of metamorphosed diabase, and related eruptives. Interfolded with these are jaspery or quartzose magnetite bands, which represent a sedimentary phase of the period. The eruption of the greenstones, and deposition of the iron formation beds, was followed by an extended intrusion of quartz porphyrite, dikes of which penetrated the older greenstones and iron formation rocks. It is thus possible to distinguish three divisions in the igneous-sedimentary series of rocks just described, although in the case of the older greenstones others no doubt exist. These rocks, which comprise the Keewatin formation, have been cut by a coarse biotite granite belonging to the Laurentian in age.

The intrusion of the Laurentian was followed by a long period of quiescence from eruptive activity, during which epigene forces were in active operation. The ordinary present day processes of erosion and decay were doubtless at work on the Keewatin-Laurentian rock surface at this time, the long-continued action of these destructive agencies resulting in the accumulation of large quantities of fragmental materials. The Huronian rocks were then deposited on this uneven and weathered floor in the general sequence, conglomerate, greywacké, quartzite, conglomerate, all in apparent conformable succession.

The formation of the Huronian clastics was followed by two successive igneous intrusions, the first of which consists of granite and the second of diabase, the latter being the equivalent of the rocks with which the silver-cobalt ores of Ontario are associated.

The post-Huronian intrusion concluded, as far as can be recognized, eruptive activity in the area; but widespread oscillations of a continental type, as well as more local differential movements, have occurred since that time. The climax of a downward movement was reached in the Palæozoic period when the whole area was submerged and a great thickness of sediments deposited, a remnant of which remains in the Silurian syncline of the north end of Lake Timiskaming. The denudation which took place prior to the transgression of the Palæozoic ocean was so tremendous that it is difficult to form an adequate estimate of the time which must have elapsed. It was sufficient for the carving down of an uneven, possibly mountainous country to the condition of a peneplain, and for the further erosion of such rocky excavations as the Timiskaming cañon, 1,000 feet deep.

On the retreat of the Palæozoic ocean, and the return to continental conditions, the work of surface degradation was resumed, and continued without interruption up to the time of the glacial epoch. The disintegrated materials accumulated during this long interval of decay were then swept from the surface by the advancing ice sheet, leaving it in the uneven, mammillated condition characteristic of the rocky portions of the region. On the retreat of the glacier the debris acquired during the more aggressive periods of its history was left behind, scattered over the rocky floor as gravel, sand and till. A large fresh-water lake then covered all the lower areas of the region, depositing the flats of stratified clay so prominent in the district. The deposition of these post-glacial clays concluded in the main the geological history of the area, the processes of erosion and decay having effected little change since that time.

Keewatin.

METAMORPHOSED GREENSTONES.

The oldest and most extensive subdivision of the Keewatin formation is an igneous complex of a number of altered intermediate to basic rocks, the exact original nature of which cannot always be determined, but to which the general name metamorphosed greenstones is applicable. They resemble one another in that they are all green in colour, have been greatly metamorphosed, are igneous in origin, and belong to the same very ancient period of eruptive activity, though they are not all of exactly the same age, since they are sometimes observed to cut one another.

These greenstones are found in five localities, which may be defined as the Baby, Duhamel, Rousselot Lake, Lac Clair, and Fabre areas.

The Baby greenstone consists in reality of two portions. The smaller one, occurring in the southern part of ranges IV and V, is cut off from the larger area by intruded quartz-porphyrite. This main area, which occupies nearly the whole of the northern part of the township, has its southern limit marked out by the quartz-porphyrite, the contact with which extends from the south end of Cameron lake to a point north of Kirwan lake, then southward around the south end of Long lake. On its western border the greenstone disappears beneath the clay, so that its extent in this direction can only be approximately determined from isolated exposures along the watercourses, where erosion has removed the overlying Pleistocene materials. The most westerly outcrops of the rock occur at a chute on Cameron creek, on lot 35, range VIII, Guigues, and on Rivière des Quinze from lot 57, range IX, of the same township. Ascending Rivière des Quinze, on lot 57, range IX, Guigues, the greenstones continue until the Maple rapids are reached, where they are followed by a gneissoid granite. The dividing line between the two rocks occurs on the north shore immediately above the rapids, from which point it crosses the river obliquely to the south-east, and maintains this direction for nearly a mile, when it turns southward, passing about midway between Long and Warne lakes. How far the Baby greenstone extends northward beyond Rivière des Quinze was not ascertained, being beyond the limit of our investigations.

The greenstone of Duhamel township consists entirely of a mass of serpentine rock, almost completely buried beneath the clay, and appearing on the surface merely as a succession of four small exposures, extending from lot 15 to lot 29, range VII.

The third greenstone area parallels the north shore of Rousselot lake. It may be roughly defined as extending, in a north and south direction, from lot 33 to lot 36, and in an easterly and westerly direction, from range III, to range VII, Laverlochère township. Two very small exposures of greenstone occur on lots 37 and 38, range VII, Laverlochère, which probably belong to the same rock mass, though the rock is not exposed in the intervening distance.

In the vicinity of Lac Clair, on range XIII of Laverlochère, the greenstone appears again. The rock here occurs in a belt nearly one and a quarter miles in width, extending eastward beyond the limits of the area examined. The southern border of the band skirts the north shore of Little Otter lake.

An area of Keewatin rocks occupies the central portions of lots 7, 8, 9 and 10, range VII, Fabre, the northern part of which is composed of the more basic member of the series—the greenstone, and the southern part of the acid type of eruptive—the porphyrite. Mining development work has been carried on here for the last two years, by the Jessie Fraser Copper Mining Company, the property being known locally as the Mitchell mine.

The greater part of the rocks comprising the metamorphosed greenstones have not only undergone the ordinary alterations which must necessarily have taken place in rocks of such antiquity, but have also undergone structural changes resulting from the mechanical stresses to which they have been subjected. Hence, while massive types of the rock sometimes occur, they more frequently show at least some trace of foliation. A peculiar variation in the greenstone was observed on the north shore of Rivière des Quinze, at the foot of the Cypress rapids. Large, augen-like aggregates of feldspars, showing a rough parallelism in their elongation, occur enclosed in a fine-grained, ophitic groundmass. The occurrence of this rock was observed by Mr. McOuat, who describes it as follows: 'There are also in many places numerous obscure lenticular masses of a feldspathic character, ... showing crystals of feldspar, and usually flakes and streaks of a dark green hornblende. The latter, as well as the whole mass, which may be from an inch to several feet long, and from a line to several inches in thickness, are parallel with the general bedding (foliation) of the rock.' Uralitic diabase or gabbro and hornblende schist, with a series of rocks of an intermediate type, comprise the mass of the greenstones. Serpentine rocks also occur to a limited extent.

The last-mentioned rock was observed to comprise five rock exposures, four of which form the Duhamel greenstone area, and the fifth a small, rocky point on the north shore of Rousselot lake. In the first locality the rock is a soft, dark-green, massive variety, which, under the microscope, is seen to be made up of fibrous serpentine through which is disseminated fragmental and dusty magnetite. In the second locality the serpentine is a light-green, granular rock, which, when microscopically examined, was found to consist of serpentine, magnetite, ilmenite, and leucoxene, the whole traversed by veinlets of calcite.

The diabase-gabbro-hornblende schist series of greenstones, which comprise the mass of the Keewatin basic eruptives, examined in section show very distinctly the successive stages in the paramorphic and metasomatic metamorphism to which the rocks have been subjected. The first step in the transformation of the rock is the alteration of the pyroxene to a strongly pleochroic hornblende, and of the plagioclase to saussurite. As the process of degradation continues, the hornblende becomes fibrous, frayed out at the margin, and altered to chlorite, while the alteration of the plagioclase becomes so complete that even the outline of the original feldspar disappears, the presence of epidote, sericite, and other decomposition products being the sole evidence of its former existence in the rock. Very often the plagioclase is fractured and broken, especially in those localities where dynamic action has been most intense. Secondary quartz and feldspar, calcite, pyrite, and ilmenite—the latter frequently enclosed in a border of leucoxene—are the other constituents most frequently observed in the rock. In those greenstones possessing a distinctly schistose structure an almost complete recrystallization appears to have taken place. The hornblende occurs in well defined rod-like fragments showing a distinctly parallel arrangement, the remainder of the section being filled with interlocking grains of secondary quartz, slightly elongated in the direction of parallelism. A few scattered fragments of magnetite occur in the section, being the only other mineral usually present.

The transition, which can be observed both microscopically and in the field between the more massive greenstones and the schists, leaves little doubt but that originally the two rocks were identical, consisting largely of diabase, with possibly some gabbro. While no doubt the metamorphism of the diabase was in part of a regional type, the close association of the schists with the borders of the intruded acidic rocks would indicate that contact action was an important transforming agency. Not only do the schistose rocks adjoin the intrusives, but the direction of their foliation is parallel to their margin. This is best exemplified along the greenstone-granite contact east of Long lake and above the Maple rapids on Rivière des Quinze.

The few small areas of serpentine which occur in the district appear to form quite a distinct rock from the other Keewatin basic eruptives. Their correlation with the greenstones is largely a matter of analogy, since they were never observed in actual contact with one another. Their metamorphosed character, however, together with the fact that similar rocks occur associated with the Keewatin schists in other localities, seemed to be sufficient basis for their classification with the Keewatin greenstones, though in what relationship to the other members of the group was not ascertained. The alteration which has taken place in the rock has been so complete that little evidence was obtained as to its original nature from its microscopic examination.

The Keewatin greenstones of the area are to a large extent intrusive, or if volcanic, they at least cooled under great pressure. They do not show any of the characteristics of effusive rocks, unless the occurrence of an ellipsoidal schistosity is to be considered as such. This feature resembles in some respects the ellipsoidal structure described in the Vermilion district of Minnesota, but differs from it in being less pronounced and much more regular. The structure is best shown in the Lac Clair greenstone area, the regular succession of ellipsoids giving the weathered surface a net-like appearance. It was also observed in the same locality, that the longer axes of the ellipsoids were parallel to the strike of the neighbouring iron formation. This peculiar foliation, unlike that of the Vermilion district, would appear most probably to have originated from the application of pressure to a rock possessing a columnar structure, though the shearing of a regularly jointed rock might produce the same result.

IRON FORMATION ROCKS.

The iron formation rocks of this region include two types of a somewhat different character, consisting of magnetite or siliceous magnetite, interbanded in one case with quartz and in the other with jasper (jaspilite). The former variety occurs in the vicinity of Lac Clair, and the latter crossing the portage from Rivière des Quinze to Kakake lake. Both of these ranges have a nearly vertical dip, and a strike corresponding to the foliation of the including greenstones.

The iron formation which occurs enfolded in the Lac Clair greenstone area consists of a number of outcrops, a few feet in length, appearing on the surface at intervals for a distance of over two miles. The maximum width of the exposure is about 30 feet, and the general strike N. 96° E. These iron-bearing rocks are very siliceous, and contain a considerable amount of iron pyrites. They have been greatly faulted and are cut by porphyry dikes. It is probable that the large quantities of iron oxide being deposited on the pebbles and boulders on the shores of Little Otter lake have been derived from this source.

The Kakake Lake jaspilite, being located on the portage route which follows Rivière des Quinze, was observed by Mr. W. McOuat when making his geological examination of that river. The following description of the occurrence is taken from his report:[1] 'It occurs in the form of layers, from the thickness of paper to about an inch, and is interlaminated with similar layers of a whitish, grey and dull-red fine-grained quartzite. The iron ore constitutes probably from one-fourth to one-third of the whole, and as the thickness of the whole band is about thirty feet, the total thickness of the layers of iron ore would probably not be less than eight feet. The band was traced along the strike for about one hundred yards.' The presence of jasper in this locality is due no doubt to slightly different local conditions, which caused red oxide of iron to be disseminated through the quartzose bands. The strike of this iron formation is N. 20° E., and the dip N. 70° E. $< 75°$.

In the Lac Clair district there are a number of elongated patches of conglomerate, included in the Keewatin, and which contain pebbles of greenstone and banded iron, evidently derived from the surrounding rocks. The exact geological position of these conglomerates is not at all apparent, though it would seem probable that they represent remnants of the basal member of the Huronian which at one time overlay the greenstone. This rock is possibly similar to the 'disturbed and squeezed conglomerates intimately related to the Keewatin,'[2] mentioned by Mr. Brock in his report on the Larder Lake district. There are some quartzite rocks included in the Keewatin greenstones which may possibly be of sedimentary origin. Examples of this occur a short distance south of the Head rapids on Rivière des Quinze, and on the south shore of the same river below the Cypress rapids.

QUARTZ PORPHYRITE.

The youngest member of the Keewatin igneous rocks, to which the name quartz porphyrite has been applied, has its largest extent in the southern part of Baby, and the adjoining portions of Guigues township. The rocks in this locality on the whole are but poorly exposed; more especially is this the case in the western and southern portions, where they are overlain by the post-glacial stratified clays. The northern boundary of the area is defined by the greenstone contact, which extends eastward from the southern end of Cameron lake. Like the older Keewatin eruptive farther north, it is cut off

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[1] Report of Progress, Geol. Surv. Can., 1872-73, pp. 131-2.
[2] Report of Bureau of Mines, Pt. I, p. 208.

on the east by granite, the junction occurring about one mile east of Robinson lake. The southern border of the porphyrite area, with the exception of the portion in ranges IV and V, Baby, which is intercepted by greenstone, is also in contact with granite. The junction between the porphyrite and greenstone occurs on lot 9, range IV, from which point the area of porphyrite extends southward, the most southerly exposure in Baby township being situated on lot 4, range III. There are no outcrops of granite or porphyrite in close proximity to one another in range II, Baby, but the dividing line between the two rocks probably occurs on lot 6, continuing westward across range I into Guigues township. A southerly extension of the porphyrite here occurs, reaching to lot 58, ranges VI and VII, Duhamel. The rock is not sufficiently exposed for its western border to be delimited, but its most westerly exposure occurs on the Otter river, on lot 13, range VII, Guigues.

Two other small areas of porphyrite were observed in the region, one of which occurs on lots 7, 8 and 9, range VII north, Fabre, comprising the southern part of the Mitchell mine, Keewatin area. The second of these areas is found on lots 7 and 8, range V south of the same township.

The Keewatin quartz porphyrite, unlike the older greenstones, has not been subjected to great mechanical deformation, although minerals of a secondary type have been abundantly developed in the rock. Macroscopically the porphyrite is usually variegated in colour and decidedly porphyritic. Blebs of blue quartz are distinctively characteristic of the rock wherever it occurs.

Examined under the microscope the quartz-porphyrite is found to consist of phenocrysts of quartz and plagioclase enclosed in a cryptocrystalline groundmass of which quartz and feldspar are the most prominent constituents, but also containing epidote, calcite, chlorite and other minerals. Determinations of the extinction angle, in sections at right angles to the brachy-pinacoid, show the plagioclase to be largely labradorite. A few crystals possess a zonal structure, as indicated by zonal extinction under crossed nicols. An abundance of microlitic inclusions of epidote and muscovite occurs disseminated through the feldspars, apparently the result of their incipient decomposition. The crystals of plagioclase are distinctly idiomorphic, though somewhat corroded on their margin; those of quartz are rounded and granular on the edge, with embayments of the groundmass running into them. The quartz is frequently broken, the fracture being filled with calcite and epidote. Aggregates of epidote, associated with chlorite, frequently occur in the section, suggesting the former presence in the rock of some ferromagnesian mineral. Ilmenite and leucoxene are occasionally observed to be present.

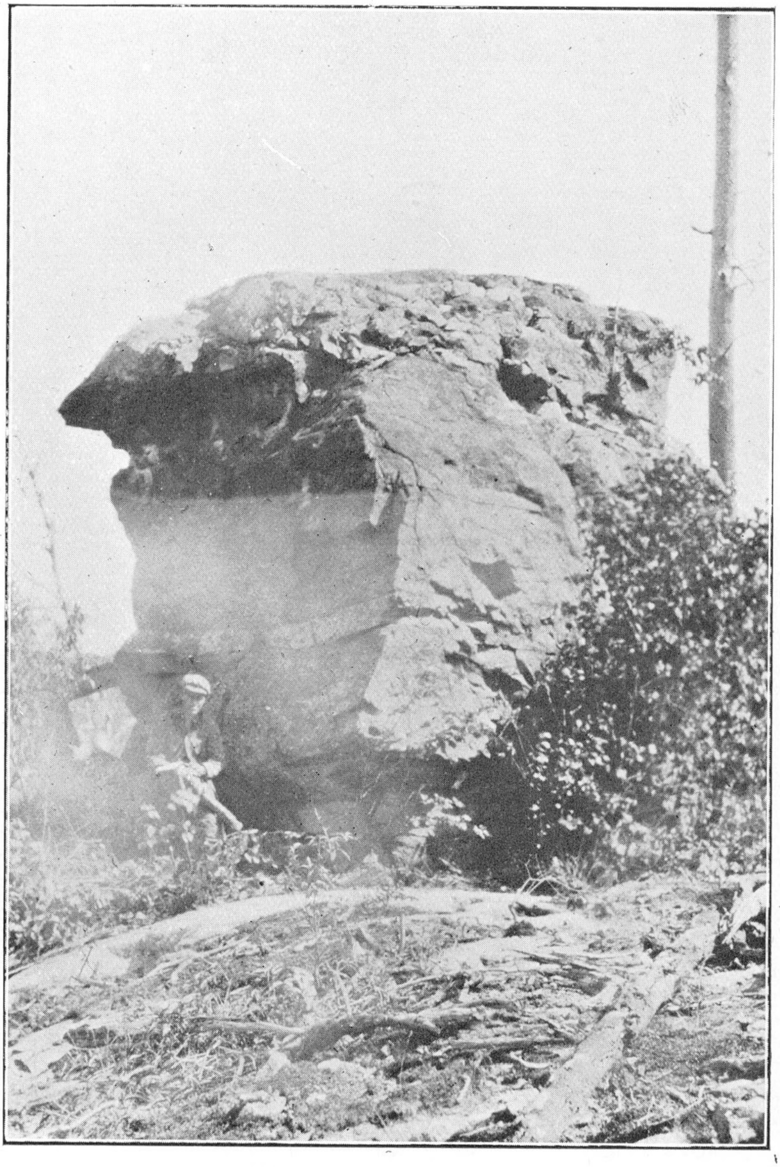
Along the borders of the quartz-porphyrite areas we sometimes find dikes penetrating the adjoining greenstones, which, while not porphyritic when examined microscopically, are found to be precisely similar to the groundmass of the porphyrite. In the absence of the structures characteristic of effusive rocks, it would thus seem probable that the quartz-porphyrite is intrusive, and that the large areas of the rock represent sills or laccolites rather than surface flows.

LAURENTIAN.

GRANITE AND GNEISS.

The acid igneous rocks, granite and gneiss, comprise nearly the whole of the eastern and southern portions of the area mapped. Commencing below the Head rapids on Rivière des Quinze, the western border of these rocks extends southeasterly for nearly a mile, then turns southward, passing from nearly midway between Long and Warne lakes to the eastern extremity of range V, Baby township. Between this point and Otter lake a westerly extension of granite occurs, occupying the whole of northern Laverlochère and reaching to range IV of Duhamel, where it disappears beneath the quartzite and arkose. It again emerges, however, on the shores of Baie des Pères in two small areas. From Otter lake the border extends in an almost straight southeasterly direction to lot 18, range I, Fabre. With the exception of the Lac Clair Keewatin area, and occasional dikes of intermediate to basic rocks, all the district to the east of this limit consists of granite and gneiss.

The rocks included in the area just outlined, however, are not all of the same age, as shown by their relationship to the Huronian. Several contacts, which have been described below, occur in Duhamel, northern Laverlochère and Fabre, where the granite is unconformably overlain by conglomerate or arkose. But in contrast with this, a contact was observed about two and a half miles southwest of Otter lake, where the granite is intruded into the Huronian. The Huronian is represented at the point of juncture by greywacké, large masses of which are included in the granite in the vicinity of the contact.



Glacial erratic of Laurentian gneiss, near Otter Lake.

The dividing line between the two rocks is fairly definite, the granite sending off small stringers into the greywacké along its margin. It may also be noted in this connexion that small areas of conglomerate occur, surrounded by the granite near its contact with the Huronian, east of Otter lake. While these may be remnants of a conglomerate laid down on the granite, in view of the relationship which exists farther west, it would seem more probable that they had been included in the granite by its intrusion.

We thus have in this area acid igneous intrusives of two ages, one of which, the post-Keewatin, is younger than the Keewatin, but antedates the Huronian, while the second, the post-Huronian, is younger than both the Keewatin and Huronian. In the absence of overlying Huronian it is not possible to distinguish the two varieties of the rock with sufficient certainty for mapping purposes; but since the granite which cuts the Huronian passes into and is apparently continuous with the banded gneiss which occurs so extensively in the southeastern part of the area mapped, it may be possible that all of this rock should be classed as post-Huronian. If this assumption were correct, the gneissic rocks, usually called Laurentian, in this area at least, would be of later age than the Huronian. For the purpose of petrographical description the granite found in Duhamel, northern Laverlochère, and southern Fabre, which is undoubtedly pre-Huronian in age, has been separated from the remaining areas of acid intrusives in which the banded gneiss predominates.

The rock belonging to the first class is a massive granite, usually coarse, sometimes porphyritic in texture, varying in colour from red to grey according to that of the feldspar, its dominant constituent. As found on the shores of Baie des Pères, this rock is a coarse, red variety, identical with the Lorrain granite—so designated by Professor Miller—which occurs directly opposite on the Ontario side of Lake Timiskaming. A ridge of granite porphyry extends along the line between ranges I and II, Laverlochère, from lot 30 to lot 38, which contains large pink crystals of orthoclase up to an inch in length, but elsewhere throughout this township the rock is a grey uniformly textured type. In southern Fabre it is finer grained and slightly gneissoid.

Examined in section, this rock is generally found to be a biotite granite, though hornblende is occasionally present. The feldspars consist of orthoclase, microcline and acid plagioclases, the microcline being usually the more abundant. The plagioclase is often clouded and altered to sericite and epidote. The biotite is never abundant, and is usually in the last stages of alteration to chlorite. Hornblende, when present, occurs in strongly pleochroic, idiomorphic individuals, which are also sometimes greatly chloritized. Calcite, scattered grains of magnetite, and wedge-shaped fragments of titanite, are frequently found in the section. The quartz is usually pink, slightly fractured and allotriomorphic. The microcline is much fresher than the other feldspars, and is evidently of secondary origin.

The prevailing rock in the second division of acid intrusives is a banded biotite or hornblende gneiss, but with which are associated areas of homogeneous granite, or gneissoid granite, varying in extent from a few feet to several miles. The alternating bands, which are sometimes definite, but more frequently merge into one another, are distinguished by variations in colour and composition, arising from differences in either the quantity or variety of their constituent minerals. They also vary in texture, sometimes consisting of pegmatite, or possessing lenticular feldspathic inclusions. Bands of hornblende gneiss up to several inches in width may alternate with those in which biotite is the dominating bisilicate; or bands in which biotite or hornblende are abundant may alternate with those in which lesser quantities of these minerals are present. The banded gneisses are sometimes interrupted abruptly by local areas of rock, consisting of granite similar in mineralogical composition to the bands, but cutting one another irregularly. At such points ball-like segregations of very basic gneiss a foot or more in diameter occasionally occur. In these areas, where the banded gneisses are replaced by a uniform gneiss or granite, the ferromagnesian constituents are usually found in aggregates, the foliation shown by the rock being due to a parallel arrangement of these nuclei. The strike and dip of the gneissic rocks are in general remarkably uniform, though many minor variations occur, the banded gneisses more especially being folded locally into dome-like and other plicated forms. The general direction of foliation is northeasterly, except in the vicinity of the upper part of Lac des Quinze, where it becomes northerly.

Of the division of acid intrusives which are largely foliated, the portions consisting of the banded type of gneiss are confined to either the southeastern part of the area or to the neighbourhood of the upper part of Lac des Quinze. Elsewhere the rock is either a uniform gneiss or a granite. It may be noted in attempting to point out the distribution of the varieties of these gneissic rocks, that

PLATE III.

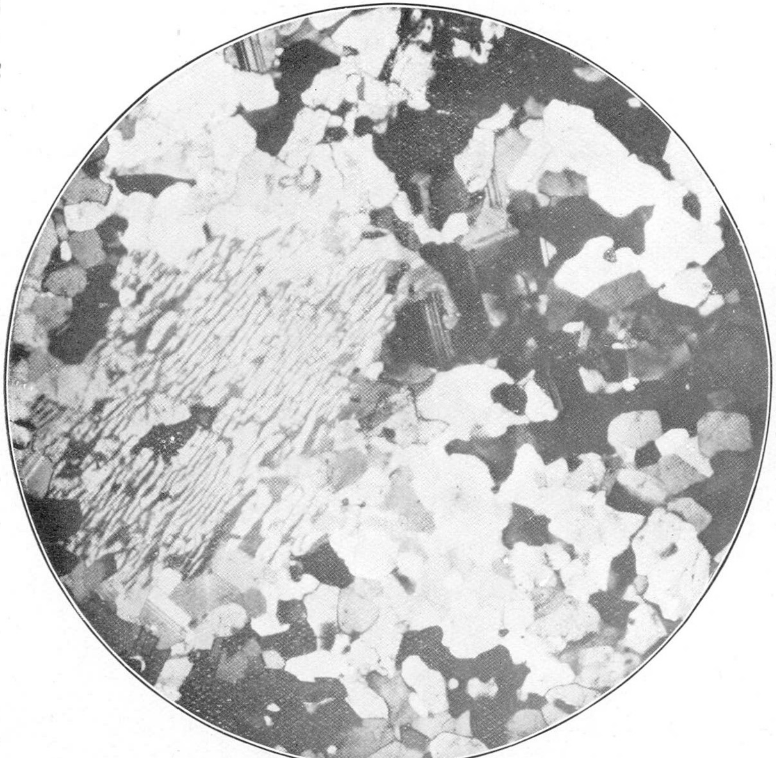


Fig. 1.—Granite associated with Gneiss from Shingwak Lake x 28.

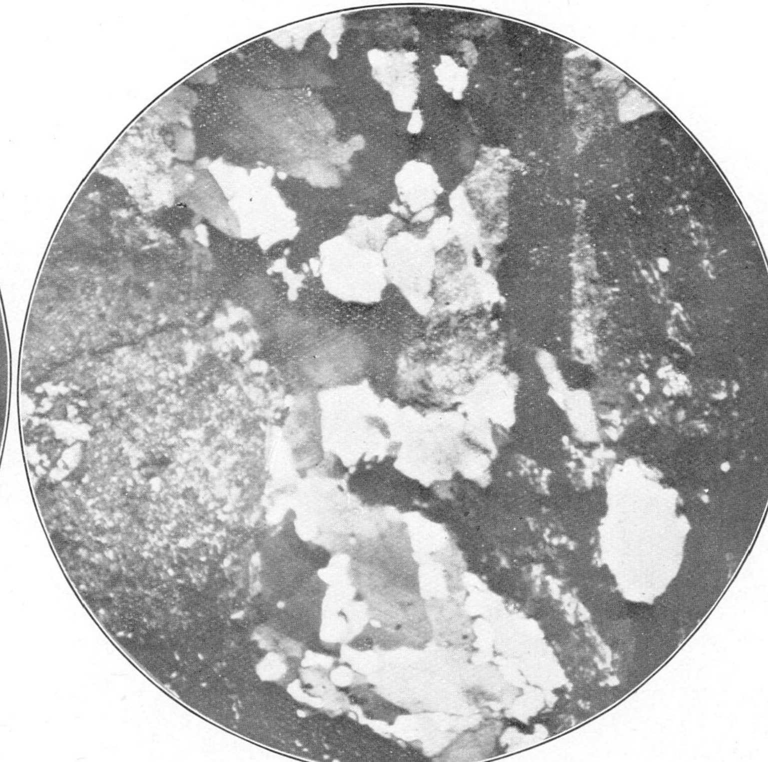


Fig. 2.—Altered Feldspar enclosed in fresh Quartz and Orthoclase, Lac des Quinze x 28.

there usually appears to be a transition from banded gneiss through the unbanded type to massive granite, whenever it occurs adjoining the Keewatin formations.

When examined microscopically these rocks are generally found to conform in mineralogical composition to some variety of granite or its foliated equivalent gneiss, although in a few localities the hornblendic varieties are found to approach that of a syenite, or even that of a diorite. The chief minerals present in the rock, in addition to quartz and feldspar, are biotite, epidote, hornblende and muscovite, the particular variety of granite or gneiss being determined by the relative abundance of one or more of these constituents.

By far the most widespread type of rock comprising these acid intrusives may be described as a biotite granite or gneiss. Examined microscopically, the rock is found to contain an abundance of quartz, usually fresh and free from inclusions, and often forming a mosaic of interlocking grains. Sometimes a whole section is largely made up of such a mosaic of quartz and feldspar, while at other times large feldspar aggregates, usually in various stages of decomposition, are enclosed in a matrix of fresh granular quartz or of quartz and feldspar. Micropogmatitic intergrowths of quartz and orthoclase sometimes occur in sections of this granular type.

In those feldspars in which decomposition has set in, the alteration products are found to consist of sericite and epidote, the transformation usually proceeding along the cleavage lines. Orthoclase is the dominating feldspar, although the more acid plagioclases frequently occur. Microcline is often present, and appears to replace the orthoclase where dynamic action has been more intense. The biotite present in the rock occurs, as a rule, in elongated, strongly pleochroic fragments, usually fresh but sometimes altered, either completely or in part, to fibrous, green chlorite. In addition to the biotite the mineral epidote is generally prominent, not only as a decomposition product, but also as an original constituent of the rock. It usually occurs in well defined fresh, pleochroic, idiomorphic fragments, associated with and sometimes completely enclosed in biotite. In many sections cavities in the mineral, as well as inlets along its border, have been filled with quartz. Cleavage parallel, 001 (0P), while not frequent, as a rule, is very distinctly shown in the epidote individuals. Kernel-like or wedge-shaped fragments of sphene are frequently present in the rock, exhibiting the high relief and interference colours characteristic of the mineral. Calcite is also abundant as an interstitial and cavity filling constituent. Other accessory minerals observed to occur are apatite and zircon as microlitic inclusions in the feldspar, garnet, magnetite, pyrite and hematite.

Outside of an area near the north end of Morin lake, muscovite is not a very prominent constituent of the foliated granitic rocks. In the Morin Lake occurrence the mineral is chiefly developed along cleavage lines traversing the gneiss. The mineral constituents of the rock, with the exception of the change in the variety of mica present, do not differ essentially from those found in the biotite gneisses of the region.

In contradistinction to the biotite gneisses or granite, a variety frequently occurs in which hornblende is the dominant coloured constituent. This mineral occurs in large, strongly pleochroic, well defined fragments, idiomorphic to the feldspar and quartz surrounding it. The rock contains, like the biotite granite and gneiss, considerable quantities of epidote, associated in this case with hornblende. The accessory minerals present are the same as in the other varieties of gneiss, although the quantity of titanite and plagioclase is rather more abundant.

In occasional localities the hornblende granite, or gneiss, is found to pass into a syenite, or even to approach a diorite in composition, by the loss of its quartz and alkali feldspar. This type of rock is exemplified by a pink, slightly gneissoid syenite, occurring on the shore of Lac des Quinze to the south of its outlet. This contains the usual minerals of a more basic type—hornblende, epidote and sphene—a little orthoclase, and an abundance of microcline and plagioclase, but no quartz.

Some other rocks of a basic character were observed associated with the granite and gneiss, on the south arm of Lac des Quinze, near its junction with the main body of the lake. The rock consists of aggregates of hornblende, or of hornblende and biotite, enclosed in feldspar, partially decomposed to saussurite. Occasionally distinct crystals of hornblende can be observed in the section. Sphene, epidote, calcite and magnetite are usually present, and sometimes a few fragments of interstitial quartz occur. In some localities the rock possesses a porphyritic appearance, due to the presence of the dark hornblende aggregates surrounded by a light-coloured feldspathic matrix, while at other times, where the feldspar is less prominent, it becomes uniform and basic in appearance. The relationship of this rock to the granite in its southern border would suggest that it had been enfoliated in the gneissic rocks. On the west shore of the lake it is cut by granite dikes, while on the east shore it has been broken up into a breccia, the matrix of the rock consisting of granite.

Although both the Keewatin and the granitic rocks occur very extensively in this area, contacts between the two are rarely exposed. The granite and the quartz porphyrite were never observed adjoining one another, although exposures of the two rocks were observed in close proximity. The relationship of the granite to the Keewatin diabase and schist is best shown along the northern border of the Rousselot Lake greenstone area. The junction between the rocks was seen at two points, one along the line between ranges IV and V, and the other along that between ranges III and IV. In the former locality the dividing line is exceedingly definite, with dikes of the granite penetrating the adjoining greenstones; in the second the contact is of a transitional type. The effect of the dynamic action on the granite near the point of transition was well shown in a section examined. The feldspars showed wandering extinction and were much broken, the quartz had become granulated, and the biotite was bent and frayed out at the margin. Calcite and pyrite were present in abundance.

Huronian.

The Huronian formation, as found in the district adjoining the east side of Lake Timiskaming, is composed of the usual series of fragmental rocks, following one another in regular and conformable succession. The basal member of the formation is usually a conglomerate, containing pebbles and boulders of granite, diabase, quartz-porphyrite, and other eruptives, enclosed in a matrix of varying texture and composition, the latter depending, in part at least, on the character of the adjacent underlying rock. The basal conglomerate, as a rule, passes upward into greywacké by the gradual loss of its pebbles and boulders, the greywacké in its turn being replaced by quartzite or arkose. This last mentioned rock is followed in a few local areas by an upper coarse conglomerate. While the above sequence is that found in the most typical sections, it is not always so complete. Patches of arkose, or of greywacké, are sometimes found included in the conglomerate. Occasionally the greywacké is entirely wanting, the conglomerate passing into quartzite; or we may have arkose resting directly on granite, without the presence of the intervening conglomerate or greywacké. For mapping purposes the conglomerate and greywacké have been separated from the remaining upper part of the series, the intimate and varying association of these rocks making any further subdivision impracticable. On the whole these rocks have not been greatly disturbed, usually occurring in gentle undulations, with a dip rarely exceeding 20°.

The relationship of the Huronian clastics to the various older rocks of the district is such as to indicate that they were deposited on a greatly decayed surface, such as may now be observed in some of the non-glaciated regions of the earth. Actual contacts between the conglomerate and the Keewatin greenstones were never observed, although exposures of the two rocks are sometimes found within a few feet of one another. The quartz-porphyrite and the conglomerate, however, were found adjoining one another in at least two localities.

On the point which occurs at the south end of Cameron lake, on lot 30, range II, Laverlochère, a small area of conglomerate occurs overlying the quartz-porphyrite. Pebbles and boulders of the latter are enclosed in a base, which in places can scarcely be distinguished from the included fragments, the whole of the conglomerate having evidently been formed by the decomposition of the rock surface beneath. A very similar association of the two rocks occurs on lot 5, range IX, Guigues. Here, as on Cameron lake, the base of the conglomerate consists wholly of debris derived from the porphyrite; but, as we get farther away from the Keewatin eruptive, fragments of other rocks appear, the pebbles and boulders also become better defined and less angular, and the coarse, dark-green cementing material becomes finer grained and more uniform.

The contacts between the Huronian and the older granites exhibit this transitional relationship in a still more striking manner. A very detailed description of one of these, occurring on the south shore of Baie des Pères, has been given by Dr. Barlow, in which he points out the various stages in the disintegration of the granite, and the resultant formation of the overlying arkose. In the northern part of range IX, Duhamel, a similar degradation of the granite surface is shown in a section over 200 feet in thickness, consisting of boulders and fragments of granite enclosed in an arkose matrix.

In this locality the feldspar of the underlying rock is white in colour, and has not undergone the sericitic decomposition to such an extent as that on the lake shore, in consequence of which there is so little contrast between the two rocks that the line of junction cannot be fixed within a wide latitude. The slight mechanical action to which the disintegrated granitic material has been subjected also makes it exceedingly difficult to distinguish the matrix from the enclosed fragmental masses.

Junctions between granite and conglomerate of a transitional type were observed in two other localities in the region, namely, on the shore of Lake Timiskaming opposite Drunken island, and at the east end of lot 30, range I, Laverlochère. In the first locality the granite surface is covered by a thin layer of arkose, followed immediately by conglomerate, containing the usual pebbles of granite, diabase and other eruptives, enclosed in a reddish matrix. In the second locality the rocks are associated in the usual transitional way, the base of the conglomerate being composed of closely compacted pebbles and boulders of the underlying granite porphyry. This fact, in view of the very limited extent of this porphyrite variation in the granite, would indicate the extremely local origin of the conglomerate.

A contact between the Huronian conglomerate and the granite was observed, however, on the shore of Lake Timiskaming, on lot 18, range I, Fabre, which is of a very different type to those so far described. The junction between the two rocks is not transitional, but very definite. In this case the conglomerate has evidently not been derived from the granite by its disintegration in situ, but obtained its material, to a large extent at least, from foreign sources. The few feet of the contact exposed do not permit of an extended examination; but the way in which the conglomerate fills in the hollows in the granite surface, the close resemblance between the border of the granite and an eroded surface, and the absence of any evidence of metamorphism in the conglomerate, seems to prove that the granite is unconformably overlain by the Huronian. The junction at this point is no doubt a continuation of that occurring on the west side of the lake, some distance farther south, which Dr. Barlow describes as follows: 'The line of contact in the immediate vicinity of the lake runs in a general direction S. 75° W., but this line is not perfectly straight, as the granite has a somewhat sinuous edge, which is followed very faithfully by similar irregularities in the schistose structure of the breccia-conglomerate. It is quite evident from an inspection of the coarser fragments that they have not been derived from the disintegration of the gneissic rocks with which these clastics were in contact, for the minerals composing them are much coarser in their method of crystallization, and of a deeper red colour, resembling closely in these particulars the granite exposed on both shores of the lake to the north of Old Fort Narrows.'[1]

CONGLOMERATE AND GREYWACKÉ.

The Huronian conglomerate and greywacké, while not usually occurring in extensive areas, are widely distributed in the region, either in small isolated outcrops, or as narrow bands at the base of quartzite ridges. The latter type of occurrence is best exemplified in the cross sections of Huronian rocks to be found on the shores of Lake Timiskaming, as on the south side of Lavallée bay or of Joanne bay. The largest exposed area of these rocks is that occupying the southwestern part of Laverlochère township, extending from Otter lake to range I, and from Rousselot lake to range VII of Fabre township. There are some portions of this area which might be more properly mapped as arkose; but their intimate association with the conglomerate or greywacké, and their limited extent, did not permit of their separation. From the number of outcrops of conglomerate and greywacké occurring along the watercourses in the clay-covered areas, it is probable that a large proportion of the clay flats are underlain by Huronian, and that the exposed portions form only a small part of the area of these rocks actually present in the region.

The Huronian basal conglomerate, sometimes referred to as slate conglomerate, chlorite slate conglomerate, or breccia-conglomerate, is a massive rock, as found in the region in question, exceedingly variable both as regards its included fragments and the finer-grained material enclosing them. On the weathered surface the rock is usually white, grey or greenish-grey in colour, the greenish shade being particularly noticeable where the rock is not freely exposed to the atmosphere.

All the pre-Huronian rocks of the region are represented among the pebbles and boulders of the conglomerate; but, as indicated by

[1] Annual Report Geol. Surv. Can., Vol. X, p. 189 I.

the majority of the contacts described above, their relative abundance is largely controlled by the variety of rock lying immediately beneath. Granite is by far the most frequent of the included fragments; but diabase, quartz-porphyrite, green schist, jasper and quartz are also present. Although these are sometimes angular or subangular in outline, especially so in the transitional contact zones, on the whole they are moderately well rounded, exhibiting all the characteristics of water-worn littoral or possibly fluvitile debris. The included fragments are usually numerous, and are frequently so closely compacted as to leave little room for interstitial material. They vary in size from pebbles to boulders two or three feet in diameter.

The detrital material forming the matrix of the rock, as the name slate conglomerate would imply, most frequently has a greenish slate-like appearance, which, when examined microscopically, is found to consist of fragments of quartz and feldspar, included in a groundmass, consisting largely of chlorite, sericite, and epidote. There are, however, a number of localities in which the enclosing material is comparable to an arkose or feldspathic quartzite in composition, consisting almost wholly of coarse, angular fragments of feldspar and quartz.

As the basal conglomerate is followed upward, the pebbles and boulders generally disappear, the rock becoming greywacké, which is identical in composition with the finer-grained, slaty matrix of the conglomerate. Under the microscope the rock consists of grains and irregular fragments of quartz, orthoclase, microcline, and plagioclase, embedded in a groundmass, chiefly composed of chlorite and sericite, though epidote, leucoxene, hematite, magnetite, ilmenite and tourmaline were also observed in some sections. Sir Wm. Logan in describing his chlorite slates, the equivalent of what we have termed greywacké, states 'that sometimes the rock has a semblance of porphyry, appearing to contain opaque white crystals of feldspar; but these are more probably small angular fragments of the mineral.'[1] This property of the rock can be observed on Drunken island and on the greywacké ridge which forms the southern boundary of the valley of the Little river. It was in the former locality, no doubt, that Sir Wm. Logan made his observations. A similar pseudo-porphyritic rock occurs at Wright mine, in association with the ore

[1] Report of Progress, Geol. Surv. Can., 1845-6, p. 67.

deposit, but in this case grains of quartz are also present. Although the greywacké as a rule is structureless, massive rock, it sometimes occurs, in local areas more especially, either in association with conglomerate or near its contact with the overlying quartzite, well stratified and delicately banded in various shades of green and red.

QUARTZITE, ARKOSE, AND CONGLOMERATE.

The quartzite, arkose, and conglomerate, the topmost members of the Huronian series, while by far the most extensive of the Huronian rocks in the region, are practically confined to the townships adjoining the east side of Lake Timiskaming. With the exception of the small bands of conglomerate, greywacké or granite occurring at the base of the hills or ridges, all of the rock exposed in the southwestern part of Guigues, the whole of Duhamel, and the northern part of Fabre, consists of arkose or quartzite.

The association of these rocks with the conglomerate and greywacké is worthy of note, because of the unconformable relationship between the two parts of the series described by Prof. Miller as occurring on lot 4, in concession XII of Lorrain, on the basis of which he has classed the arkose and quartzite as middle Huronian. The gradual transition of the conglomerate and greywacké upward into quartzite can be observed on the south shore of Lavallée bay, on a point to the south of Joanne bay, on the shore of the bay to the north of Wright mine, and on the slope of the ridge which parallels the Quinze road across ranges IV and V, Duhamel. In all of these localities the underlying rock passes into quartzite by the gradual introduction of the coarser quartzose grains, without the slightest evidence of a structural break.

Where this upper portion of the Huronian occurs in direct contact with pre-Huronian granite, the rock is a typical arkose; but in those portions more remote from the granite, upon which katamorphic agencies have been at work, it becomes a quartzite. Between these two extremes all gradations exist, the predominating type of rock being a feldspathic quartzite. In ranges V and VII of the township of Fabre, some areas of quartzite occur which are overlain by conglomerate not unlike some of the coarser phases of the basal member of the series. There are also some localities, very numerous in the vicinity of Ville Marie, where

PLATE IV.

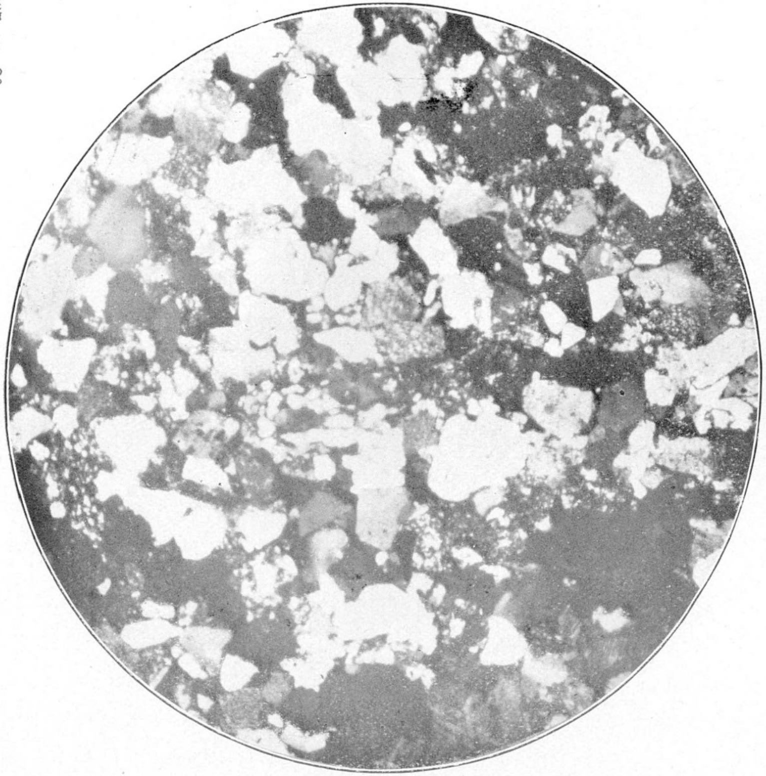


Fig. 1.—Feldspathic Quartzite near Otter Lake x 28.

Fig. 2.—Reaction rims in Olivine Diabase, Blueberry Island, Lake Kipawa x 28.

6487—p. 30.

the quartzite contains bands of well rounded pebbles of jasper and quartz, forming a rock somewhat similar to the jasper conglomerate of the north shore of Lake Huron, but distinguished from it by its granular and less massive groundmass. These rocks usually show some trace of stratification, and occasionally, near their contact with the underlying greywacké, are very perfectly bedded. Examined microscopically, sections of the rock are found to consist of a mosaic of rather angular grains of quartz, plagioclase, orthoclase and microcline, the feldspars being in various stages of alteration to sericite and epidote. The interstitial material is usually limited in quantity, and apparently derived to a large extent from feldspathic decomposition, though small quantities of minerals from other sources, such as chlorite, magnetite, hematite and pyrite occur.

ORIGIN OF THE HURONIAN ROCKS.

From an examination of the Huronian clastics, it would seem quite probable that the underlying basement had been the source of all the materials of which they are composed. If such be the case, we must then consider the whole formation as a series of sediments, deposited upon an uneven and greatly decayed surface, the unusual thickness and extent of the conglomerate being due to the immense amount of fragmental material which had accumulated, and to the disintegrated condition of the rock surface. The transition which occurs from granite through arkose to quartzite, and the frequent and undoubted bedding planes which occur in the quartzite, seems to prove that the upper portion of the formation originated in this way; but the mode of origin of the conglomerate and greywacké is not so evident, as might be indicated by the differing opinions expressed on the subject by various authorities. These rocks have been described as volcanic breccias, as sediments, or combinations of the two, and quite recently Professor Coleman has presented arguments in favour of their glacial origin.[1] As regards the conglomerate and greywacké, as they occur on the east side of Lake Timiskaming, there seems to be little basis for the volcanic hypothesis. The most typical breccia conglomerate occurs at those points where the enclosed fragments can be directly connected with the adjacent underlying rocks. Nowhere were included fragments observed which might be described as bombs, scoriae or other materials resulting from vol-

[1] Journal of Geo., Vol. XVI, 1908, p. 149.

canic activities of an explosive type, nor do any effusive rocks occur in the district such as would probably accompany such an extended eruption. There does not appear to be any conclusive evidence, in the area in question, whether the conglomerate and greywacké on the whole represent water-laid sediments or a tillite, deposited during a glacial epoch, as advocated by Professor Coleman. The contacts between the Huronian and the older eruptives, however, with but one exception, show that the basal portion of the conglomerate originated by the degradation in situ of the underlying rock surface, and hence this part at least has not been glacially deposited. As to the remainder of the conglomerate and the greywacké, there is no definite evidence of extended sedimentation, although local areas of well stratified greywacké, often intimately associated with the conglomerate, are of frequent occurrence. It is nevertheless worthy of note that the remarkably uniform gradation from conglomerate upward into greywacké, not only in this area but elsewhere throughout the Huronian of the Timiskaming district, is characteristic of sedimentation following a widespread submergence rather than glacial deposition, interrupted by several interglacial periods.

DIABASE AND GABBRO.

If the few outcrops of diabase occurring in the township of Fabre, which probably form part of an intruded sheet or sill, be excepted, the post-Huronian diabase or gabbro is represented on the east side of Lake Timiskaming by merely a few dikes, the largest of which does not exceed a third of a mile in width. These occur most frequently cutting the granite and gneiss, their contacts with the adjoining rock being always very sharply defined. They are usually coarse in the centre, becoming fine-grained and trap-like on the border.

One of the largest of these dikes was observed crossing the north end of Blueberry island in Lake Kipawa. Macroscopically this is a porphyritic rock consisting of large phenocrysts of very dark labradorite enclosed in a dark-grey ophitic groundmass. On the weathered surface, the fine-grained matrix enclosing the labradorite crystals becomes a rusty-brown colour, while the phenocrysts show up white or pink. Examined under the microscope, the rock was found to consist essentially of olivine, plagioclase and augite, and hence may be described as a porphyritic, olivine diabase. The plagioclase, though very fresh in appearance, is clouded with a fine brown dust, the composition of which was not determined. The ophitic structure is well shown in the thin section, the feldspar occurring in lath-like idiomorphic crystals. From determinations of the extinction angle in sections at right angles to the albite twinning plane, the plagioclase was found to be labradorite. This mineral exhibits not only the usual albite twinning, but also the pericline, and occasionally the carlsbad law. The augite is abundant, occurring in well defined light-brown, slightly pleochroic fragments, showing very distinctly the cleavage characteristic of the mineral. The olivine occurs in round or oval fragments, which in section appear almost colourless. The mineral is always fresh, but wherever it adjoins the labradorite it is bordered by a double zone of reaction products, the outer of which consists of light-green hornblende, and the inner of colourless pyroxene. Both of these zones, where examined under crossed nicols, show a distinct radial arrangement from the olivine centre outward. The outer hornblende zone is usually fibrous, but occasionally shows the prismatic cleavage of the amphibole group, while the pyroxene, on the other hand, possesses the rectangular cleavage which characterizes that mineral. This phenomena is precisely similar to the reaction series described by Adams,[1] Williams[2] and a number of other authorities. Fragments of ilmenite are very numerous throughout the section, usually associated with the olivine, and always enclosed in a border of deep-brown, strongly pleochroic mica, resulting apparently from the interaction of the olivine, plagioclase and ilmenite. A few hexagonal and rod-like crystals of apatite also occur scattered throughout the feldspars. The order of crystallization is very clearly indicated in sections of this rock. The olivine and ilmenite were the first minerals to crystallize, the ilmenite being generally included in the olivine, which always presents a round or elliptical form. The labradorite crystals were then formed, followed by augite, which filled in the remaining interstitial portions of the rock. A reaction seems to have gone on around the border of the olivine during the crystallization of the feldspar, forming the double zone of pyroxene and hornblende, when olivine alone was present, but when in association with ilmenite, resulting in a more basic ferro-magnesian mineral, probably lepidomelane. The augite, on the other hand, whenever it occurs adjoining either the plagioclase or the olivine, presents a very

[1] Am. Nat., 1885.
[2] Am. Jour. of Sc., 1886.

definite boundary, conforming to the outline of these minerals, being concave when in contact with the olivine, and straight in the case of the plagioclase.

All the diabase dikes observed in the area, with the exception of that of olivine diabase just described, have a general northerly and southerly direction. This fact, together with the similarity in the rock itself, would indicate a common origin for the whole series. They are composed of a grey or greenish-grey rock, with a more or less distinctly diabasic structure. Microscopically the rock is found to contain an abundance of the usual idiomorphic plagioclase, showing twinning according to the albite, or albite and pericline laws combined. The mineral is usually fresh, but occasionally the incipient stages of saussuritic alteration are to be observed. Granophyric intergrowths of orthoclase and quartz sometimes occur, filling in the interspaces between the other minerals. The augite is sometimes twinned, and is usually characterized by the basal and prismatic cleavage of the proxene group. Its boundaries are well defined and allotriomorphic, it being one of the last minerals generated. Biotite, pyrite and magnetite were also found in many of the sections, while calcite and epidote were occasionally observed.

These dikes occur widely distributed, though usually not exposed for any great distance. One of the longest observed occurs about one mile east of the outlet of Lac des Quinze, extending in a north and south direction across the lake, and then fringing the east shore of the lake for nearly two miles. This dike is paralleled by a number of others crossing the islands in the head rapids of Rivière des Quinze. Another of these dikes that might be mentioned is that extending in a northeasterly direction from the north end of Otter lake, and reaching to lot 13, range XI, Laverlochère.

The diabase, which occurs in the township of Fabre, is so poorly exposed that it is difficult to determine its actual extent, or to gather any evidence as to its relationship to the other rocks in its vicinity. Its examination is further obscured by the great amount of chemical alteration and mechanical deformation which has taken place in the rock, so that even the freshest specimens obtainable are for the most part a mass of decomposition products.

While it is quite probable that all the Fabre diabase forms part of one intrusive sheet, it occurs in two separate areas, one on the lake shore in the vicinity of Lavallée bay, and the other about two miles farther inland. The Lavallée Bay area comprises the rocky

PLATE V.

Fig. 1.—Diabase near Fabre Wharf x 28.

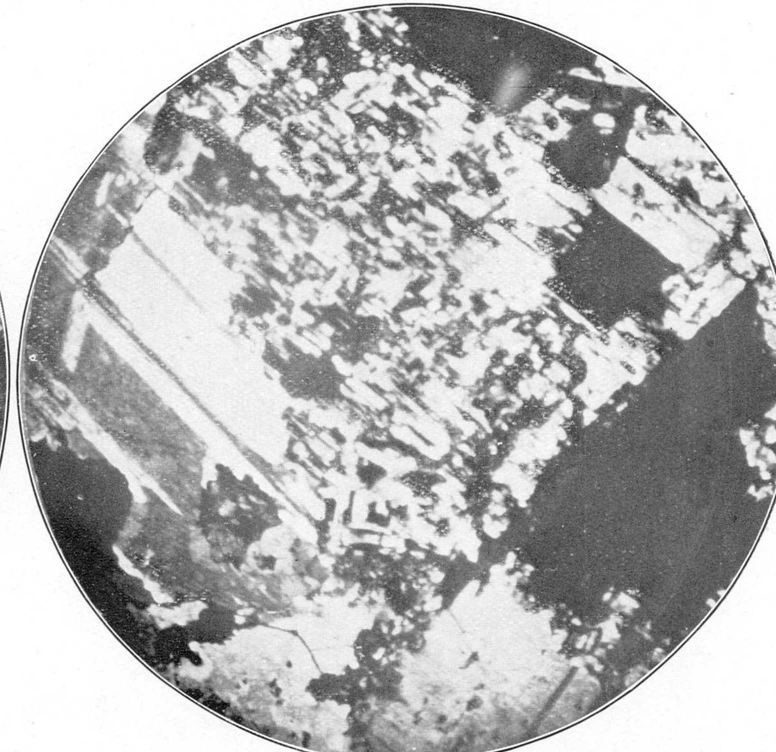


Fig. 2.—Intergrowth of Feldspars in Diabase, Fabre township x 28.

knob which occurs at Fabre wharf, and the rugged outcrops which form Quinn point a short distance farther north. The exposures of this rock in the interior part of the township form a triangular area, the western border of which extends from the middle of lot 20, range III, Fabre, northward to the western extremity of lot 34, range IV. Its northern limit extends eastward from the last-mentioned point across the south end of range V north, meeting the granite just outside the surveyed ranges. Its southeastern boundary is delimited by its junction with the granite, which maintains a general southwesterly direction, crossing the line between ranges V south, and VI south, on lot 11, and that between VI and VII south, on lot 3, range IV.

The Fabre diabase is a greenish-grey rock, presenting in some localities the appearance of a fine-grained diabase, but in others resembling a coarse diorite. In the coarser dioritic varieties an abundance of fragments of fibrous hornblende derived from the alteration of the augite is very characteristic of the rusty weathered surface. The rock is so greatly decomposed that its microscopic examination is very unsatisfactory. Plagioclase is always abundant, but is frequently completely altered, the idiomorphic outline of the mineral, however, being usually apparent. Peculiar intergrowths of orthoclase and plagioclase are sometimes present in the rock, as well as micropegmatitic intergrowths of quartz and feldspar, Throughout the greater part of the sections examined the alteration of the augite to hornblende was nearly complete, the uralitic product presenting a fibrous or a minutely columnar structure. Calcite, ilmenite and pyrite are the other constituents of the rock, the iron ores being usually abundant. The ilmenite is often altered to leucoxene in lamellar parallel rhombohedral lines, resulting in a gridiron structure.

As far as can be learned from its field relationships, the Fabre diabase is post-Huronian in age, although the evidence is not as conclusive as might be desired. The outcrops of conglomerate and greywacké which occur in its vicinity have been greatly tilted and metamorphosed, the pebbles of the conglomerate being elongated and a distinct foliation imparted to the greywacké, parallel to the diabase margin. On its eastern limit the rock is in contact with the granite border of the gneissic rocks, but the junction where exposed is of such a transitional character that no evidence has been obtained as to whether the two rocks are contemporaneous in age or one intrusive through the other. A section of the intermediate type of rock was found to contain a considerable amount of rather fresh quartz, but otherwise showed no evidence of dynamic action.

Silurian.

CLINTON AND NIAGARA.

The Silurian syncline which occupies the north end of the Timiskaming depression, by reason of its isolated position and abundant fossil fauna, has attracted the attention of geologists for a number of years. It was described by Sir Wm. Logan, first in 1845, then more fully in the Geology of Canada in 1863. The names of thirteen species collected from the outlier and identified by Mr. E. Billings are mentioned in the latter publication. Additional collections of fossils made by Dr. Bell in 1887, and by Dr. Barlow in 1892-4, were identified by Dr. Ami and Mr. L. M. Lambe. From the determination of these fossils, Dr. Ami placed the rock in the Clinton or Niagara, the species being for the most part forms referable to the Niagara, although a number occur which belong to rocks assigned to the Clinton formation. He also points out the similarity in fossil fauna of this area with the Silurian of Lake Huron rather than with that of the Hudson Bay and Winnipeg basins.

The rock comprising this Silurian outlier is a limestone, usually fine-grained but becoming coarse and fragmental near its junction with the adjacent underlying rock. It is found on the east side of Lake Timiskaming merely as small, basal remnants fringing the lake shore. Thus, on the shore opposite Bryson island, to the north of Joanne bay, and in the bay to the north of Wright mine, small patches of an arenaceous well-bedded limestone occur, dipping from 5° to 10° to the southwest. The shore of the lake between Piché point and Chief island is bordered by a fringe of conglomerate and sandstone, the sandstone forming a sort of terrace along the high-water margin of the lake. Between this and the water's edge the rock consists of fragments and hummocks of the quartzite floor enclosed in a calcareous matrix, in which some fragmental fossil remains are present. At the east end of lot 19, range II, Guigues, a small outcrop of calcareous, non-fossiliferous sandstone is exposed, dipping 5° in a southwesterly direction. The occurrence of this outlier so far inland and nearly 150 feet above the level of Lake Timiskaming, would indicate that the Silurian had been originally very much more extensive in the area than at present.

PLATE VI.

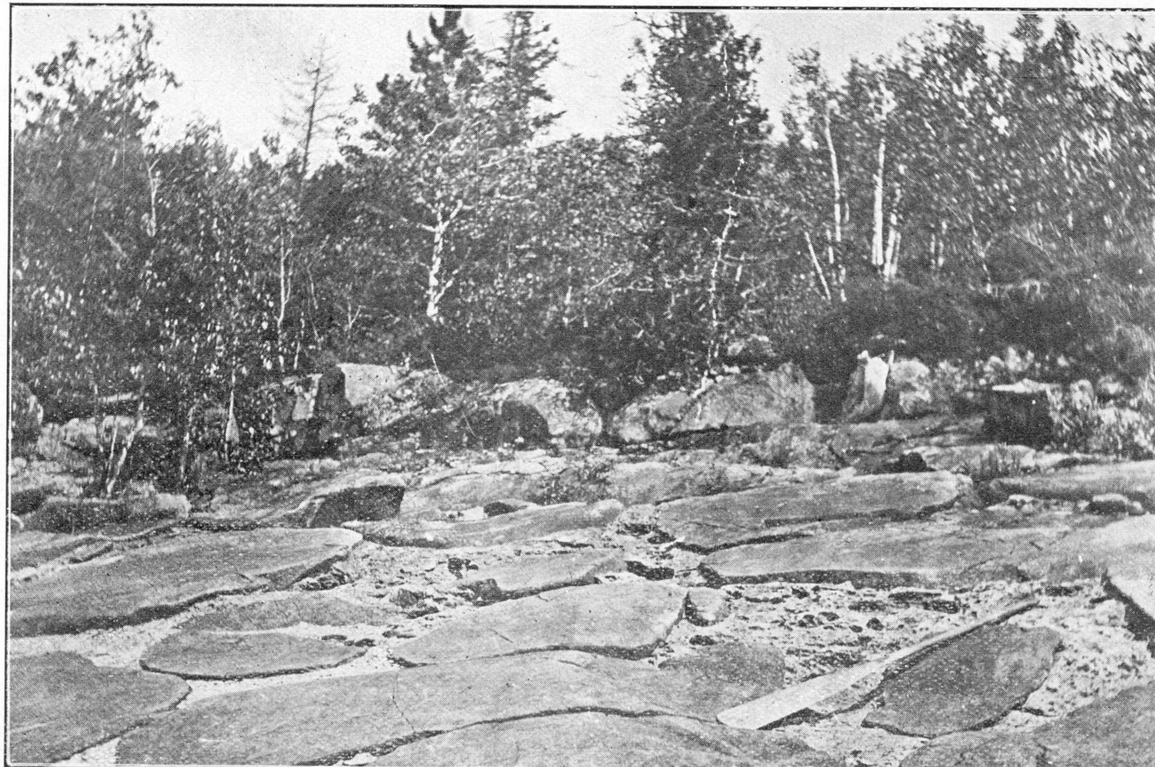


Photo by W. G. Miller.

Contact of Silurian Limestone and Huronian quartzite, near Piché Point.

Pleistocene.

The pleistocene deposits of the area east of Lake Timiskaming are very closely related to the work of the glacial ice sheet. The material dropped by the glacier is found, to a large extent, scattered irregularly over the surface, without assuming many of the forms characteristic of glacial deposition, although a few ridges of gravel and sand occur, which probably represent terminal moraines, two of the best examples of these being the ridges east of the north end of St. Amant lake, and that which crosses Lake Timiskaming at Old Fort Narrows. In the eastern rocky portions of the area mapped, the pleistocene consists wholly of this glacial debris, but in the vicinity of Lake Timiskaming the depressions of the surface have been filled in with post-glacial clay. These clays are well stratified, and in the vicinity of the lower part of the basin of the Otter river have a distinct terrace form, probably representing stages in the retreat of the post-glacial lake.

Economic Geology.

Gold.—Quartz veins are very numerous throughout all the rock formations found in the area, but occur most extensively traversing the granites, and interfoliated with the gneisses. These usually contain small quantities of disseminated pyrite and chalcopyrite, and occasionally galena, the latter being most abundant in the Huronian. These veins are not, as a rule, auriferous, or if gold is present the percentage is not high enough, or the quantity of ore sufficiently large, for profitable operation.

Silver.—The proximity of the east side of Lake Timiskaming to the silver-bearing district of Ontario has directed the attention of a large number of prospectors to this area during recent years, but so far the results have been largely negative. Since the post-Huronian diabase, with which the silver-cobalt ores of the Timiskaming area are associated, has its largest extent in the township of Fabre, these minerals are more likely to occur in that district. The diabase occurring in Fabre township, however, is so poorly exposed that prospecting is rendered very difficult, and although a number of minerals have been found in small quantities in the rocks, no deposits of economic importance have as yet been discovered.

An occurrence on lot 5, range V north, of Fabre, which is being developed by the Pontiac Mining and Milling Company, is worthy of attention, because of its similarity to the silver-bearing series of James township and elsewhere in that vicinity. On the surface the deposit consists largely of specularite, with sulphides of copper and iron, but these are replaced immediately beneath by red feldspar and calcite, carrying small quantities of galena, pyrite and chalcopyrite. Examined microscopically, the orthoclase was found to be very fresh, and frequently twinned according to the Carlsbad law, while the calcite was observed to fill in the cavities and interstitial portions of the sections as if of secondary origin. Some fragments of epidote also occur, as well as grains of the sulphides mentioned above. The proportion of feldspar and calcite in the vein is exceedingly variable, some parts consisting almost wholly of feldspar, while in others the calcite predominates. Sometimes pure calcite occurs up to 6″ in width, filling what are apparently secondary fractures in the vein-matter. There does not appear to have been any marked ore-concentration in the formation of these veins; the calcite is entirely barren and the quantity of sulphides unimportant. An assay of a specimen of the average type of vein-matter, made by Mr. M. F. Connor of this Department, yielded 3·12 ounces of silver per ton of 2,000 pounds. From this result it seems probable that the silver values in the vein arise solely from the galena present, so that those portions in which galena is more concentrated would give a much higher silver content than the above. The shaft on the property has been sunk to a depth of about 50 feet, the vein having a maximum width in that distance of 3 feet.

The most important and interesting ore deposit of the east side of Lake Timiskaming is the property known as Wright mine, which comprises the western parts of lots 61, 62 and 63, range I, Duhamel township, shown on the maps as Blocks A and B. The ore body, which is exposed on the water-worn rock surface of the lake shore, was observed by the early French explorers, since the location is marked Ansé à la mine on a map of the lakes of Canada published in 1744, a print of which appears in Professor Miller's report of 1905.[1]

The rock in the neighbourhood of the mine is the Huronian conglomerate, but adjacent to and included in the deposit it assumes

[1] Report of Bureau of Mines, Pt. II, 1905, p. 43.

a porphyritic appearance, very similar to the greywacké occurring on Drunken island. Examined in section this is found to consist of fragments of quartz and feldspar enclosed in a granular groundmass of the same minerals. An abundance of chlorite, as well as some calcite and ilmenite, occur throughout the finer-grained material. The quartz fragments are generally corroded on the margin, and the feldspars clouded with decomposition products. The ore deposit occurs in a brecciated zone in this porphyritic phase of the conglomerate, fragments of the rock being completely enclosed in calcite and galena, which also contains small quantities of iron and copper pyrites.

Operations on this deposit were first begun in 1886, by Mr. C. V. Wright, of Ottawa, but no extensive work was carried on until 1890, when the property was acquired by the Mattawa Mining and Smelting Company. A very complete plant was installed and mining actively prosecuted until March, 1891, when work was suspended. From 1896 to 1902 the mine was operated in a small way, first by the Petroleum Oil Trust and later by the British Canadian Lead Company, both of these corporations representing English capital. Quite recently the property has again changed hands, the present owners being the members of the La Rose Mining Company, of Cobalt. Active mining, however, has not been resumed. At the time of the suspension of work in 1902, a depth of 250 feet had been reached in the main shaft, while short drifts had been made at the 65, 100, 200, and 250 ft. levels.

A number of assays of the ore from this mine have been made, both in this department and by private assayers. The galena entirely free from gangue is found to yield from 13 to 26 ounces of silver to the ton, with about 18 ounces as a mean value. It is also found to have a lead content of about 52 per cent, and usually yields traces of gold. The values obtained in operation were greatly diminished, however, by the large amount of rock which had to be mined and the consequent crushing and concentrating which this involved. During the earlier part of its history the lack of transportation facilities was also a difficulty.

The origin of this irregular deposit is very obscure. The vein-matter has no doubt been deposited by replacement along a zone of fracture or brecciation in the Huronian, though the immediate cause of the brecciation of the conglomerate is not apparent. The occurrence of the ore in association with the porphyritic variation in the conglomerate is probably a mere coincidence, similar porphyritic rocks occurring quite frequently in the Huronian, as on Drunken island, and in the greywacké ridge which forms the southern boundary of the valley of the Little river.

Copper.—Small vein-like deposits of iron pyrites occasionally occur throughout the Keewatin greenstones. These usually contain a very small percentage of copper, due no doubt to chalcopyrite disseminated through the iron sulphide. The Jessie Fraser Copper Mining Company has been engaged during the last two years in developing one of these sulphide deposits, which occurs on lot 8, range VII north, Fabre township. In this occurrence the schist adjoining the deposit sometimes shows a thin film of native copper along the lines of parting. Quartz veins containing chalcopyrite and pyrite are very abundant in the area. Thus, on lot 7, range V north, of Fabre, these minerals occur associated with an irregular quartz vein traversing the Keewatin quartz-porphyrite. The sulphides have been impregnated through the rock to a width of four or five feet at some points, but the quantity of chalcopyrite so far disclosed by development work is unimportant.

Iron.—The iron ranges which were observed in the district have already been described under the rocks of the Keewatin formation. In neither of the two localities mentioned, Lac Clair and Kakake lake, is the ore body high enough in iron content, or of sufficient extent to be of economic value.

Asbestos.—Fibrous serpentine occurs in small veinlets traversing the Keewatin serpentine rock of range VII, Duhamel, but the quantity of the material is not extensive, nor its quality of very high grade.

Limestone.—The occurrence of the Silurian limestone at the north end of Lake Timiskaming is of great economic importance, both on account of its accessibility, and the limited extent of the rock in the region from Lake Timiskaming northward. It can not only be used for the manufacture of lime, but also makes a very excellent building stone. Professor Miller gives the following analysis of the rock as found at Farr's quarry, Haileybury:—

	Per cent.
Lime	29·50
Magnesia	21·59
Ferric oxide and alumina	0·66
Insoluble residue	1·60
Carbon dioxide	46·84
Sulphur trioxide	0·70
Total	100·89

Clay.—The stratified clays which occur so extensively on the east side of Lake Timiskaming are well adapted for the manufacture of brick and earthenware, but are more important from an agricultural standpoint. A large part of the clay flats in the district has been cleared, and now supports a numerous and prosperous farming community. The central distributing point for the settlement is the village of Ville Marie, situated on the lake shore at the foot of the very picturesque inlet known as Baie des Pères.

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CANADA

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BRANCH.

HON. W. TEMPLEMAN, MINISTER; A. P. LOW, DEPUTY MINISTER;
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SELECTED LIST OF REPORTS AND MAPS

(SINCE 1885)

OF SPECIAL ECONOMIC INTEREST

PUBLISHED BY

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No. 245.	Report of Mines Section,	1886.	No. 662.	Report of Mines Section,	1897.
272	" "	1887.	698	" "	1898.
300	" "	1888.	718	" "	1899.
301	" "	1889.	744	" "	1900.
334	" "	1890.	800	" "	1901.
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360	" "	1892.	893	" "	1903.
572	" "	1893-4.	928	" "	1904.
602	" "	1895.	971	" "	1905.
625	" "	1896.			

Mineral Production of Canada:—

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415	" 1887.	555	" 1894.	719a	" 1901.
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417	" 1889.	612	" 1896.	861	" 1903.
418	" 1890.	623	" 1886-96.	896	" 1904.
419	" 1891.	640	" 1897.	924	" 1905.
420	" 1886-91.	671	" 1898.	981	" 1906.
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Mineral Resources Bulletins:—

No. *818.	Platinum.	No. 860.	Zinc.	No. 881.	Phosphate.
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859.	Salt.				

Reports of the Section of Chemistry and Mineralogy:—

No. *102.	Year 1874-5.	No. 169.	Year 1882-3-4.	No. 580.	Year 1894.
*110	" 1875-6.	222	" 1885.	616	" 1895.
*119	" 1876-7.	246	" 1886.	651	" 1896.
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148	" 1879-80.	333	" 1890-1.	821	" 1900.
156	" 1880-1-2.	359	" 1892-3.	*958	" 1906.

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* Publications marked thus are out of print.

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745. Altitudes of Canada, by J. White. 1899.
*972. Descriptive Catalogue of Minerals and Rocks, by R. A. A. Johnston and G. A. Young.

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*260. Yukon district, by G. M. Dawson. 1887. Maps Nos. 274, scale 60 m. = 1 in.; 275—277, scale 8 m. = 1 in.
295. Yukon and Mackenzie basins, by R. G. McConnell. 1889. Map No. 304, scale 48 m. = 1 in.
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884. Klondike gold fields, by R. G. McConnell. 1901. Map No. 772, scale 2 m. = 1 in.
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979. Klondike gravels, by R. G. McConnell. Map No. 1011, scale 40 ch. = 1 in.
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1016. Klondike Creek and Hill gravels, by R. G. McConnell. (French). Map No. 1011, scale 40 ch. = 1 in.
1050. Whitehorse Copper Belt, by R. G. McConnell. Maps Nos. 1,026, 1,041, 1,044–1,049.

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996. Nanaimo and New Westminster districts, by O. E. LeRoy. 1907. Map No. 997, scale 4 m. = 1 in.
1035. Coal-fields of Manitoba, Saskatchewan, Alberta, and Eastern British Columbia, by D. B. Dowling.

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*237. Central portion, by J. B. Tyrrell. 1886. Maps Nos. 249 and 250, scale 8 m. = 1 in.
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868. Souris River coal-field, by D. B. Dowling. 1902.
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357. Victoria, Peterborough, and Hastings counties, by F. D. Adams. 1892-3.
627. On the French River sheet, by R. Bell. 1896. Map No. 570, scale 4 m. =1 in.
678. Seine river and Lake Shebandowan map-sheets, by W. McInnes. 1897. Maps Nos. 589 and 560, scale 4 m. =1 in.
723. Iron deposits along the Kingston and Pembroke railway, by E. D. Ingall. 1900. Map No. 626, scale 2 m. =1 in.; and plans of 13 mines.
739. Carleton, Russell, and Prescott counties, by R. W. Ells. 1899. (*See* No. 739, Quebec.)
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MAPS.

1042. Dominion of Canada. Minerals. Scale 100 m. = 1 in.

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805. Explorations on Macmillan, Upper Pelly, and Stewart rivers, scale 8 m. = 1 in.
891. Portion of Duncan Creek Mining district, scale 6 m. = 1 in.
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916. Windy Arm Mining district, Sketch Geological Map, scale 2 m. = 1 in.
990. Conrad and Whitehorse Mining districts, scale 2 m. = 1 in.
991. Tantalus and Five Fingers coal mines, scale 1 m. = 1 in.
1011. Bonanza and Hunker creeks. Auriferous gravels. Scale 40 chains = 1 in.
1033. Lower Lake Laberge and vicinity, scale 1 m. = 1 in.
1041. Whitehorse Copper belt, scale 1 m. = 1 in.
1026. 1044-1049. Whitehorse Copper belt. Details.

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767. Geological Map of Crowsnest coal-fields, scale 2 m. = 1 in.
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890. Nicola coal basin, scale 1 m. = 1 in.
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987. Princeton coal basin and Copper Mountain Mining camp, scale 40 ch. = 1 in.
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997. Nanaimo and New Westminster Mining division, scale 4 m. = 1 in.
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1068. Sheep Creek Mining camp. Geological sheet. Scale 1 m. = 1 in.
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594-596. Peace and Athabaska rivers, scale 10 m. = 1 in.
808. Blairmore-Frank coal-fields, scale 180 ch. = 1 in.
892. Costigan coal basin, scale 40 ch = 1 in.
929-936. Cascade coal basin. Scale 1 m. = 1 in.
963-966. Moose Mountain region. Coal Areas. Scale 2 m. = 1 in.
1010. Alberta, Saskatchewan, and Manitoba. Coal Areas. Scale 35 m. = 1 in.

SASKATCHEWAN.

1010. Alberta, Saskatchewan, and Manitoba. Coal Areas. Scale 35 m. = 1 in.

MANITOBA.

804. Part of Turtle mountain showing coal areas, scale 1½ m. = 1 in.
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