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DEPARTMENT OF MINES

HON. CHAS. MCCREA, *Minister of Mines* THOS. W. GIBSON, *Deputy Minister*

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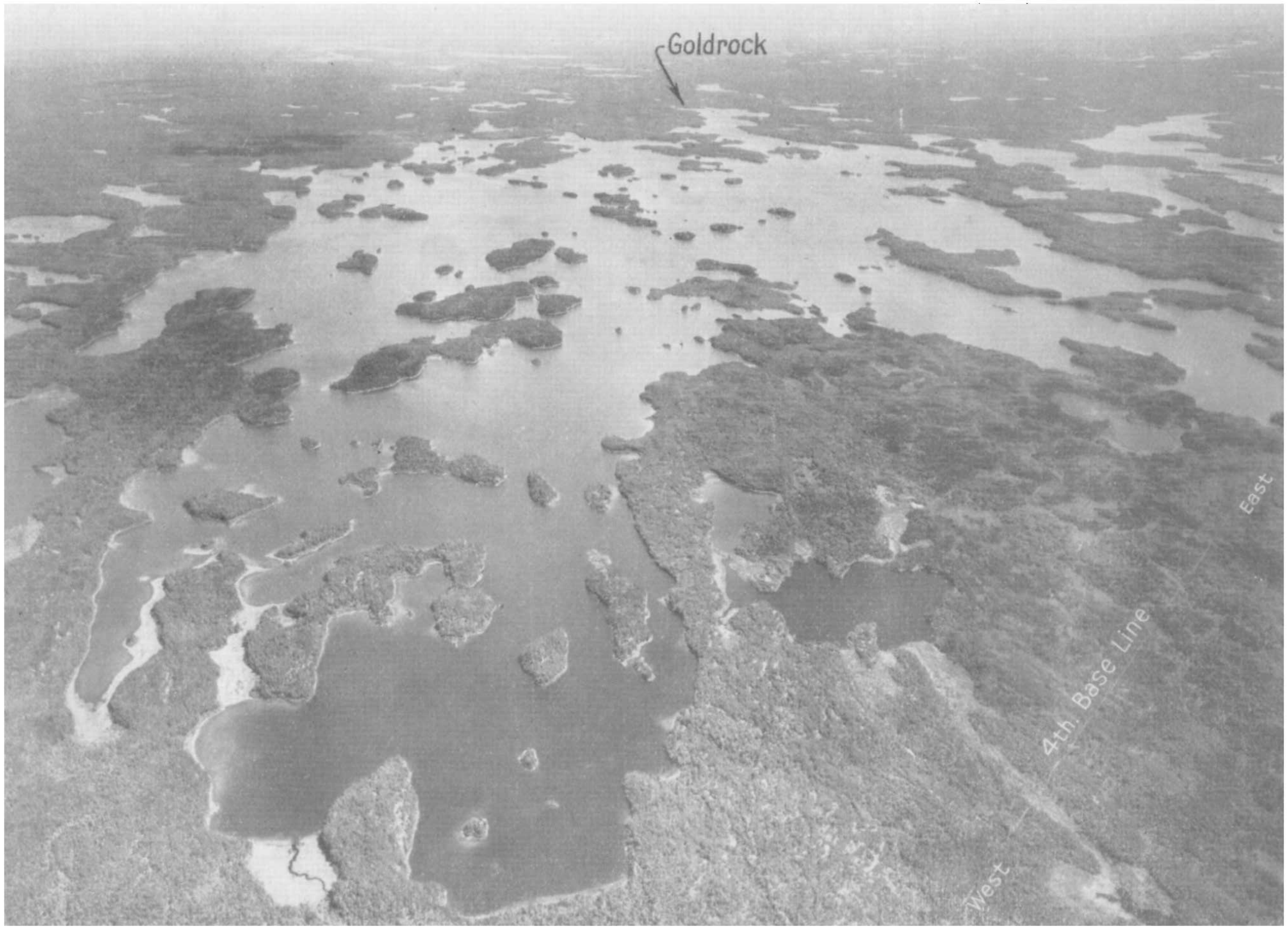
Courtesy Royal Canadian Air Force



Aerial photograph of Upper Manitou lake looking northeastward across the lake from the southwestern corner.

Geology of the Manitou-Stormy Lakes Area

By Jas. E. Thomson

INTRODUCTION

About thirty years ago the Lake of the Woods region became the scene of considerable gold-mining activity. During the same period the Manitou Lakes area had a similar "rush," and several gold mines were opened. The majority of these never reached the production stage, but a small amount of gold was recovered from a few properties. Around 1912 practically all mining in the area ceased. Since that time sporadic attempts have been made to reopen a few of the old mines but, so far, without success. The failure of these early mining ventures somewhat curbed prospecting activity in the area, although each year

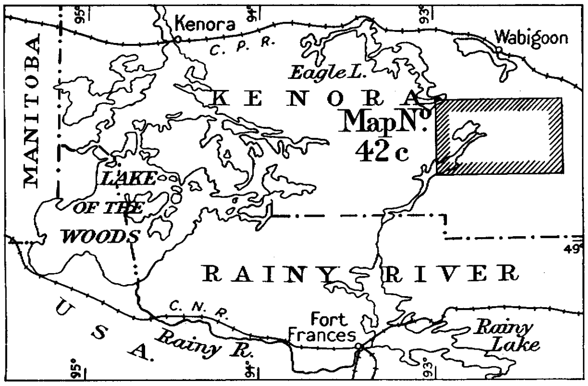


Fig. 1—Key map showing location of the Manitou-Stormy Lakes area. Scale, 50 miles to 1 inch.

a few prospectors have returned to the area, generally to do development work on old mining locations.

The recent intensive search for gold deposits in the older regions located within a short distance of the railways makes areas such as this assume a new importance. During the summer of 1932, the writer was instructed to make a geological survey of a considerable part of the Manitou Lakes area in the hope of obtaining new geological information that would be of assistance in further prospecting of the country. Favourable conditions for the occurrence of gold deposits were found, the geology, in general, being similar to that in the well-known gold camps of Northern Ontario. Gold has been found over a widespread area around the Manitou lakes, but, in recent years, a concentration sufficient to make an ore body of commercial importance has not been found. Despite the long and rather disappointing history of the area, there is reason to believe that an intensive search may yet reward the investigator.

The Manitou Lakes area lies south of Wabigoon, which is a station on the Ignace-Kenora division of the Canadian Pacific railway in the district of Kenora. The area examined during the field season is shown on the geological map (No. 42*c*) that accompanies this report. It is underlain by early pre-Cambrian rocks and extends from Upper Manitou (also known as Anzhekumming) lake eastward to Kawashegamuk and Stormy lakes and from Minnehaha lake on the north to Lower Manitou, Meggisi, and Wapageisi lakes on the south. This is only a part of the larger belt of similar rocks that extends northward towards Sioux Lookout and southward into the district of Rainy River.

The Dryden sheet (No. 52F) of the National Topographic series, issued by the Topographic Survey of Canada, provides an excellent aerial map of the region. This was used in the preparation of the geological map of the area. A few minor alterations and additions have been made to this topographic map, chiefly in the drainage of small lakes and the location of portages. The area is included in two general geological maps, prepared by McInnes,[1] but apart from reports by Parsons[2] and Bruce[3] on some of the mining locations, there has been no previous detailed investigation of the geology.

Acknowledgments

The writer and his party wish to express their appreciation of the many courtesies extended during the summer by various individuals. The writer is indebted to Chas. W. Merrill, of Wabigoon, for transportation of supplies and assistance in the location of abandoned mine workings. The kindness and hospitality of Mr. and Mrs. Geo. B. Scattergood at "Camp Find Us," their summer home at Goldrock, added greatly to the pleasure of the field season.

G. S. MacKenzie, F. H. Burnaby, and Bruce Russell rendered able assistance in the field. Mr. MacKenzie, as senior assistant, did a considerable part of the geological mapping. The party is indebted to W. J. Russell, professor of the University of Western Ontario, and Bruce Russell for the use of their outboard motor during the summer.

Assays and chemical analyses of samples were made by the staff of the Provincial Assay Office.

Access

The Manitou-Stormy Lakes area may be easily reached from either Wabigoon or Fort Frances. During the summer months Chas. Merrill operates a transport service, generally bi-weekly, from Wabigoon to Goldrock. Goldrock is located at the northern extremity of Upper Manitou lake and was a small village during the days when the gold mines in the vicinity were operating. A 7-mile government road extends from Goldrock to Minnehaha lake. In the summer Mr. Merrill operates a 1½-ton truck on this road and runs a large motor boat from Minnehaha lake to Wabigoon.

The area is covered by a myriad of lakes, so that all parts may be reached by convenient canoe routes. From Goldrock motor boats can run southward through the various lakes and straits to the dam located on the Manitou river above Rainy lake. At the outlet of Upper Manitou lake and above Mr. Watson's farm there are narrows that offer some difficulty to boats with a draught of more than about 2 feet of water.

Two canoe routes extend eastward from the Manitou lakes. The northerly route passes through Boyer, Aiabewatik, Nozheiatik, and Stormy lakes to Kawashegamuk lake. The southerly route is from Manitou straits through

[1]Wm. McInnes, Manitou Lake Sheet, Geol. Surv. Can., Map No. 720, 1902; Ignace Sheet, Geol. Surv. Can., Map No. 663, 1906.

[2]A. L. Parsons, Gold Fields of Lake of the Woods, Manitou and Dryden, Ont. Bur. Mines, Vol. XX, pt. 1, 1911; Vol. XXI, pt. 1, 1912.

[3]E. L. Bruce, Gold Deposits of Kenora and Rainy River Districts, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925.

Cane and Scattergood lakes to Meggisi lake. A fairly good canoe route extends from Boyer lake south to Washeibemaga lake and through Sagenak and Kawijekiwa lakes to Stormy lake. Meggisi lake may also be reached from Washeibemaga lake by way of Kennewapekko lake and from Eagle Rock lake on the south.

Previous Geological Work

Geologists and inspectors of the Ontario Bureau of Mines made short visits at the various mines and prospects of the Manitou Lakes area in the days when mining operations were being carried on. Coleman and Miller have described some of the geological features in the vicinity of mining locations; and Bow, Carter, and Corkill, during their trips of mining inspection, have discussed the development of properties. As previously mentioned, general geological maps of the area have been made by McInnes,[1] and were published by the Geological Survey of Canada in 1902 and 1906. In 1911, Parsons described the gold mines around Goldrock and made a geological map of a small area in that neighbourhood. He revisited the area in 1912. In 1925, Bruce reported on the gold deposits of Kenora and Rainy River districts. He included in this survey a detailed examination of the Laurentian, Big Master, and Sakoose mines.

The following is a selected bibliography of literature on the area:—

A. Blue, Ont. Bur. Mines, Vol. V, 1895, p. 163.

Jas. A. Bow, Ont. Bur. Mines, Vol. VII, pt. 1, 1897, pp. 75-78; Vol. VIII, pt. 1, 1899, pp. 72-76; Vol. IX, 1900, pp. 61-64.

E. L. Bruce, Gold Deposits of Kenora and Rainy River Districts, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, pp. 34-39.

W. E. H. Carter, Ont. Bur. Mines, Vol. X, 1901, pp. 97-102; Vol. XI, 1902, pp. 244-249, 255; Vol. XIII, pt. 1, 1904, pp. 66-70; Vol. XIV, pt. 1, 1905, pp. 51-54.

A. P. Coleman, Ont. Bur. Mines, Vol. IV, 1894, pp. 62-67; Vol. VI, 1896, pp. 83-87; Vol. VII, pt. 1, 1897, pp. 121-125.

E. T. Corkill, Ont. Bur. Mines, Vol. XV, pt. 1, 1906, pp. 50-53; Vol. XVI, pt. 1, 1907, pp. 57, 58.

Wm. McInnis, Geol. Surv. Can., Vol. X, 1897, pp. 42, 43.

W. G. Miller, Ont. Bur. Mines, Vol. XII, 1903, pp. 91, 92.

A. L. Parsons, Gold Fields of Lake of the Woods, Manitou, and Dryden, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, pp. 178-188; Vol. XXI, pt. 1, 1912, pp. 194-198.

History and Development

It is impossible to state when gold was first found in the Manitou Lakes area. In 1894, after Coleman's first visit to the area, he wrote:—

> Up to the present Manitou lake has yielded only specimens, some of them exceedingly fine, however. There is no mine and no stamp mill on its shores, and the deepest exploration at the time of our examination did not go down more than 25 feet.[2]

During 1895 and 1896, there were glowing accounts of gold discoveries in the area, and in 1896 a small mill was constructed near the present location of the Gold Rock mine to handle job lots of ore from nearby properties. In 1897 communication was aided by the construction of a government road from Goldrock to Minnehaha lake. A dam was also built at this time on the Manitou river to raise the level of Lower Manitou lake, so that boats could navigate the full length of the chain of lakes. Then followed a great mining "boom." Between 1895 and 1912, reports of the Ontario Bureau of Mines show that at least 20 mines were opened up around the Manitou lakes, and other prospects are referred

[1]Wm. McInnes, op. cit.
[2]A. P. Coleman, Ont. Bur. Mines, Vol. IV, 1894, p. 66.

to. In many cases these so-called mines would be more properly termed prospects, as only a small prospect shaft was sunk and then the property was abandoned. However, complete surface equipment, including a mill, was generally erected at each mine. By 1900, Bow reported that mining development was slow but stamp mills were coming into the area, which was believed to be an encouraging sign.

About this time there was some prospecting activity in the area northeast of Kawashegamuk lake. This became known as the "New Klondike" area. Interest was chiefly centred around a property that later was developed into the Sakoose mine. In 1906, there was a revival of interest in the Manitou country by the discovery of very spectacular gold ore on the first level of the Laurentian mine. However, the ore body proved to be small. By 1912, mining in the area had practically ceased. During the entire period only three mines—the Laurentian, Big Master, and Sakoose—ever milled any appreciable amount of ore. The total gold production from the Laurentian mine is recorded at about $141,000, although it is reported that much gold was stolen. The production from other properties is not known.

A few of the more promising mining locations have been re-examined. In 1913 and in 1916, the Laurentian was examined, but no work was done. The Big Master was also investigated in 1916. During 1928 and 1929, the Gold Rock mine was opened on an old mining location at the southwest end of Upper Manitou lake. No work has been done since 1929. The Sakoose mine was sampled in 1931, and a small amount of diamond-drilling was done.

Systematic exploration of claims on Manitou island and around the northern part of Lower Manitou lake has been carried on in recent years.

Topography and Drainage

The Manitou-Stormy Lakes area shows the typical topographic features of the pre-Cambrian shield. It is essentially a nearly level peneplain, although low rounded hills in some parts present a rather rugged appearance. The relief is probably not more than 200 feet at any point. From the height-of-land that runs across the northern part of the area a very gentle slope extends southward. In the extreme northern part of the map-sheet, glacial lake deposits form a thin veneer over a small part of the country. These form the southern margin of the clay belt that is found around Wabigoon and Dryden. The remaining part of the area is very largely rock outcrop. The rocky shore line of almost every lake adds to the natural beauty of the country. Areas of swamp and muskeg are rare. Underbrush is rather sparsely distributed except in a few areas of brulé, where walking is impeded by small thickly interwoven jackpines.

The most conspicuous feature of the topography is the abundance of lakes. Probably one-quarter to one-third of the area is covered by water. The shape and general pattern of these lakes have been largely determined by the character of the bed rock. In those parts of the area where the underlying rock is schistose greenstone or sediments, the general elongation of the bodies of water is either parallel to the regional schistosity or controlled by the structure of the sediments. For example, the general northeast-southwest trend of Upper and Lower Manitou and neighbouring lakes is approximately parallel to the strike of the rock cleavage. Mosher bay presents a distinct departure from this general pattern but has developed along the contact of a belt of steeply folded sedimentary rocks. Faulting has undoubtedly been responsible for the shape and location of certain lakes. A fault of considerable magnitude extends through the Manitou straits and northward to Kabagukski lake. It may possibly continue southward along the eastern shore of Lower Manitou lake. A zone of soft fissile schists was developed along the fault. These were rapidly eroded in comparison with the surrounding massive rocks, and lake basins were formed in the resulting depressions when the post-glacial drainage system was established. The general trend of topographic features in the upper part of Lower Manitou lake is well brought out in aerial photographs.

In the eastern part of the area, Kawashegamuk, Stormy, and other lakes lie parallel to the underlying rock structures. Where the bed rock is hard massive greenstone or granite the lakes are irregular in outline. Boyer, Aiabewatik, Meggisi, and Wapageisi lakes are examples.

The main drainage systems are largely through lakes connected by short streams or straits. North of the height-of-land, the lakes from Aiabewatik to Minnehaha flow into Dinorwic lake and thence to the Wabigoon river. East of the divide, the drainage is through Stormy and Kawashegamuk lakes to Dinorwic lake. South of the height-of-land there are three drainage basins, which empty into Rainy lake. The most easterly drains by way of the Turtle river; the central, of which Meggisi lake is part, is by way of Kaopskikamak lake into Redgut bay; and the westerly is through the Manitou river.

Natural Resources

Timber

Much of the timber within the area is second growth and of little economic importance. The forest trees are principally spruce, balsam, poplar, birch, cedar, red and white pine, and jackpine. Old saw-mills and lumber camps at various places throughout the country indicate considerable lumbering activity in the past. A few good stands of red and white pine may still be seen, but they are of small extent and in the more inaccessible parts of the country. Many large pines were noticed north and east of Wapageisi lake. A small ground fire swept through part of this area in 1932.

Brulé of several different ages is found, but the extent of recently burnt-over country is not great, the largest areas being near Scattergood lake and from Wapageisi lake eastward to the limit of the map area.

Game and Fish

The area abounds with game. Deer, moose, bear, porcupines, wolves, weasel, and skunk are very plentiful. Partridge are seen everywhere, and ducks are abundant in the summer and fall on some of the smaller lakes.

All the larger lakes contain lake trout, whitefish, and pike. Black bass are caught in Johnar lake. Brown trout have been placed in Sasakwei lake. An occasional maskinonge is caught in the Manitou lakes. Commercial fishing is carried on in Upper Manitou, Lower Manitou, and Boyer lakes. In the past, Stormy and Kawashegamuk lakes have also been fished commercially.

Agriculture

There is very little of the area suitable for farm land, but small patches of clay soil north of Kawashegamuk lake could be so utilized if necessary. Excellent vegetables are grown in gardens at Goldrock and at Mr. Watson's farm on the Manitou straits.

Tourist Camps

Every summer, tourists make canoe trips through the Manitou lakes, which are on a canoe route from Rainy lake north to the C.P.R. and on to the C.N.R. While the whole region contains delightful scenery and abundance of game and fish, the natural beauty and accessibility of the Manitou lakes renders them particularly attractive to lovers of the outdoors. Tourist camps are located on the north end of Rainy lake within easy reach of Lower Manitou lake.

GENERAL GEOLOGY

The consolidated rocks of the area are almost entirely of early pre-Cambrian (Archean) age. They present an interesting diversity of types. In some localities such a variation and intermingling of rocks is found within short distances that it is difficult to represent them on a geological map. On the whole, there is a certain similarity between the succession of rocks in the Manitou-Stormy Lakes area and that in the Rainy Lake area to the south, which has been described by Lawson.[1] The greater part of the map area is underlain by Keewatin lavas, pyroclastics, and associated sediments. Near the western margin of the greenstones a complex of gneisses and sediments somewhat resembles the Coutchiching rocks. A belt of sedimentary rocks, lying stratigraphically above the Keewatin series, is of Timiskaming age. While the greater part of the granite and associated porphyries belongs to the Algoman period of plutonic intrusion, certain small areas of the earlier Laurentian granite are found.

The various formations may be classified as follows, the oldest rocks being placed at the bottom:—

QUATERNARY	
PLEISTOCENE and RECENT:	Stratified clays, boulder clay, sand, gravel, peat.
	Great uniformity
PRE-CAMBRIAN	
KEWEENAWAN(?):	Diabase.
	Intrusive contact
ALGOMAN:	Quartz and feldspar porphyry; aplite. Hornblende and biotite granite and gneiss.
	Intrusive contact
PRE-ALGOMAN:	Gabbro, diorite, quartz diorite, lamprophyre.
	Intrusive contact
TIMISKAMING:	Manitou Series: Conglomerate, arkose, quartzite and slate, with some associated agglomerate and tuff.
	Unconformity
LAURENTIAN:	Altered granite and gneiss, granodiorite, quartz monzonite, sericite schist.

[1]A. C. Lawson, The Archæan Geology of Rainy Lake Re-Studied, Geol. Surv. Can., Mem. 40, 1913.

Intrusive contact

KEEWATIN:	Clastic sediments, chiefly arkose and quartzite, interbedded with lava flows. Agglomerate and tuff with occasional interbedded lava flows. Acid volcanics: Rhyolite, trachyte, felsite. Basic volcanics: Massive andesite, basalt, and pillow lava. Feldspar basalt porphyry. Chlorite and hornblende schist. Complex of gneisses, sometimes garnetiferous; impure quartzite; chlorite schist. (This may be Coutchiching in age.)

Keewatin

Complex of Gneiss, Quartzite, and Schist

West of Upper and Lower Manitou lakes, there are three belts of much altered gneisses, quartzites, and schists, which lie between the Keewatin green-

Banded gneisses on the east side of Olsen bay, Lower Manitou lake. These gneisses may be Coutchiching in age.

stones and the granite. Hornblende syenite and other differentiates of the granite have been injected into these metamorphosed rocks, making a sort of transition complex. However, in Olsen bay of Lower Manitou lake, the gneisses have a distinct sedimentary character. In places a lamination resembling bedding may be seen in these rocks, and they have the appearance of an impure quartzite. Certain horizons of the gneiss are highly garnetiferous, others contain narrow bands of chlorite schist. Near the greenstone the beds dip at angles of 20° to 35° S.E., which would carry them under the Keewatin rocks. On the west side of the bay erosion remnants of gently dipping gneisses lie on the massive granites. The contact between the two is sharply defined.

Thin sections of the gneisses from the vicinity of Olsen bay show a mosaic of quartz, biotite, and epidote, with lesser amounts of hornblende, garnet, zoisite, magnetite, orthoclase, and plagioclase. The feldspar is generally decomposed. The lamination of the rock appears to be due to the disposition of the quartz, biotite, and epidote in bands. Some of these gneisses correspond in mineralogical composition to the "Coutchiching mica schists" described by Lawson.[1]

A chemical analysis of a typical gneiss from Olsen bay shows the following composition:—

	Per cent.
SiO_2	63.17
TiO_2	1.01
Al_2O_3	17.38
Fe_2O_3	1.03
FeO	4.86
CaO	5.42
MgO	1.57
Na_2O	3.09
K_2O	1.20
H_2O	1.04
CO_2	.29
P_2O_5	.12
S	nil
Total	100.18
Specific gravity	2.811

The ratio of magnesia to lime and of potash to soda in this sample is in accordance with the general characteristics of igneous rather than sedimentary gneisses.

Both structurally and lithologically this complex, especially that portion near Olsen bay, somewhat resembles the Coutchiching rocks on Rainy lake. Owing to the fact that the writer spent only a couple of days at the end of the field season in examining the Olsen bay section, it is not possible to make too conclusive statements, but further examination of this and the country to the south of the map area might disclose a pre-Keewatin series. McInnes[2] shows that this belt extends to the southwest for several miles.

Basic Volcanics

The greater part of the Keewatin series consists of lavas ranging from andesite to basalt in composition. They generally extend in monotonous continuity for long distances, but in certain sections are interbedded with agglomerate and tuff. Pillow structures are found, but they are not sufficiently numerous or well preserved to afford a key to the structure of the lava flows. The pillows often contain amygdules near the periphery. The lavas are ordinarily fine-grained, and are metamorphosed to the typical dark-greenish coloured rocks which may be appropriately termed "greenstones" in the field. In certain places they assume a coarse-grained texture and resemble a gabbro in appearance. Close examination of such exposures will often show that the gabbroic phase may grade into a lava containing flow structure, amygdules, or pillows. Undoubtedly the coarse-grained material represents the central zone of a lava flow where cooling proceeded slowly and crystals were allowed to grow. Where isolated outcrops of this gabbro-like rock are found, it is often impossible to determine whether they are part of a lava flow or the pre-Algoman intrusive gabbro.

Porphyritic lava flows are of common occurrence, and since they somewhat resemble porphyritic intrusives their distinction is important. Phenocrysts of feldspar, often assuming crystal outlines and up to an inch in diameter, occur across widths of from 4 to 150 feet in the lava matrix. The bands are quite

[1]A. C. Lawson, op. cit., pp. 28-33.
[2]Wm. McInnes, Manitou Lake Sheet, Geol. Surv. Can., Map No. 720, 1902.

persistent along the strike. They evidently represent a horizon in a flow, as the zone of phenocrysts gradually fades out on either side into lava. Sometimes pillows may be found in the lava within a few feet on either side of a porphyritic band. Hurst[1] has described a rock of similar appearance which occurs in the Sioux Lookout area as a feldspar basalt porphyry, or "leopard rock." This name has been adopted here, although it is probable that the lava matrix is sometimes andesitic in composition.

Locally the lavas have been sheared to form chlorite and hornblende schists. These are found near granite and porphyry contacts, although occasionally this marginal phase of the greenstones is recrystallized to a dark-coloured, medium-grained amphibolite.

Exposure of agglomerate at Goldrock.

Acid Volcanics

These are very sparsely distributed, being found only in the vicinity of Uphill lake. Here the rocks vary from rhyolite to trachyte in composition. Near the granite they have a felsitic appearance.

Agglomerate and Tuff

Bands of fragmental rocks are associated with the lavas in several parts of the area. They are particularly abundant in the vicinity of Upper and Lower Manitou lakes. Fragments of light-coloured material, sometimes porphyritic, occur in a dark-green matrix. The fragments are occasionally angular in shape but more often are elongated parallel to the schistosity. The matrix is largely altered to chlorite schist, but there is ample evidence that it was once of a tuffaceous nature. Bedding is often observed in the tuffs, and occasionally cross-bedding is found. The beds pass gradually above and below into a tuff breccia or agglomerate. In some cases beds of slate and fine-grained quartzite are interbedded with the agglomerate. A fine example of this may be seen along the Manitou straits immediately west of the northern part of Beaverhead

[1]M. E. Hurst, Geology of the Sioux Lookout Area, Ont. Dept. Mines, Vol. XLI, pt. 6, 1932.

island. The fragments that make up the agglomerate are generally of an acid nature. Microscopic examination shows them to be rhyolite and felsite. The fragments have a maximum dimension of 2 feet and range from this size to minute particles. In some places the agglomeratic fragments are rounded and evidently water-worn. On the first island south of Goldrock, in Trafalgar bay, a narrow horizon of conglomerate occurs in the agglomerate and tuff. This conglomerate contains a few well-rounded pebbles of granite.

The bands of agglomerate and tuff are intimately associated with lava flows. This relationship is well demonstrated at many locations around Upper Manitou lake. Narrow bands of agglomerate and tuff occur in the lavas, and in places an alteration of flows and fragmental material is found across a considerable section normal to the strike of the formation. The contact between

Agglomerate and bedded tuff as exposed on an island in Upper Manitou lake.

individual lava flows and bands of pyroclastics is very well defined. The larger areas of the fragmental rocks associated with the lavas are outlined on the accompanying geological map, but the boundaries between these and the areas underlain by lavas alone must be considered rather arbitrary.

The fragmental-appearing rocks at Goldrock have been interpreted in various ways. McInnes[1] mapped them as greywackés, volcanic tuffs, and agglomerates, but Parsons[2] states that the so-called agglomerate is really a brecciated portion of a quartz porphyry. Bruce[3] was inclined to accept this explanation. The writer's views are in accordance with the earlier interpretation of McInnes. The above-mentioned evidence seems to clearly indicate a certain amount of water-sorting of volcanic *ejectamenta*. It is apparent that volcanic fragmental material, including much ash, was thrown off by explosions from the same sources that produced the lavas. At certain times the fine ash was sorted by erosional agencies. Not only are the agglomerate and tuff associated with the lavas, but they are found to a lesser extent with the sediments of the Manitou series, as will be pointed out later.

[1]Wm. McInnes, op. cit.
[2]A. L. Parsons, Ont. Bur. of Mines, Vol. XX, pt. 1, 1911, p. 180.
[3]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, p. 34.

Clastic Sediments

Narrow bands of bedded greywacké, quartzite, arkose, and a small amount of conglomerate are found in the greenstones at a rather distinct horizon, which is stratigraphically not far below the sediments of the Manitou series. Many of the bands are too narrow to be shown on a geological map. The largest number of these isolated occurrences are found around Glass bay, Lower Manitou lake. Here several parallel bands of arkose, quartzite, and greywacké are interbedded with the lavas. The sediments occur in bands from less than 10 feet to over 600 feet in width. They have distinct bedding planes, which dip at very steep angles both to the northwest and southeast. Often the beds dip vertically. Plotting of the strikes of the bedding shows that in some parts of the bay these sediments have been faulted considerably. On the northeast shore of Stormy lake and the adjacent shore of Kawashegamuk lake similar bands are found, but here the beds dip at angles of 65 to 80 degrees towards the main sedimentary series.

It is possible that these narrow bands are remnants of the main body of the Manitou series that have been so deeply infolded as to escape erosion. This seems the more logical assumption in the case of the isolated area of sediments east of Cane lake, which is much larger than the others and which contains conglomerate similar to that of the Manitou series. However, the majority of the bands are more probably independent horizons of sediments in the Keewatin series. Their relationship to the lavas would suggest that they were deposited during relatively short-termed, intermittent periods of sedimentation towards the end of Keewatin time, when volcanic extrusions were less frequent in occurrence. The variable thickness, lens-like shape, and clastic nature of the material indicate terrestrial conditions of deposition as flood-plain or deltaic deposits. Bruce[1] has suggested this mode of origin to explain the intimate association of early pre-Cambrian sediments and lavas.

Structure of the Keewatin

The structure of the Keewatin rocks may be vaguely inferred in certain places from fragmentary evidence. As previously stated, the pillow lavas are not sufficiently well developed or widespread in occurrence to furnish a key to the major structural features. However, the bands of agglomerate and bedded tuff provide some information. Inasmuch as the pyroclastics are interbedded with the lavas, the trend of these bands of agglomerate and tuff is approximately the strike of the formation. Thus, the general strike of the lava flows and intercalated volcanic sediments on Upper and Lower Manitou lakes is roughly northeast and southwest, or approximately parallel to the western granite contact. In the tuffaceous horizons the dip of the bedding along this section is 70° to 85° S.E. Moreover, in the neighbourhood of the granite contact, the bedding of the sedimentary gneisses dips at angles of 20° to 35° S.E. This would indicate that the part of these two lakes west of the fault is on the western limb of a syncline, the axis of which trends roughly northeast-southwest.

In other parts of the Keewatin series, little of the structure can be determined.

Laurentian

Small areas of acid plutonic rocks that were intruded at an earlier period than the main mass of granite occur on Upper and Lower Manitou lakes. They

[1]E. L. Bruce, Bull. Geol. Soc. Amer., Vol. 38, 1927, pp. 778-781.

are of a medium- to fine-grained texture and have a grey or greenish-grey colour. The rock is generally an altered granite or granite gneiss, but more basic phases are also found. Granodiorite occurs on Frenchmen island and on some of the other islands in Upper Manitou lake. On Manitou island there is an area of acidic rock that is largely sericite schist. The less altered part of this material, which may be seen in the pits on the sulphide showing owned by Frank Gaffney, is a quartz monzonite. It is a dark-green, medium-grained rock and contains distinct phenocrysts of quartz.

Microscopic Characteristics

Thin sections show the granite gneiss to be composed largely of quartz, orthoclase, andesine, and dark minerals that have become decomposed. There is considerable evidence that hot solutions have circulated throughout the rock. These have altered the primary constituents, producing a large amount of epidote, zoisite, chlorite, pyrite, and carbonate veinlets. The feldspars are sericitized.

The granodiorite contains a mosaic of quartz, orthoclase, andesine, augite, biotite, and hornblende. Secondary minerals are chlorite, epidote, and carbonate in veinlets and stringers. The constituent minerals are granulated along certain crushed zones in the sections.

The quartz monzonite differs from the granodiorite mainly in having a larger content of alkali feldspar, the orthoclase being equal in amount to plagioclase. Thus the rock comes within the limits of quartz monzonite as defined by Lindgren.[1]

A chemical analysis of the Laurentian granite is given below. For purposes of comparison, an analysis of the typical Algoman granite of the area was also obtained. The higher content of water and carbon dioxide in the older granite is due to the above-mentioned alteration effects.

Analyses of Granites

	No. 1	No. 2
	per cent.	per cent.
SiO_2	63.07	66.95
TiO_2	1.04	.39
Al_2O_3	16.26	16.53
Fe_2O_3	1.39	1.60
FeO	4.63	1.17
CaO	2.94	2.83
MgO	1.50	1.36
Na_2O	4.59	5.12
K_2O	.91	2.95
H_2O	2.08	.48
CO_2	1.43	.33
P_2O_5	.24	.10
MnO	....	.08
S	.04	.01
Total	100.12	99.90
Specific gravity	2.757	2.703

Sample No. 1.—Altered Laurentian granite from an island in the northern part of Upper Manitou lake. Analysed at the Provincial Assay Office.

Sample No. 2.—Pink hornblende granite of Algoman age, Uphill lake. Analysed at the Provincial Assay Office.

[1] W. Lindgren, Amer. Jour. Sci., Vol. IX, 1900, p. 269.

Field Relationships and Correlation

It is difficult to show that all the dikelike masses in Upper Manitou lake that have been mapped as earlier granite are Laurentian rather than Algoman in age. Some of these are included with the earlier granite on account of a lithological similarity to other areas where the evidence is more definite. The reasons for delineating the Laurentian granite from the later Algoman granite that intrudes the Manitou series are as follows:—

1. The Laurentian rocks are schistose, the schistosity being parallel to that of the Keewatin greenstones. It is, therefore, apparent that the intense folding, which preceded or was contemporaneous with the intrusion of the Algoman granite, deformed Keewatin and Laurentian rocks alike. The Laurentian granites are definitely intrusive into the greenstones. This relationship may be observed on several islands in Upper Manitou lake. Xenoliths of agglomerate are found as inclusions in the granite on the island immediately south of Frenchmen island.

2. The sheared granitic rocks are intersected by massive quartz porphyry dikes. The porphyry dikes are intrusive into the Manitou series of sediments, and they present every evidence of being genetically related to the Algoman granite.

3. Quartz veins intersect the Laurentian granitic intrusives. Throughout the area these veins show a close genetic relationship to the Algoman rocks.

4. Microscopic examination shows the older granites to have suffered considerable alteration by circulating hydrothermal solutions. These probably came from the magma which produced the Algoman rocks.

5. Both in field relationships and in microscopic characteristics these rocks have a certain similarity to the Laurentian granites on Rainy lake.[1]

Manitou Series

This is a well-defined band of sedimentary rocks which has been given the specific name of Manitou series. The belt averages about 2 miles in width and is divided into two parts, which are on the same strike but separated by a mass of intrusive granite. Each of the two bands has been traced about 14 miles. The sediments extend as an arcuate band from the north end of Lower Manitou lake to a point near Rattlesnake lake, where they are nosed out by the granite. They are found again on Washeibemaga lake and were traced eastward along the southern part of Stormy lake to its southeastern extremity.

The sedimentary series is composed of boulder and pebble conglomerate, arkose, quartzite, slate, and a certain amount of agglomerate and tuff. No lavas were found within the boundaries of the series.

Conglomerate is of very widespread occurrence and probably is the commonest of all the members. As one crosses the strike of the formation, conglomerate is often found over a width of half a mile. Near Mosher bay, where the most detailed study was made, the conglomerate seems to be largely confined to the southern side of the series, and arkose, quartzite, and slate lie stratigraphically above it. However, in some localities, e.g. on the northeast shore of Stormy lake, arkose and quartzite are found at the base of the series. Beds of conglomerate and arkose are often interbedded. A splendid example of this may be seen on the east side of Manitou straits about a mile south of the portage to Cane lake. Thirty-four alternating beds of arkose and conglomerate, all over 6 inches in width, were counted across a distance of 100 feet normal to the strike

[1]A. C. Lawson, op. cit., pp. 51-59.

of the beds. There were also innumerable beds of conglomerate one-quarter to one inch in thickness. The beds maintain their uniformity of width along the strike. The maximum thickness of a bed of conglomerate was 5 feet. The boulders lie with their long axes parallel to the strike of the beds, although some of the larger granite boulders are well rounded. Boulders were observed here up to 8 inches in diameter, the average being between 1 and 4 inches.

Pebble counts at different locations in the area, including the above-mentioned spot, show the conglomerate to be composed of pebbles in the following proportions:—

<table>
<tr><th>Composition of pebbles</th><th>Mosher bay, immediately north of creek from Uphill lake, 106 pebbles counted in 6 sq. ft.</th><th>East shore of Manitou straits S. of portage to Cane lake, 188 pebbles counted in 8 sq. ft.</th><th>Lake east of Kawijekiwa lake, 186 pebbles counted in 8 sq. ft.</th></tr>
<tr><td></td><td>per cent.</td><td>per cent.</td><td>per cent.</td></tr>
<tr><td>Greenstone</td><td>7</td><td>44</td><td>65</td></tr>
<tr><td>Granite</td><td rowspan="2">43</td><td>16</td><td>10</td></tr>
<tr><td>Porphyry</td><td>4</td><td>6</td></tr>
<tr><td>Quartz</td><td>14</td><td>18</td><td>7</td></tr>
<tr><td>Chert</td><td>32</td><td>7</td><td>8</td></tr>
<tr><td>Jasper</td><td>4</td><td>...</td><td>...</td></tr>
<tr><td>Banded iron formation</td><td>...</td><td>2</td><td>1</td></tr>
<tr><td>Slate or schist</td><td>...</td><td>9</td><td>3</td></tr>
</table>

The pebbles always show a considerable degree of rounding. Occasionally granite boulders are found over a foot in diameter; and boulders of banded iron formation 6 inches in diameter were seen. Boulders 2½ to 3 feet in diameter occur on the lake immediately southeast of the central part of Washeibegama lake.

The matrix of the conglomerate is arkose, consisting of small fragments of quartz, chert, oligoclase, and orthoclase embedded in a groundmass of sericite, chlorite, limonite, and silica. Carbonate and pyrite are seen in thin sections and are secondary.

A thin section of a well-rounded grey granite pebble obtained from the conglomerate south of Mosher bay showed the rock to be a normal hornblende granite, composed of quartz, orthoclase, oligoclase, and hornblende, with a little garnet, apatite, and biotite. A remarkable feature is the freshness of the constituent minerals, which are not as greatly altered as some of those in the Algoman granites. Evidently the surface of the pebble was disintegrated by mechanical processes, such as abrasion, to a much greater extent than it was decomposed by chemical agencies.

Agglomerate and tuff are associated with the conglomerate in certain parts of the area. The best examples of this are found north of Uphill lake, on Washeibegama lake, and south of Snake bay of Stormy lake. Half a mile east of the portage from Uphill lake to Mosher bay, conglomerate may be seen along the shore of the bay. It grades into agglomerate to the east. The conglomerate contains well-rounded pebbles of jasper, chert, quartz, and granite. The agglomerate is composed of elongated fragments of light-coloured porphyritic material in a tuffaceous matrix. This pyroclastic rock contains an occasional well-rounded pebble of jasper and chert. Interbedded with the agglomerate is a band of slate, 2 feet wide, showing distinct bedding and having a sharp contact on either side with the agglomerate. On the south side of Washeibemaga lake the same features may be observed. Here it often happens that the fragments in the rock are entirely light-coloured agglomeratic material that has been somewhat rounded, so that it is almost impossible to differentiate the pyroclastic from the clastic rock.

The association of volcanic sediments with the conglomerate would indicate that volcanic activity continued in the region after the commencement of deposition of the conglomerate. Volcanic ash and larger fragments were then intermingled with the sedimentary material derived from the erosion of a terrain of greenstones, iron formation, and granite.

The best exposures of arkose, quartzite, and slate are found in Mosher bay and Manitou straits. The arkose and quartzite weather to a light-grey colour, and distinct grains of quartz and feldspar may be seen with the naked eye. Microscopic examination shows most of these sediments to be arkose. At several

Conglomerate and arkose of the Manitou series, south end of Beaverhead island, Lower Manitou lake.

points in Mosher bay, beds 5 to 6 inches in thickness exhibit a perfect gradation from arkose at the base of the bed to slate at the top. The gradation may sometimes be seen across a dozen or more successive beds. Well-bedded slates, relatively free from coarser-grained clastic phases, also occur in this locality.

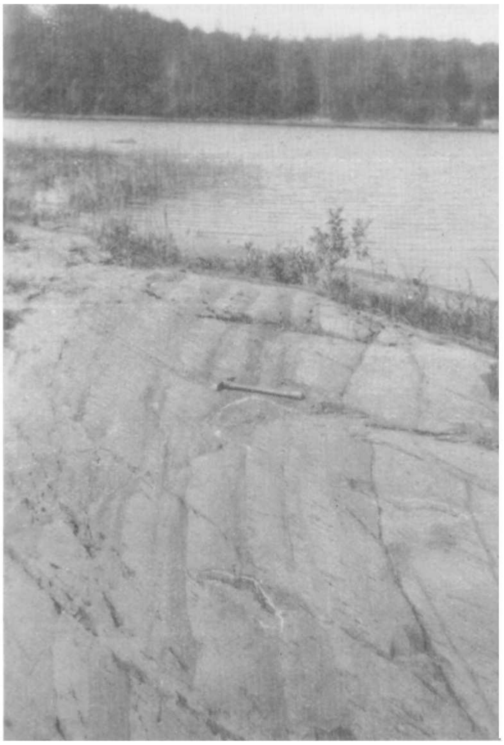
Near Washeibemaga and Sagenak lakes a massive grey arkose is found. Quartz grains of such size are present that it is often difficult to distinguish hand specimens of this rock from massive grey quartz porphyry, which also occurs in the same locality. However, a little careful searching will generally reveal bedding or conglomeratic horizons in the arkose.

Thin sections of arkose from various parts of the area reveal a general similarity of mineral composition. Clastic grains of quartz, plagioclase, orthoclase, and occasionally titanite and apatite, are embedded in a matrix of chlorite, sericite, quartz, carbonate, kaolin, and iron oxide. In some cases almost half the grains are feldspar. The grains show evidence of considerable abrasion and are sometimes well-rounded but more often subangular. Only one section showed sufficient evidence of clastic ferromagnesian minerals to be called a greywacké. The general absence of these minerals is remarkable, considering the fact that the sediments were derived from a terrain of basic igneous rocks. Only one section was sufficiently devoid of feldspar to be called a quartzite.

STRUCTURE OF THE MANITOU SERIES

Western Belt

Folding.—The most detailed study of the structure of the sediments was made in the vicinity of Mosher bay. Here the beds are well exposed, and the



Bedded sediments on a small island south of the entrance to Mosher bay, Upper Manitou lake. Note the gradation in grain from light-coloured arkose to darker slate, indicating that the tops of the beds are to the right. A fault with a small horizontal displacement occurs near the hammer.

minor structural features are fairly well preserved. The tops of beds may be determined by (1) the gradation in size of the original grains across individual beds, (2) cross-bedding, and (3) the relationship of regional cleavage to the bedding in vertical section. Gradation in grain size from coarse on the bottom side of the bed to fine on the top is perfectly exhibited along the shore of Mosher bay in beds of arkose which grade upwards into slaty material. It has been pointed out that variation in the size of grains is not always a safe criterion for the determination of the tops of beds and that sometimes it gives diametrically opposite results from those obtained by other more reliable methods.[1] As shown on the

[1]H. C. Cooke, Trans. Roy. Soc. Can., Vol. XXV, Sect. IV, 1931, pp. 71-74.

accompanying sketch map (Fig. 2), which shows some details of the structure, there is a general, but not complete, agreement between all methods of determining tops of beds near Mosher bay. Difficulty is often encountered in proving the tops of beds by the relationship of cleavage to bedding, owing to the fact that they differ only a few degrees in dip. Cross-bedding is rarely seen.

Near Mosher bay the sediments appear to occur in a closely folded syncline, the axis of which strikes about N. 70° E. and pitches to the southwest. On the south limb the tops of the beds are to the north, and the dip is to the north at a steep angle. Occasionally the beds are slightly overturned to the south.

Sediments of the Manitou series occurring near the fault on the south end of Beaverhead island, Lower Manitou lake. The lighter-coloured material is arkose; the darker is slate. Distortion of the beds is due to faulting movements.

The north limb of the syncline has been partly removed by faulting. The one exposure of slate on the northeast shore of Mosher bay dips to the south. In the southern part of Manitou straits near the fault contact, the beds dip steeply to the southeast, suggesting that this may be part of the northwest limb of the syncline. A more detailed examination might show that this is not a simple synclinal fold but rather a series of close folds, the axial planes of which are not far apart.

Faulting.—The contact between the sediments and greenstones on the northwest side follows a zone of highly sheared, fissile chlorite and sericite schists. This sheared zone is about 200 feet wide and was traced from the south end of Beaverhead island northeast to Mosher bay and thence to Kabagukski lake.

Near Mosher bay the schists have a vertical dip, but in Manitou straits the dips are from 70° to 85° S.E. Near the contact the sedimentary beds are truncated by this sheared zone at an angle of about 15 degrees in Mosher bay and 25 degrees on Beaverhead island. This structure can only be explained by a fault of considerable magnitude. In Mosher bay there is concrete evidence of great disturbance in the sedimentary beds near the faulted contact. Drag folds are developed in the arkosic and slaty beds, and small minor faults may be observed in several places. The distortion of hard, competent arkose, which is interbedded with the softer less competent slates, has produced a breccia in places. This consists of irregularly shaped masses of arkose, which yielded by fracturing, surrounded by slaty material, which flowed around the more massive rock. On the south end of Beaverhead island the beds near the fault are also distorted but not to the extent of those in Mosher bay.

No gouge or breccia was noted along the fault zone. This may have been obliterated by continued shearing, or it may be that the shearing now exposed took place at considerable depth and over a long period of time. Instead of a well-defined fracture the fault is more of a shear, probably with a large horizontal component. In this respect it resembles a fault described by Hawley[1] in the Sapawe Lake area.

A branch fault appears to extend from the north side of Mosher bay southwest to the east end of Uphill lake. Evidence for this is the occurrence of an outcrop of quartzite on the shore in the northwest corner of Mosher bay, the southerly extension of conglomerate to the shore of Uphill lake, and the offset of a prominent band of conglomerate in the small bay to the south of Mosher bay. A second fault, approximately parallel to the first, probably extends southwest from the entrance to Mosher bay. On the west side of the small island and on the adjoining mainland small faults are seen, which strike N. 45° E. In the depth of the bay to the south a highly sheared zone with small drag folds is found. It is also to be noted that west of this supposed fault the tops of the beds face south, whereas to the east they face north. Perfect gradation in grain on the small island indicates that the beds face to the north; while on the mainland immediately to the west, and almost directly along the strike, gradation in grain, equally well displayed, shows the tops on the south.

The dip of the highly schistose zone along the contact of greenstone and sediments should approximate the dip of the fault. In the northern part this is essentially vertical, but along the Manitou straits the dip is 70° to 85° S.E. Since the sediments do not occur on the northwest, that side must have been raised, and the fault is thus of the normal type.

The direction of the fault movement cannot be definitely stated, but the data at hand give some suggestions as to the relative direction of horizontal displacement. Since no definite horizons are offset by the fault, the true nature of the major movement can only be inferred from a study of the minor structural features on either side. These are best displayed in the sediments, where minor faults and drag folds are found close to the fault and were evidently produced by faulting movements.

At the entrance to Mosher bay, the flow cleavage in the sediments, which is here more probably related to the major faulting movements than the regional folding, strikes 20 degrees more to the north than the beds. This implies a movement of the northwest side to the northeast. Drag folds in the sediments near the fault in Mosher bay were found to have always the northwest side moved northeast with respect to the southwest side. The same direction of

[1]J. E. Hawley, Ont. Dept. Mines, Vol. XXXVIII, pt. 6, 1929, pp. 16-19.

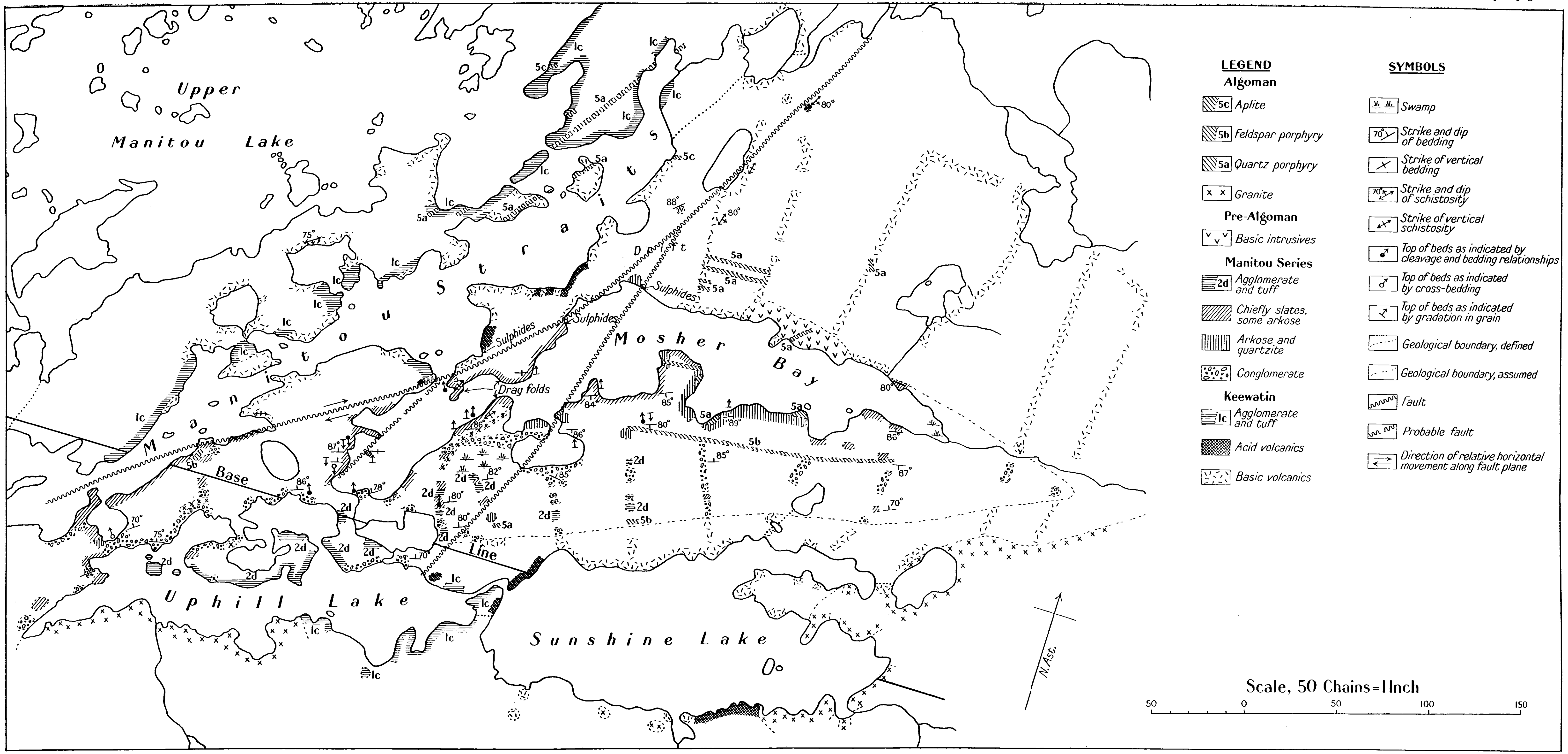


Fig. 2—Geological sketch map showing details of structure and lithology in the vicinity of Mosher bay, Upper Manitou lake.

movement is indicated by drag folds in the chlorite schists of the fault zone near the narrows east of Beaverhead island. The position of the branching faults in Mosher bay implies a similar movement. The accompanying sketch (Fig. 3) shows how these could be formed by the same stresses that produced the major fault. Stresses applied in a northeasterly and southwesterly direction would produce a fracture pattern that would correspond with that made by the faults in Mosher bay.

The age of the faulting may be inferred within certain limits. On the small island south of the entrance to Mosher bay, a narrow lamprophyre dike has been injected along a fault where the horizontal displacement of the beds is

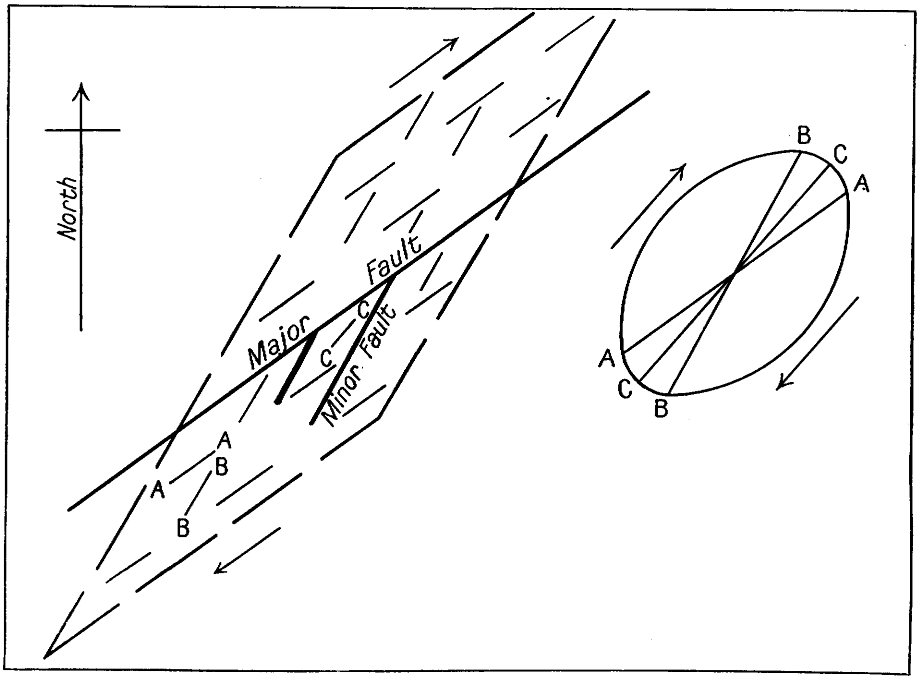


Fig. 3—Diagram showing how mechanics of faulting in Mosher bay may be explained by reference to the strain ellipsoid. The two faults are parallel to the two directions of non-distortion or shear planes (i.e. AA and BB). Schistosity (flow cleavage) would be parallel to the direction of greatest elongation (CC).[1]

only a few feet. The dike was injected along this line of weakness after the faulting took place. The lamprophyre dikes are either part of the pre-Algoman basic intrusion or a phase of the Algoman rocks. Thus the faulting took place at some time prior to the end of the Algoman period and after the folding of the Manitou series. Furthermore, massive sulphides are found along or near the fault zone, which suggests a structural control over their deposition. They were probably introduced along this line of weakness by a solution emanating from the same magma that produced the granites and porphyries. These sulphides also contain traces of gold, which elsewhere throughout the area is genetically related to the Algoman rocks.

Eastern Belt

The structure of the eastern belt of sediments is similar to that of the western section. The rocks are more massive, and bedding is not often found.

[1]C. K. Leith, Structural Geology, Henry Holt and Co., 1927, pp. 44-46.

However, the available information shows that they also occupy a synclinal basin that tends to nose out against the granite east of Washeibemaga lake. This tendency of the sediments to nose out on either side of the granite mass around Rattlesnake lake is strongly suggestive of a once continuous syncline that has been domed up by the intrusion of the granite and subsequently eroded to its present form.

On the north and east sides of Stormy lake the dip of the beds is from 55 to 80 degrees to the south and southwest, indicating that this is the north limb of a syncline. Near the southern contact of the series bedding was rarely found. On the north end of Sagenak lake the beds dip at an angle of 70° N. East of of Washeibemaga lake they are also inclined to the north; but about 2 miles east of Kawijekiwa lake, beds were found to dip southward not far from the contact.

Evidence of an Unconformity

As previously mentioned, it is impossible to determine the attitude of the lava flows with any accuracy, so that no evidence of a structural unconformity between the Keewatin series and Manitou series was obtained in the vicinity of the contact between these two formations. However, in those areas where volcanic sediments are interbedded with the lavas, a rough approximation as to the strike of the flows is possible. A glance at the geological map will show that a band of agglomerate and tuff runs parallel to the elongation of Kawashegamuk lake. If this roughly represents the strike of the lava flows, then there is a distinct angular discordance between the greenstones and the Manitou series. The same relationship may be seen in the vicinity of Upper Manitou lake and Mosher bay. While faulting has occurred here, it could hardly account for the great difference in strike between the sediments in Mosher bay and the bedded tuffs to the west of the fault in Upper Manitou lake.

The nature of the sediments is strongly suggestive of an unconformity. They are undoubtedly of terrestial origin, being probably deposited in shallow lakes or seas. The large amount of conglomerate with its variety of well-rounded pebbles and boulders must have been derived from a great terrain of pronounced relief.

CORRELATION OF THE MANITOU SERIES

The Manitou series corresponds stratigraphically and structurally to the Timiskaming rocks found elsewhere in Northern Ontario and Quebec. The various sediments resemble the Seine series on Rainy lake in many respects. It is possible that the sediments continue south of Manitou lake. An older geological map shows that the same general complex of early pre-Cambrian rocks extends southward for a considerable distance into the Rainy River district.[1]

Pre-Algoman Intrusives

Irregularly-shaped areas of plutonic rocks, varying from intermediate to basic in composition, intersect the Keewatin lavas and the sediments of the Manitou series. They consist of gabbro, diorite, and quartz diorite, all of which are somewhat altered. In many places it is virtually impossible to distinguish these from the coarse-grained phases of the lava flows. However, in certain locations a definite intrusive contact may be seen, and offshoots from the intrusive cut the surrounding rocks. This relationship may be seen on Boyer lake.

[1] A. C. Lawson, Rainy Lake Sheet, Geol. Surv. Can., Vol. III, pt. F, 1887.

It is possible that there are two ages of these basic intrusives in the area, the other being a late phase of Keewatin activity. On one of the larger islands in the northern part of Upper Manitou lake an altered gabbroic rock appears to intrude the agglomerate and tuff and is itself intersected by the Laurentian granite. Unfortunately, this relationship could not be checked by other similar occurrences.

Under the microscope these rocks always exhibit a granitic texture. The feldspars are generally so decomposed that it is impossible to distinguish between gabbro and diorite. The constituent minerals of these rocks are hornblende, biotite, orthoclase, plagioclase, magnetite, and titanite, with secondary epidote, zoisite, chlorite, carbonate, sericite, and leucoxene. Several sections contain primary quartz and may be classified as quartz diorites.

A few lamprophyre dikes that occur in the area may also be included with this group, although their relationship is not definitely known. These dikes are too small to be shown on a geological map. They penetrate the Keewatin greenstones and sediments of the Manitou series, but their relationship to the Algoman granite and porphyries could not be established. Northwest of the map area, near Wabigoon lake, Bruce[1] has found that lamprophyre dikes are earlier in age than the porphyry dikes and granite.

The lamprophyre dikes are dark-coloured, rather fine grained rocks containing a large amount of biotite. A thin section of one of these dikes showed the rock to have the mineral composition of minette. It contained a predominance of anhedral flakes of biotite with lesser amounts of quartz and orthoclase, and a trace of plagioclase.

Algoman

Granites and Gneisses

A considerable area of granite intrudes the sediments of the Manitou series and thus is Algoman in age. The correlation of the remainder of the granite with the Algoman period is chiefly on account of similarity to that part that can be definitely placed. The rock may be generally described as a medium- to coarse-grained granite, generally massive but occasionally gneissoid. The proportion of hornblende to biotite varies with the locality, the hornblende variety being more abundant near the greenstone contacts. The colour is generally pink, but at some distance from the older rocks massive grey granite may be observed along the shore of many lakes.

Microscopic examination shows the rock to be a normal granite with unaltered mineral constituents. Biotite is the predominant dark mineral.

Quartz Porphyry, Feldspar Porphyry, Aplite

Stocks and dikes of porphyry and aplite are of the same general age as the Algoman granite and probably represent a portion of the same magma from which the granites were formed. The quartz porphyry is a massive, greyish-coloured rock that contains distinct phenocrysts of quartz in a fine-grained groundmass. Some dikes near Mosher bay show quartz phenocrysts one-third of an inch in diameter. The quartz porphyry is occasionally sheared, as, for example, the large dike near the upper narrows in Manitou straits. Feldspar porphyry dikes are much less common. A large dike of this porphyry containing crystals of orthoclase one inch in length occurs south of Mosher bay.

[1]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, pp. 40, 41.

Quartz is often associated with the porphyry dikes as a stockwork of small irregular veinlets filling tension cracks. A few of the dikes also carry a considerable amount of sulphides. Assays of several grab samples of quartz from these dikes and of sulphide-bearing porphyries almost always showed small, non-commercial values in gold. A trace of native gold was actually observed in one porphyry dike. It seems rather obvious that the auriferous quartz veins and mineralized zones must be closely related to these Algoman porphyries and granites.

The aplite dikes are very fine grained, light-coloured, siliceous rocks, with the same general relationships as the porphyries.

Keweenawan(?)

An occasional narrow dike of very fine grained diabase is found. It closely resembles the Keweenawan diabase that is so widespread throughout the Lake Superior region. It was not found to intersect the Algoman granite, so cannot be definitely correlated.

Pleistocene and Recent

As previously stated, the extreme northern portion of the map area contains a few isolated areas of bedded clays, which are part of the extensive clay belt to the north. Throughout the remainder of the area glacial deposits are represented by occasional patches of boulder clay, ground moraine, and low drumloidal hills of drift material. South of Snake bay large greenstone erratics are found in abundance. On the top of some of the ridges erratics 15 feet in diameter may be seen.

Glacial carving is everywhere in evidence. Glacial striae and grooves show the direction of ice movement to have been S. 30° W. to S. 65° W.

ECONOMIC GEOLOGY

Nature of the Gold Deposits

Throughout the Manitou-Stormy Lakes area gold occurs in quartz veins, in massive sulphide bodies, in schists impregnated with sulphides, and in porphyry dikes. Of these the vein type is by far the predominant form of occurrence. Many of the veins closely correspond to the definition of a simple or "true fissure vein," in which the ore occupies a sheet-like space with well-defined walls, often in a massive rock. Composite veins or lodes, consisting of nearly parallel veins, irregularly connected, with schistose country rock intervening, are occasionally found. These usually occur along a fairly well defined sheared zone. The veins are found largely in altered lavas and pyroclastics of the Keewatin series, but have also been discovered in the sediments (e.g. Giant mine), and in acid intrusives (e.g. Manitou island veins in quartz monzonite and veins on Frenchmen island in granodiorite). The vein material consists chiefly of quartz, with or without carbonate. The carbonate is largely ankerite, is sometimes well crystallized, and occurs intimately associated with vein quartz. Secondary quartz and carbonate are found at times in fractures in the primary quartz. Tourmaline is present in many of the veins. Massive veins containing milky-white quartz and devoid of sulphides are generally barren. Pyrite and chalcopyrite are the predominant sulphides in the veins, and pyrrhotite, galena, and sphalerite occur rarely. The sulphides are largely confined to the stringers of schist enclosed along fractures in the quartz and to the schistose wall rock. Native gold is found both in the quartz and schist. Values are erratic, often being confined to high-grade ore shoots and pockets in otherwise barren or very low grade vein material. The veins are generally small but well defined. They are rarely more than 5 feet wide, generally between 1 and 2 feet.

Small bodies of massive sulphides were observed in a few places. The sulphides are pyrite and pyrrhotite with a little chalcopyrite. Most of the samples of this material taken by the writer carried small amounts of gold (20 to 40 cents per ton). One sample, obtained on the road from the Little Master mine to the government road, assayed $4.20 per ton in gold.

Irregularly shaped zones of more or less disseminated sulphides occur in schists. The largest of these bodies uncovered at present is on Manitou island. Here the mineralization is concentrated in the vicinity of quartz porphyry dikes. Small sulphide zones were noticed in the vicinity of the granite contacts in some parts of the area. Gold values occur in some of these sulphides.

Gold has been found in quartz porphyry dikes but in non-commercial amounts. The gold appears to be confined to irregular networks of quartz stringers in the porphyry. The ore body at the Glass Reef mine was apparently one of these dikes. At one location south of Mosher bay a trace of native gold was noticed in a porphyry dike.

Genesis of the Gold

The gold deposits bear a close relationship to the Algoman granite and porphyry. Prior to, or contemporaneous with, the batholithic invasion the greenstones and sediments were closely folded. As a result of this deformation fracturing, shearing, and faulting took place on a large scale. Along these lines of weakness vein-forming solutions, evidently emanating from the later phases of the granitic magma, were able to penetrate. It appears that after the quartz veins were injected, fractures were formed as the result of stresses developed during consolidation. Hydrothermal solutions penetrated these openings as well as the wall rock, depositing carbonates, sulphides, and gold. These solutions also circulated through favourable structures in the country rock to form the various sulphide masses.

Recommendations to Prospectors

From the above statements, it is evident that the conditions required for the formation of a commercially valuable gold deposit in the region are (1) the existence of a body of rather brittle rock that has been subjected to shearing movements of sufficient magnitude to produce a large shattered zone, and (2) the proximity of granite or porphyry masses from which gold-bearing solutions can emanate in sufficient quantity to fill the fractures.[1] Conditions approaching this theoretically ideal situation occur in certain parts of the Manitou-Stormy Lakes area. Generally speaking, the belt of rocks in the vicinity of Upper and Lower Manitou lakes is considerably sheared; granitic intrusives are often found, and quartz veins are common in occurrence. It is in this area that practically all the old gold mines and more recent prospects are located. Consequently, part of the territory adjacent to these lakes is now staked, and several claims are patented. Farther eastward the rocks are generally massive, and quartz veins and mineralized zones are not so common. Prospecting seems to have been rather limited in amount in this part of the country, and no mining claims are held at present. Around Kawashegamuk lake the rocks are well sheared.

[1]H. C. Cooke and W. A. Johnston, Gold Occurrences of Canada, Geol. Surv. Can., Econ. Geol. Series, No. 10, 1932, p. 14.

Although prospectors may be rewarded by searching in all parts of the greenstone and sediments, those areas near the contact of the Algoman granite and porphyry masses seem to be the more likely locations for gold occurrences.

Description of Properties

Gold has been found on many locations in the Manitou-Stormy Lakes area during the past thirty-five years. Over the period from 1896 to 1912, a number of attempts were made to mine gold, but the great majority of these ventures were failures. As elsewhere in the Lake of the Woods region, there is abundant evidence of wasted efforts and capital in attempts to develop producing mines in the early days. Bruce[1] has discussed the various reasons for the failure of these mines to become more permanent producers. Some were located on veins "too small or too low in gold content" ever to be considered as ore. There was lack of judgment in purchasing unnecessary surface equipment, including a mill, long before the development of the ore body warranted such an expenditure. Other reasons advanced are lack of knowledge concerning the nature and structure of the veins, and inefficient mining and milling methods.

At present very little may be seen at some of the old mines. At certain places the buildings have either been removed or have fallen down, so that it is difficult even to locate the old workings. Sometimes all that may be seen is a shaft, filled with water, and some ore on the mine dump, which covers, or partially covers, the surface exposure of the vein.

The properties are divided into two groups in the following discussion. Those of the first group include the older mines on which no work has been done for many years. Some of these are of little or no economic importance. The second group is composed of mines which have been investigated since they were originally closed down, and the more recent prospects.

OLDER MINES

Detola

The mine is located on the west shore of Kabagukski lake on claim H.P. 411. It was developed during 1910 and 1911. A small mill was constructed and is still located on the property, although it is reported that no ore was ever put through it. The rock in the vicinity of the shaft is massive greenstone, but along the shores of Kabagukski lake there is a highly sheared zone containing chlorite and sericite schist. There is no sign of a vein at the shaft. Parsons[2] reported in 1912 that the shaft was down 230 feet and that 852 feet of drifting had been completed. In the crosscut 436 feet northwest from the shaft, a vein about one foot wide was located, which carried about $12 per ton in gold.

The rock on the dump is largely massive basalt and slaty chlorite schist. The vein material is quartz and a little tourmaline. Small veinlets of carbonate and secondary quartz occupy fractures in the primary quartz. A little sulphide, chiefly fine-grained pyrite, occurs in the quartz and schistose wall rock. A grab sample of the best-looking vein material on the dump assayed $3.20 per ton in gold.

Giant

On claims H.W. 74 and 75, located on the southeastern shore of Mosher bay, development work was done on a vein at intervals between 1897 and 1905.

[1]E. L. Bruce, Ont. Dept. of Mines, Vol. XXXIV, pt. 6, 1925, pp. 1, 2.
[2]A. L. Parsons, Ont. Bur. Mines, Vol. XXI, pt. 1, 1912, p. 195.

The writer did not see the old mine workings. Coleman described the showing in 1897 as follows:[1]—

On Mosher bay . . . a bedded vein with no regular walls runs near a hilltop with a strike of about 65 degrees. The quartz with some rusty schist, all containing more or less gold, is seven or eight feet wide and retains the same character to the bottom of a pit 24 feet deep sunk upon it. The ore pans well and affords some rich specimens of free gold. Some ore taken by myself assays $6 per ton.

At a later date Carter[2] described a quartz vein which could be traced several hundred feet along the strike of the formation and which averaged about 6 feet in width. A shaft was sunk to a depth of over 200 feet on the property.

Glass Reef

The mine was located on the northeastern shore of Lower Manitou lake near Glass bay (claim H.W. 594). It was worked in 1900, during which year a two months' mill test was made. A shaft was sunk 200 feet, and a considerable amount of drifting and crosscutting was completed. Carter describes the underground development as follows:[3]—

. . . a faulted and schistose area in a massive dark-green trap dike, the schist carrying lenses of quartz. The shaft was started down on one of these and though it pinched out at about 20 feet depth, sinking continued in the schist, and . . . the dike of trap explored thoroughly both by drifts and crosscuts, but with unsatisfactory results, for throughout all the drifts nothing but scattered lenses and stringers of quartz were found, seldom over a foot and a half wide, short and with no apparent continuity, and in the crosscuts nothing but trap.

There is no surface exposure of the above-mentioned zone, and the timbers cover the rock in the shaft. However, from the nature of the broken rock on the dump it appears that the "dike of trap" is a sheared quartz porphyry containing a considerable amount of quartz in the form of a stockwork of small veinlets. The quartz contains a little tourmaline and carbonate with a trace of pyrite. Near the shaft the country rock is massive greenstone, but a large quartz porphyry dike is exposed to the northeast and the strike would carry it very close to the shaft. A grab sample of quartz and schist selected from the material on the dump was assayed, but contained no gold values.

Last Chance

Some work was done in the early days on claim S. 28 northeast of Goldrock. Coleman[4] discusses the showing as follows:—

A vein which has been traced for three hundred and fifty yards cuts diagonally across the slaty schist and has at some points a width of three feet, but is quite irregular in this respect. Two pits opened upon it, the deepest only ten feet, show quartz with green and brown streaks and have produced some handsome specimens of gold.

Little Master

This was located on the northwest shore of Kabagukski lake on claim A.L. 206. From 1902 to 1905, three shafts were sunk on the property. In the vicinity of these shafts the rock is massive andesite. Only very small lenses of white quartz and some schistose wall rock may be seen at the workings. A grab sample of the quartz from the large dump on the side of the hill assayed $3.80 per ton in gold.

[1]A. P. Coleman, Ont. Bur. Mines, Vol. VII, pt. 1, 1897, p. 123.
[2]W. E. H. Carter, Ont. Bur. Mines, Vol. XI, 1902, p. 247.
[3]W. E. H. Carter, Ont. Bur. Mines, Vol. X, 1901, p. 99.
[4]A. P. Coleman, Ont. Bur. Mines, Vol. VI, 1896, p. 86.

Big Dick

This name was applied to a small showing on the north shore of Mosher bay (H.W. 66). Near the shore a quartz vein 10 feet wide has been uncovered on the side of a hill by trenching. The vein strikes N. 30° E. and has a vertical dip. It is not exposed at any other place along the strike. The vein material is quartz containing a little tourmaline and a trace of pyrite and chalcopyrite. The wall rock is highly sheared chlorite schist and is impregnated with fine-grained pyrite. Trending parallel to the vein on the northwest side is a dike of quartz porphyry that contains "eyes" of quartz one-third of an inch in diameter. A sample chipped across 8 feet of the mineralized chlorite schist assayed $1.40 per ton in gold, and a grab sample of the mineralized quartz assayed 20 cents in gold.

Paymaster

On claim H.W. 20, east of Goldrock, a shaft was sunk 325 feet on a lenticular quartz vein, which is 18 inches to 2 feet wide on the surface and cannot be traced any distance along the strike. Carter[1] states that there is another lenticular quartz vein 30 feet away, but the writer did not see it. Corkill[2] has reported the vein to be 11 feet wide on the 200-foot level. A grab sample of the quartz on the dump assayed 20 cents per ton in gold.

Royal Sovereign (Lower Neepawa)

This property is located on the northwest shore of Lower Manitou lake immediately north of Manitou island. Development was commenced in 1897. In 1902, 23 tons of ore were treated in the stamp mill of the Glass Reef mine across the lake. Apparently no work has been done at the property since that time. On the edge of a ridge near the lake shore a shaft was sunk on a quartz vein, and a little drifting was done along the vein. A short tunnel was driven from the base of the ridge to intersect the drift near the shaft.

At the lake shore 6 distinct quartz veins with well-defined walls occur in chlorite schist across a width of about 50 feet. The three larger veins are each about a foot in width. The veins are roughly parallel and strike about N. 70° E.; the dip is from 75° to 80° S.E. The strike would carry them to the shaft on the hill about 50 feet away. The veins on the shore contain white vitreous quartz with a little tourmaline. At the shaft the vein is covered by the dump, but it may be observed in the tunnel. Here, a branching and irregular stockwork of quartz veins up to one foot in width forms a lenticular body about 6 feet in width near the shaft but lensing out almost entirely 20 feet to the northeast. The ore consists of white quartz and tourmaline, considerably fractured and containing numerous ankerite veinlets. A trace of pyrite occurs, chiefly in the chlorite schist. A sample, chipped across a width of 6 feet of the vein in the tunnel near the shaft, assayed 20 cents per ton in gold. A second sample of similar vein material taken from the dump assayed 20 cents per ton in gold.

About 80 feet southwest of the above-mentioned shaft, a second shaft is located. The timbers obscure any sign of a vein, but the ore on the dump is similar to that from the other shaft.

Bow has described the underground development work as follows:[3]—

> A seven by nine shaft has been sunk on the hanging wall to a depth of 65 feet. A crosscut has been commenced at the bottom. There is 11½ feet of quartz at the bottom of the shaft

[1] W. E. H. Carter, Ont. Bur. Mines, Vol. XIV, 1905, pt. 1, p. 54.
[2] E. T. Corkill, Ont. Bur. Mines, Vol. XV, pt. 1, 1906, p. 52.
[3] Jas. A. Bow, Ont. Bur. Mines, Vol. VII, pt. 1, 1897, p. 76.

and only the footwall reached. Sixteen feet of vein matter has been exposed at the bottom altogether. At this depth a pay streak in the vein assays from $5 to $140 per ton.

Queen Alexandra

In 1904 a shaft was sunk 85 feet on a quartz vein located on claim H.W. 270 on the eastern shore of Carleton lake. Carter[1] states that 18 tons of ore were treated in a small stamp mill erected on the property, and this produced $16.00 per ton in gold.

Very little can be seen now at the shaft. There is no vein exposed. The rock dump consists of chlorite schist with small lenses of quartz, both of which carry a little pyrite. A grab sample of this material assayed $1.80 per ton in gold. The country rock is schisted andesite cut by granitic dikes.

Victory (Upper Neepawa)

This mine was located on claim McA. 28 about half a mile northwest of Goldrock. It was worked in 1896 and 1897. A shaft was sunk to a depth of 100 feet on a vein, which Coleman[2] describes as follows:—

> . . . a bedded vein in schist about six or eight feet wide, so far as one could tell from the small amount of stripping done, very rich in gold, some brilliant specimens having been obtained here. The dirt overlying the vein pans richly, the gold being very coarse compared with that from some parts of the region.

At present nothing can be seen at the old shaft, but in a pit 25 feet to the west a sheared zone occurs in the massive andesite. This zone is about 5 feet wide and consists of a schisted quartz porphyry containing two quartz veins 6 inches in width. The zone is mineralized with pyrite and chalcopyrite and also considerably carbonated. A grab sample of this material was assayed but carried only a trace of gold.

Volcanic Reef

About the year 1904 a shaft was sunk 130 feet on a narrow quartz vein on claim S. 40, north of Kabagukski lake. The vein strikes N. 45° E., is about one foot wide, and is exposed over a length of 120 feet. The country rock is massive andesite. The vein is composed of sugary white quartz and a little included green schist. A sample chipped across 2 feet of quartz and schistose wall rock assayed 20 cents per ton in gold. The rock on the dump is almost entirely schistose greenstone.

MORE RECENT DEVELOPMENTS

The properties discussed in this group are either old mines which have been re-examined or prospects worked within comparatively recent years. In general, they are of greater economic interest than those previously described.

Manitou Island

The whole of Manitou island, excepting the southwest end, was held at one time by the Anglo-Canadian Explorers, Limited. They did a considerable amount of surface stripping and trenching, uncovering several quartz veins and a zone of sulphides. However, their interest was cancelled in March, 1928, and the claims were restaked for the Manitou Island Syndicate of Kenora. These

[1] W. E. H. Carter, Ont. Bur. Mines, Vol. XIV, pt. 1, 1905, p. 51.
[2] A. P. Coleman, Ont. Bur. Mines, Vol. VI, 1896, p. 85.

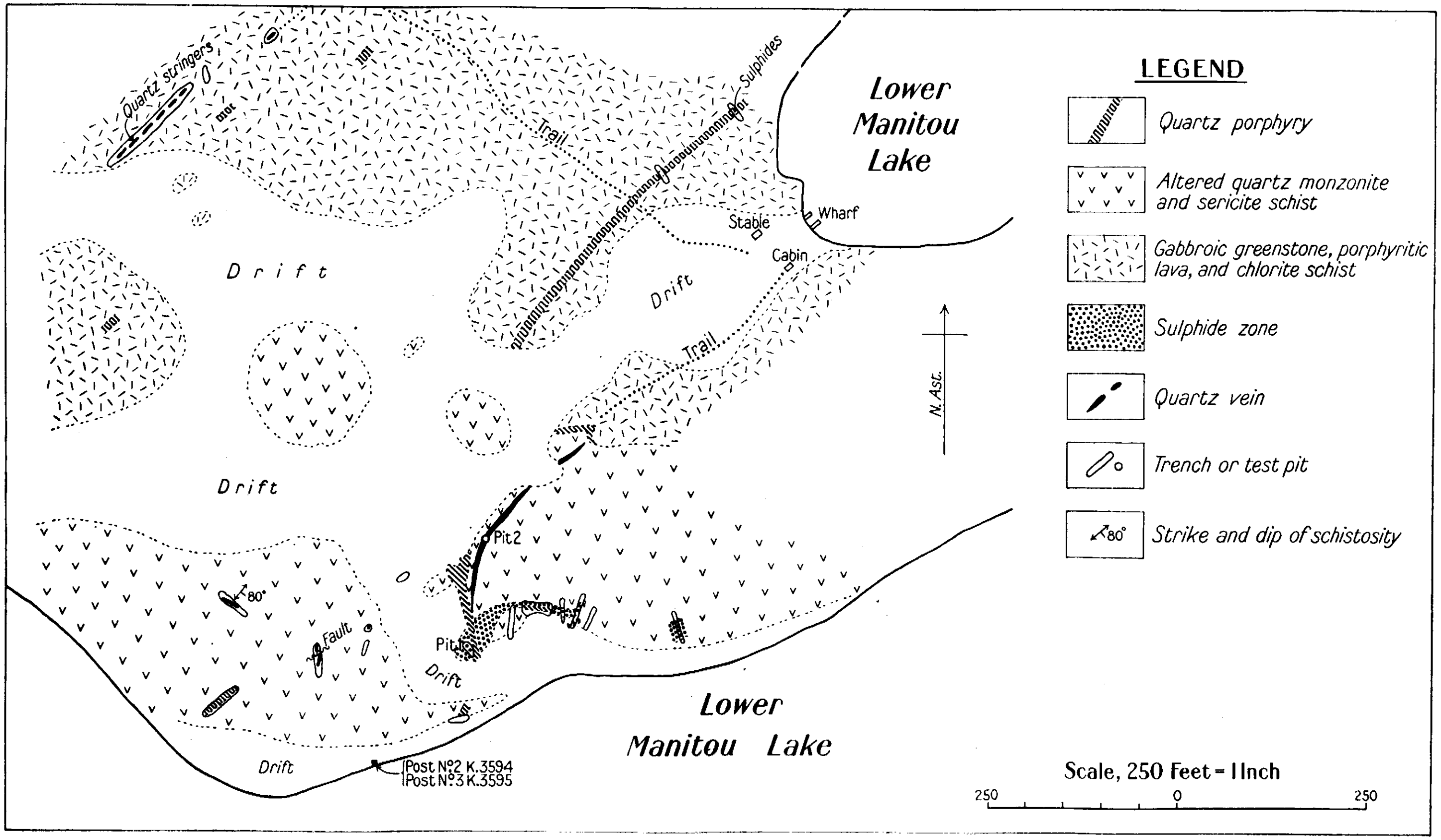


Fig. 4—Geological sketch map showing a part of Manitou island.

were again cancelled in November, 1931, and the northeastern portion of the island has since been restaked by Frank Gaffney, of Kenora, and his associates. The latest stakings include 10 claims (K. 3,594-99 and 3,795-97), one of which covers the old Bee-hive mine.

The most important discoveries on the island are shown on the accompanying sketch map (Fig. 4). The country rock in this vicinity consists of greenstone on the north, which merges into acidic rock toward the south. Immediately east of No. 1 pit this rock is medium-grained and dark-green in colour, and contains prominent "eyes" of quartz. Microscopic examination shows that it is a quartz monzonite. This same type of rock occurs throughout the western end of the workings, but it is often altered to a sericite schist. It is probably an intrusive and resembles the Laurentian rocks. The greenstones, quartz monzonite, and

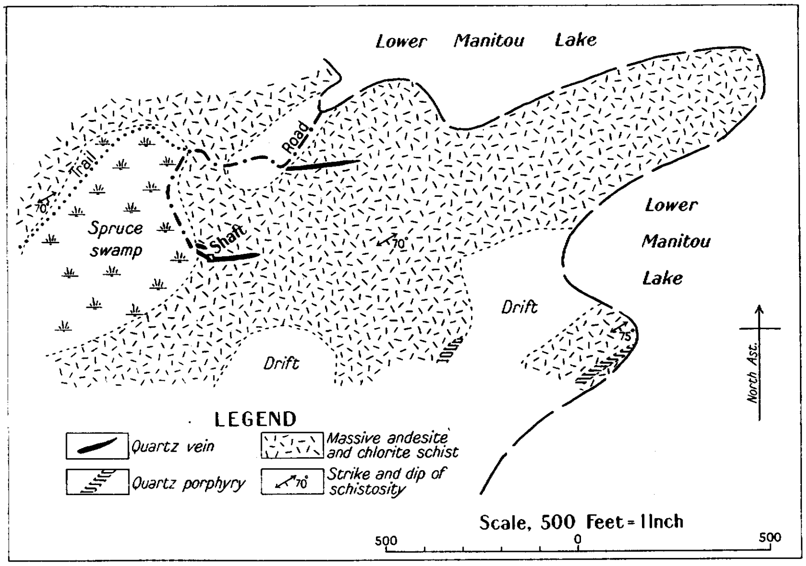


Fig. 5—Geological sketch map of the Bee-hive mine.

sericite schist are all intersected by dikes of quartz porphyry, which sometimes carry a considerable amount of pyrite.

A zone of sulphides, irregular in shape, is revealed in the quartz monzonite by a group of test pits along the side of a ridge near the south shore of the island. The sulphides are pyrite and, to a much lesser extent, chalcopyrite. They are most heavily concentrated near the contact of quartz porphyry dikes. The writer took a chip sample across 12 feet of sulphide material along the northeast face of pit No. 1. This assayed $42.80 per ton in gold. A grab sample of the massive quartz porphyry, which contained a fair percentage of pyrite and some secondary quartz, was also assayed and found to contain $3.30 per ton in gold.

North of the sulphide zone a quartz vein has been uncovered. It is composed of somewhat fractured white quartz, the fractures being filled with carbonate and fine-grained pyrite. The wall rock is carbonated quartz monzonite and is somewhat schistose. The principal vein is about 2 feet wide, but several smaller veins about 6 inches in width run parallel to it. At No. 2 pit the vein system is 6 feet wide. A chip sample across it near this point assayed $1.40 per ton in gold.

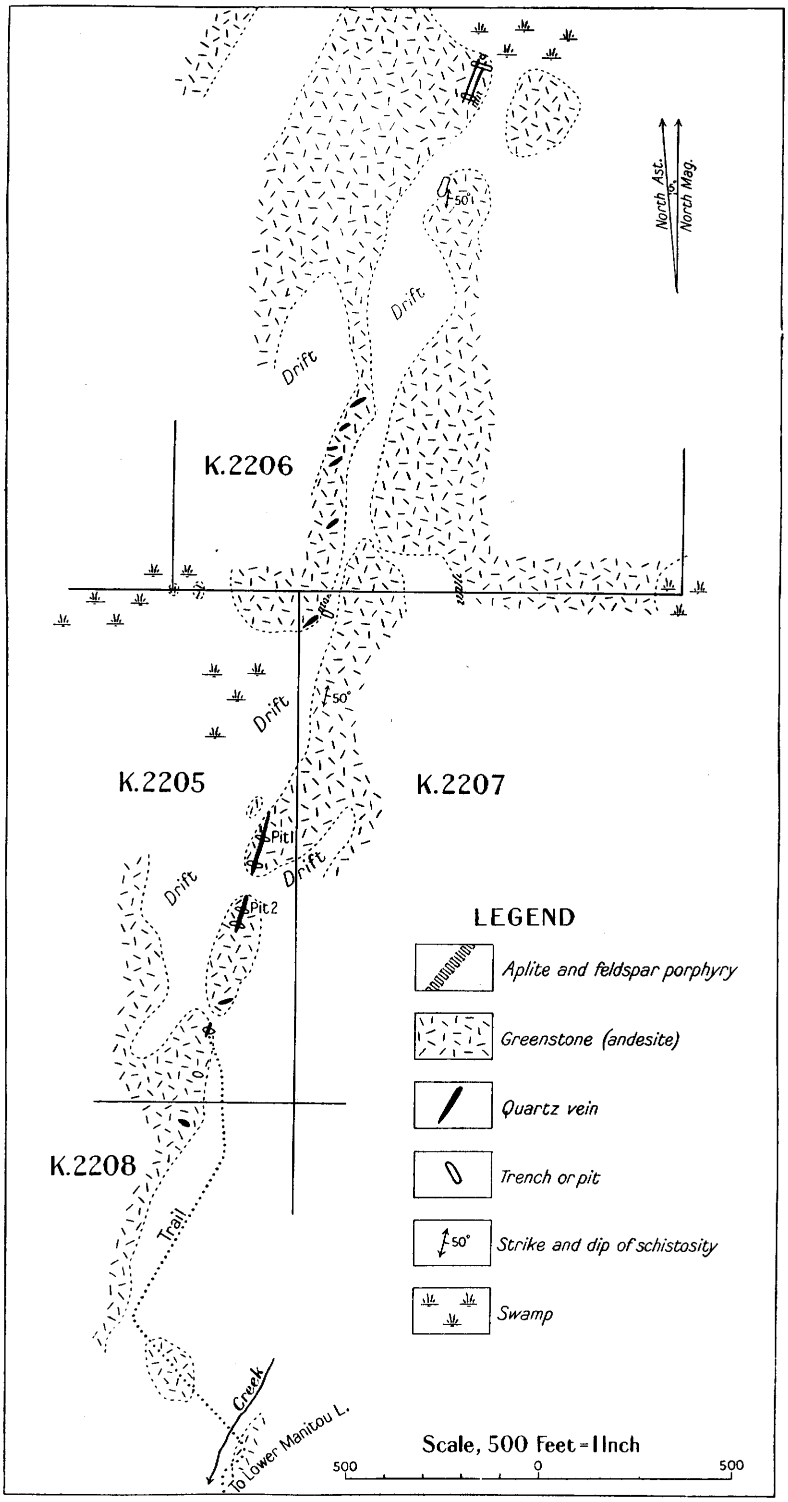


Fig. 6—Geological sketch map of the Dryden–Red Lake Partnership claims.

Near the central part of the island, west of the above-mentioned workings, there are two parallel quartz veins striking N. 65° E. and dipping 60° to 70° S.E. They may be traced 260 feet and 400 feet, respectively, and vary from a few inches to 4 feet in width. The shorter vein is somewhat fractured and contains a trace of sulphides. A sample taken across its widest part assayed 40 cents in gold.

Bee-hive

An old shaft is located on a quartz vein near the north end of Manitou island. This is the location of the Bee-hive mine, which was worked in 1897. The vein may be traced east for 140 feet from the edge of a swamp. The dip is almost vertical. It averages about 3 feet in width, but at the western extremity it splits into two parts and becomes considerably wider. The vein material consists of well-fractured white quartz containing a considerable amount of crystallized pyrite and chalcopyrite in places. Tourmaline occurs in the vein and also veinlets of carbonate. Immediately west of the shaft, the writer found some fine specimens of native gold in the quartz. A few feet west of this spot, a chip sample was taken across 10 feet of well mineralized quartz. When assayed, this was found to contain no gold values. An attempt has been recently made to dewater and retimber the old shaft.

North of the shaft there is another vein which may be traced 180 feet and averages about 3 feet in width. It consists of white quartz with a series of fractures running parallel to the walls. No mineralization was noticed.

Dryden-Red Lake Prospecting Partnership

Four claims (K. 2,205-2,208, inclusive), located north of Lower Manitou lake, are held by this group, for which C. J. Wright, of Dryden, is agent. The main showing on the property is a sheared zone containing quartz veins and chlorite schist. It strikes N. 10° E. to N. 15° E. and dips 45° to 55° E. The sheared zone lies in massive andesite and has a maximum width of 20 feet, averaging 10 to 12 feet. On claim K. 2,205 two prominent quartz veins up to 1 foot in width occur in the sheared zone. Both quartz and schist contain a little pyrite and carbonate. The sheared zone is largely covered by drift, but it has been traced about 300 feet along the strike on claim K. 2,205 and then disappears to the north under overburden. A sample chipped across 8 feet of quartz and schist by the writer in pit No. 2 assayed $1.00 per ton in gold; another sample from pit No. 1, across 4 feet of vein material, assayed $12.80 per ton in gold.

Several lenticular masses of milky-white quartz adjoin the sheared zone. These have an *en échelon* arrangement and probably occupy fractures that were formed as the result of tension stresses at the same time as the main sheared zone. These quartz masses are devoid of mineralization and do not hold much promise of gold values.

Frenchmen Island, Upper Manitou Lake

At least three quartz veins occur on this island, but development work has been confined to a vein that runs in a southeast-northwest direction across the central part of the island (claim P. 150). Test pits have been sunk at intervals along the vein, which may be traced about 525 feet but is rather poorly defined. The strike varies from E. 25° S. to E. 40° S., and the dip is about 70° S.W. The vein lies in granodiorite and varies from 1 to 8 feet in width. It consists of sugary white quartz and contains a little fine-grained pyrite. The wall rock is sericite schist, which sometimes carries pyrite and chalcopyrite. At its western extremity the vein outcrops on a cliff, and the well-defined sheared zone may be seen in vertical sections. A chip sample was taken across 3 feet of quartz and mineralized schist at this place. This assayed $3.80 per ton in gold.

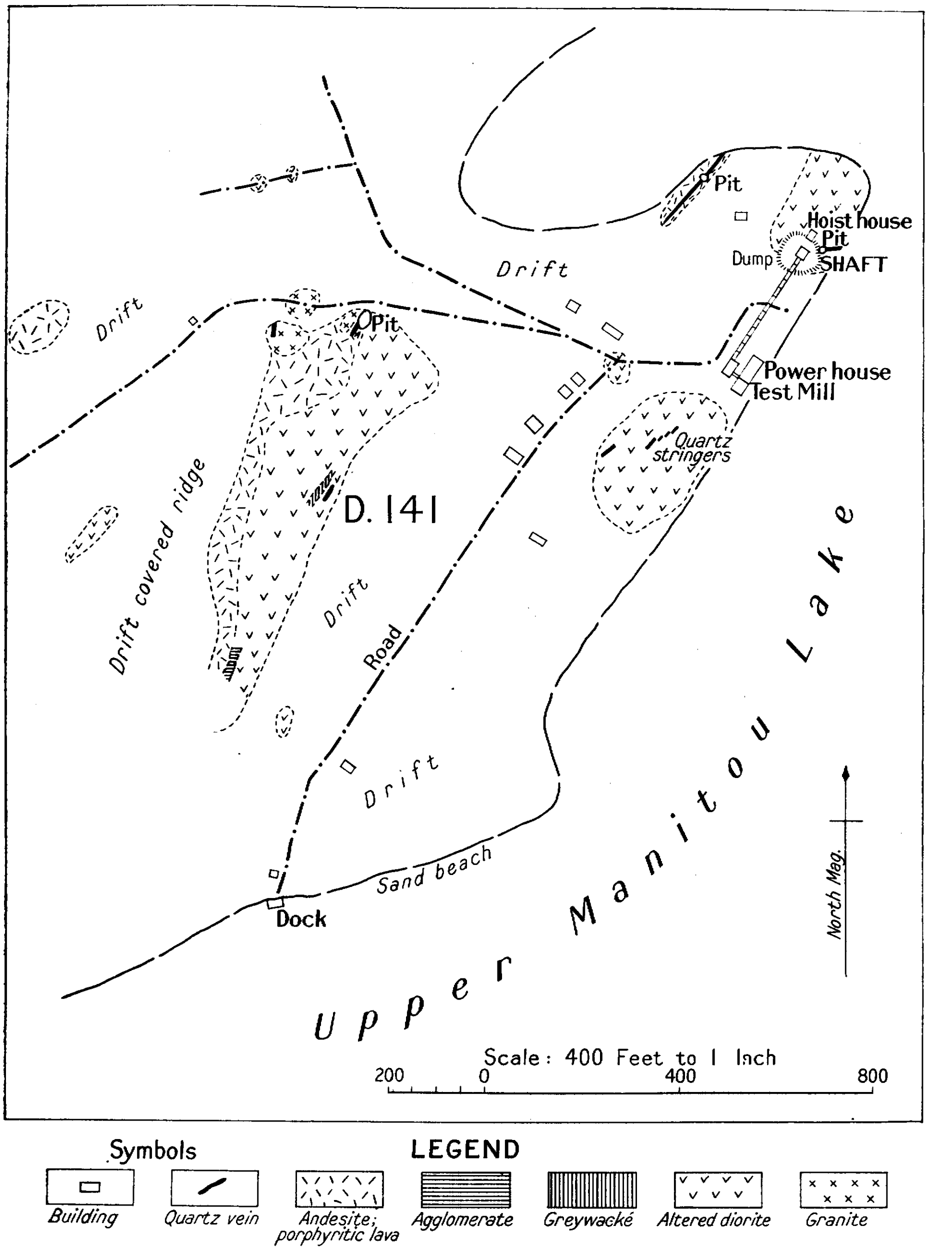


Fig. 7—Geological sketch map of the Gold Rock mine.

Gold Rock Mines, Limited

This company was organized in 1929 and took over five groups of claims from the Gold Rock Mining Syndicate, Limited. Practically all work was done on the old Haycock property (claim D. 141) on the west shore of Upper Manitou lake during 1928 and 1929. Camps were erected to accommodate 40 men, and all necessary mine buildings, including a 2-stamp mill, were completed. The old shaft was deepened and a crosscut was driven 170 feet.[1]

The rocks in the vicinity of the mine are chiefly altered quartz diorite with lesser amounts of andesite and agglomerate. It is impossible to state whether the quartz diorite is a coarse-grained phase of a lava or an intrusive. About 400 feet west of the mine buildings there is a small mass of intrusive granite.

At the shaft the vein is covered by the dump and mine timbers, but it is exposed in a pit east of the dump and may be traced a distance of 25 feet to the lake shore. The vein, which is 1½ feet wide, is well defined and consists of white quartz with a little green schist, which carries some pyrite and a trace of chalcopyrite. Native gold was observed in the quartz at the lake shore. A sample chipped across the vein in the pit assayed $2.20 per ton in gold.

Gold Rock mine, Upper Manitou lake.

A second vein occurs 125 feet west of the shaft. This has a general strike of N. 40° E. and dips 65° S.E. The vein ranges from 2 to 8 feet in width and may be traced about 200 feet from the lake shore. It consists of rather sugary quartz and a little included schist, and contains only a trace of sulphides. A representative sample taken across the width of the vein in a test pit gave no gold values. A few other small lenses of quartz occur on the property.

It is apparent that the surface showing did not justify the considerable expenditure on equipment, and there is little reason to believe that this mine could be profitably reopened.

Reliance

This has been formerly known both as the Westerfield mine and the Independence mine. It is located west of Carleton lake on claim K. 3,412 and may be reached by a wagon road from the south end of Upper Manitou lake.

As early as 1899, three shafts were sunk to shallow depths on the vein. During 1900, the main or No. 3 shaft had reached a depth of 85 feet. In 1904, No 2 shaft was down 97 feet, having been sunk that distance on the vein. A

[1]Ont. Dept. Mines, Vol. XXXIX, pt. 1, 1930, p. 97.

drift was also run to the north along the vein. Apparently no work has been done since that time. E. G. Rognon, the owner of the property, has recently fixed up the old road preparatory to further development work at the mine.

A quartz vein, which is not well exposed at the surface, has been traced along a sheared zone by shafts and test pits for a distance of about 800 feet.

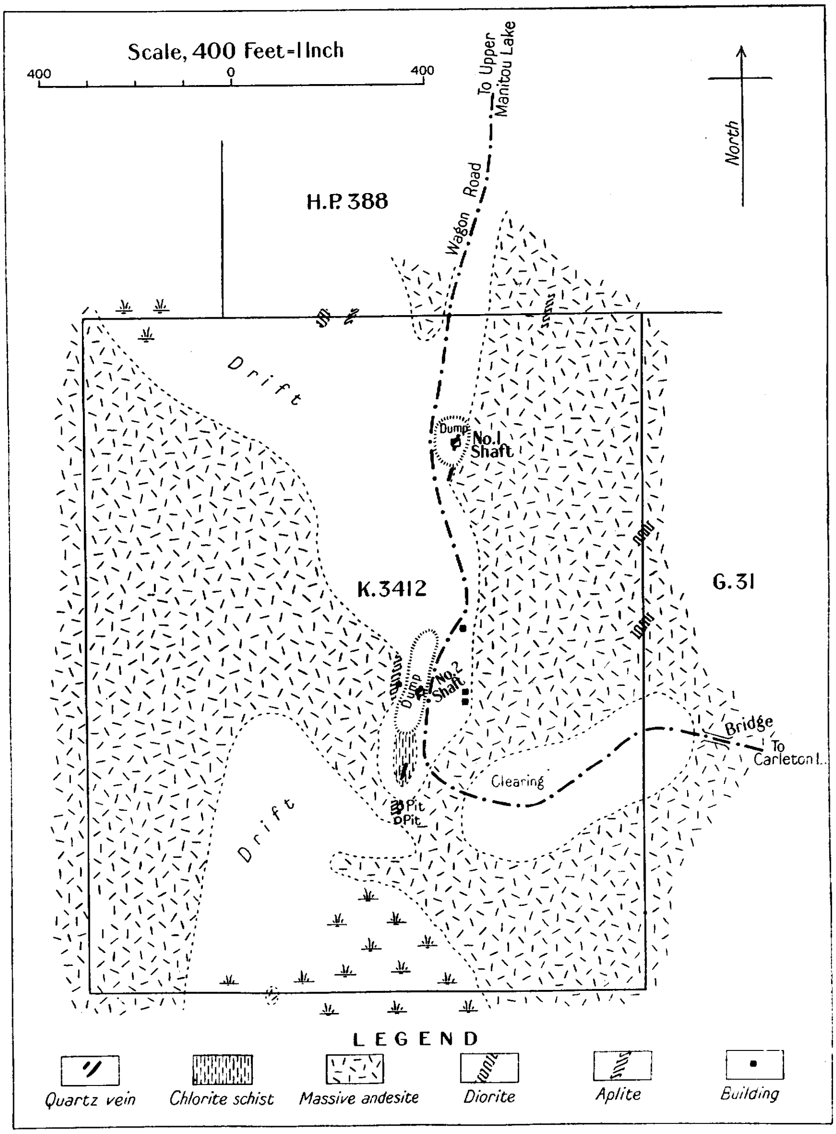


Fig. 8—Geological sketch map of the Reliance mine.

The sheared zone strikes N. 15° E. and dips 60° to 75° S.E. The vein material consists of fractured quartz containing a little tourmaline and schist. The included schist carries pyrite and sometimes traces of pyrrhotite, chalcopyrite, and sphalerite. The wall rock is a carbonated chlorite schist. The width of the vein cannot be ascertained at the two shafts, but in one of the pits there is mineralized quartz and schist across 6½ feet, the quartz vein being about 2 feet wide. A chip sample, taken across the full mineralized width, did not contain any gold values. A grab sample of the best-looking vein material on the dump at No. 2 shaft also gave a blank, but a similar sample from No. 1 shaft assayed $4.00 per ton in gold.

The claim is largely covered by massive andesite, which is intruded by an occasional aplite dike. A small stock of granite occurs near by on Carleton lake.

Merrill Claims

During the summer of 1932, Charles Merrill, of Wabigoon, restaked the old "Swede Boy" location. This lies about a mile southwest of Upper Manitou lake and may be reached by a trail from the lake.

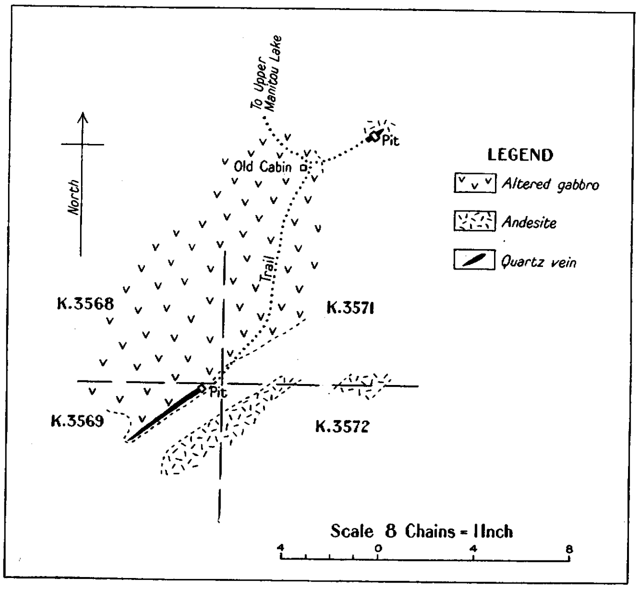


Fig. 9—Geological sketch map of the Merrill claims.

The property was originally staked by three Swedes in 1895. It was claimed that gold occurred in paying quantities in the mud of the swamp near the vein, and a crude attempt was made to establish placer mining, but only a few dollars worth of gold was recovered.[1] The source was probably a milky quartz vein 2½ feet wide, which strikes N. 53° E. and dips 47° S.E. It may be traced about 15 feet along the strike. A shallow test pit has been sunk on the vein. A sample chipped across 4 feet of quartz and schist in the pit gave no gold values.

About 850 feet to the southwest a second quartz vein occurs. It has a strike of N. 55° E. and dips 70° S.E. It may be traced roughly 250 feet and has a width of almost 7 feet in a pit located at the northern limit of its exposure. The vein quartz contains a trace of tourmaline and some green schist in which pyrite and a little chalcopyrite are found. A sample taken across the width of the vein in the pit on assay gave no gold. Native gold is reported to occur in the vein.

[1]A. P. Coleman, Ont. Bur. Mines. Vol. VI, 1896, p. 83.

The vein occurs along the side of a ridge of massive gabbro. To the east the rock is gabbro and basalt occasionally intersected by small dikes of feldspar porphyry or granite.

After the writer's visit to the property, Mr. Merrill uncovered a quartz vein about 250 feet east of No. 3 post of K. 3,571. The vein and associated schist contained some rich specimens of native gold. Mr. Merrill reported the vein to be about 18 inches in width and had traced it 100 feet.

Swede Boys Islands

On the larger of these islands (H.P. 259) an old shaft is located on a quartz vein, which strikes N. 50° E. and dips 75° S.E. The vein is about 2 feet wide and may be traced about 15 feet to the southwest. There are some old pits along the strike to the northeast, but no vein material can be observed. The wall rock of the vein is chlorite schist carrying a little pyrite. Native gold was observed in the schist. A grab sample of the ore on the dump assayed $8.80 per ton in gold.

East of the shaft on the shore of a small bay a stockwork of small quartz stringers and schist occurs across a width of 6 feet and may be traced along the shore a short distance. The quartz and schist carry a little sulphides.

Another old shaft is located on the smaller island (H.P. 260) to the northeast. It was sunk on a small lens of milky-white quartz in massive agglomerate and tuff. The quartz lens is about 2 feet in width and may be traced 30 feet. It contains a trace of pyrite and chalcopyrite. A grab sample of the material on the dump assayed 80 cents in gold.

Watson Claim

This claim (S.V. 343) is located east of Beck lake. A quartz vein occurs immediately south of a small creek. It strikes N. 30° E., dips 75° S.E., and is 5 feet wide. The vein outcrops again about 100 feet southwest of the creek. Here the quartz is 4 feet wide but is white and vitreous. A trace of sulphide, chiefly pyrite, occurs in the schistose wall rock. A sample chipped across 5 feet of quartz and schist contained no gold values. It is reported and evidently quite true that a pocket containing spectacularly rich native gold was found in the quartz vein at the creek. This must have been localized within a small area, as no sign of gold could be seen in the quartz surrounding the small pit from which the high-grade ore was supposed to have been taken. The vein occurs in massive andesite.

Wetelainen Claims

Jonas Wetelainen, of Goldrock, owns claims K. 2,956, K. 2,955, and K. 2,954, all of which adjoin the Watson vein. Several small veins and lenses of quartz occur in massive andesite. The largest of these is found near the southeastern corner of K. 2,955, where there is a vein about 60 feet in length and 1 foot wide. Mr. Wetelainen reported an assay of $3.60 in gold from this location. About the centre of claim K. 2,954 a small pocket of very rich native gold was found in a vein of quartz and mineralized schist. A sample taken by the writer across 6 feet of vein material at the spot from which the gold-bearing samples had been removed assayed $1.40 per ton in gold.

Laurentian

In 1924 Bruce[1] examined the Laurentian, Big Master, and Jubilee mines, and prepared a geological map of these properties. As no work has been done

[1]E. L. Bruce, Gold Deposits of Kenora and Rainy River Districts, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925.

at these mines since that time, the writer did not examine them in detail. Bruce's geological map is reproduced here with a slight modification in the interpretation of one of the rock formations (see Fig. 10). As previously stated, the writer

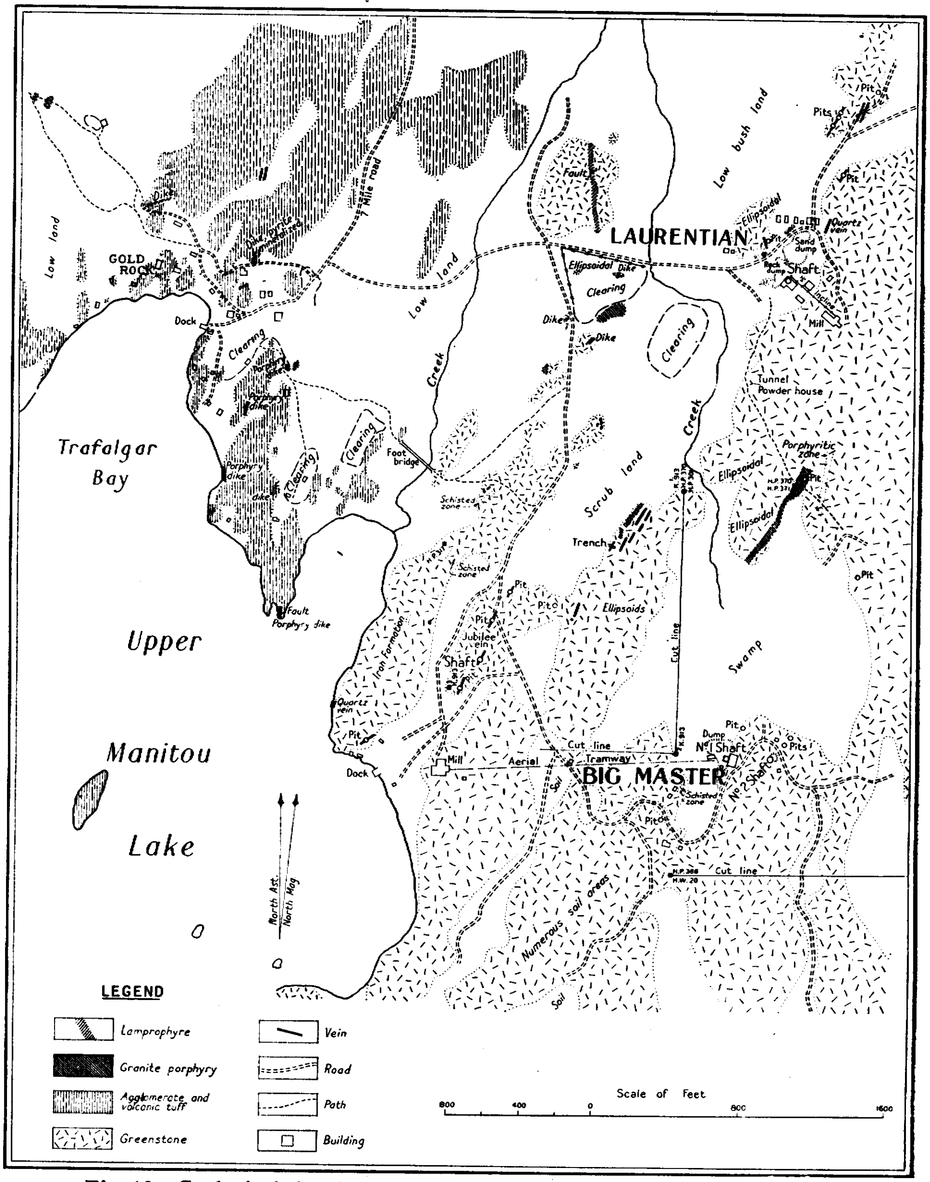


Fig. 10—Geological sketch map of the Laurentian, Big Master, and Jubilee mines (after E. L. Bruce[1]).

regards the fragmental rock near Goldrock as agglomerate and volcanic tuff rather than a brecciated porphyry.

The following information is abstracted from Bruce's report:[2]—

The Laurentian, H.P. 371, which began operations in October, 1903, was rapidly developed, and a 20-stamp mill was installed and put in operation in May, 1906. On the 1st level, rich ore

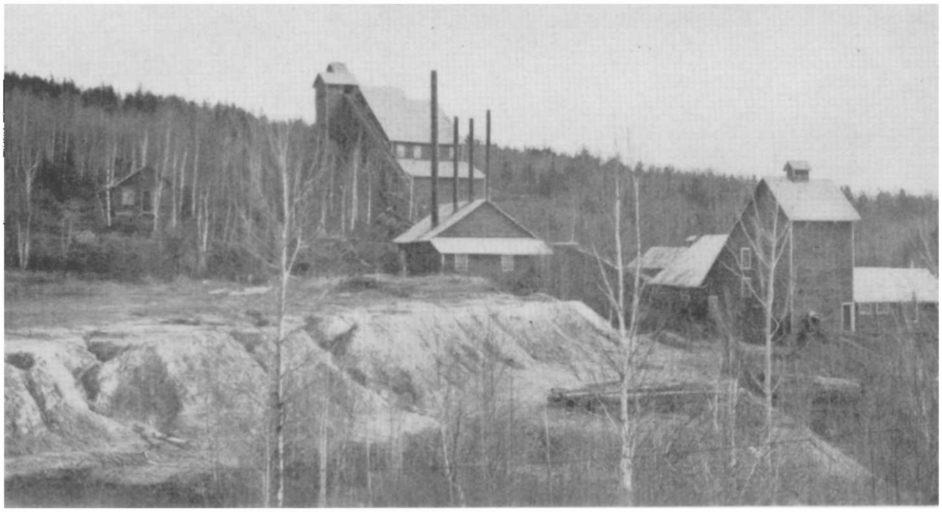
[1]E. L. Bruce, op. cit.
[2]Ibid, pp. 35, 36.

occurred in a narrow vein, in parts of which there was more gold than quartz. Production continued fairly steadily until November, 1909, when the mine went into receivership. In 1911, a little work was done; and in 1913, the Great Golconda Mines Company, Limited, took out and milled some ore from the old workings. The Dominion Reduction Company dewatered and sampled the workings early in 1916, but no work was done and their option was not exercised. . . .

The veins of the Laurentian and Big Master system trend slightly east of north. At the Laurentian shaft, the vein cannot now be seen, but following the road north from the houses a vein is exposed by pits just west of the road, and two small parallel veins lie somewhat to the east. The strike of these veins would carry them near the Laurentian shaft if they continue that far. The vein in the pits consists of two lenses of quartz, the eastern one ten inches wide and the western four inches wide, separated by three feet of rather rusty chloritic schist. A second pit 200 feet to the north exposes 80 inches of solid quartz. A sample taken across the face of this pit gave no gold and only a trace of silver.

Published descriptions of the underground workings state that the ore occurred as exceedingly rich stringers of quartz in zones of schistose rock.

"The ore body consists of bands of quartz varying from a mere trace up to several inches in width. . . . Occasionally schistose bands are found which, when quartz is present in thin



Laurentian mine, Goldrock.

stringers, may be regarded as ore bodies. The width of the principal vein is as much as forty feet, but will probably not average more than twenty feet."[1]

The total amount of quartz seems to have been very small. It is reported and is apparently true that much gold was stolen. The production is reported as follows:—

Production of Gold from the Laurentian Mine

1906	$26,325.00
1907	50,470.75
1908	32,248.75
1909	32,104.61
Total	$141,139.11

Little quartz remains on the dump, and apparently all that was of any value has been put through the mill since. A sample left in the bins carried only a trace of gold. The tailings from the milling are rather coarse, and high losses would be expected. A sample from the surface of the dump gave only eighty cents per ton, but the lower part may be somewhat richer.

Big Master

The following is taken from Bruce's[2] description of the property:—

The Big Master mine consists of claims H.P. 366, 367, 368, 369, and 373. No mention of it is made in government reports previous to 1900, when it is stated mining operations were

[1]A. L. Parsons, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, p. 182.
[2]E. L. Bruce, op. cit., pp. 35, 37.

suspended to install new machinery, and apparently the mine had then been in operation for some time, as the amount of development described was considerable. After the installation of the plant, which included a 10-stamp mill, operations proceeded steadily with some gold production until 1904. The mine remained closed for over a year and was then again operated from April, 1905, to January, 1906. It was pumped out for examination in 1911. Again in 1916, the Big Master was examined by the Dominion Reduction Company at the same time that that company sampled the Laurentian. . . .

The Big Master vein is covered by the dump at the shaft, but 200 feet northeast is exposed in a pit as several stringers of quartz one to two inches wide, in a rusty zone four to six feet wide which contains some siderite and pyrite. The shaft east of the main shaft was sunk on a rusty zone in schistose ellipsoidal-weathering greenstone. At the shaft south of the road to Goldrock, there is a vein of quartz twenty inches wide, but no sulphides.

The Big Master vein or veins, as they appeared underground, are described in various reports of the Ontario Bureau of Mines.

"The pay shoot, which lies northeast of the shaft, has a length of eighty feet along the vein (2nd level) and an average width of eight feet, both of which dimensions it maintains fairly closely from the surface down. The average value is given as $8.00 per ton. The big or east vein, lying to the southeast of the above, is also reported to have a pay shoot, which is ninety feet long and about five feet wide, lying directly opposite the one mined in the west vein. These pay shoots are well defined from the rest of the vein in that they each consist of a sudden enlargement of the quartz to about double its width elsewhere. It is stated by the manager that the quartz of the west vein carries values pretty well throughout, but that except at the so-called pay shoot, it is too narrow to mine at a profit."[1]

The report for the following year differs materially in the values quoted. The statement is made that the west vein widens from two and a half feet on the surface to nine feet at 285 feet, and that in the vein there is a shoot thirty feet in length on the surface and 156 feet long at a depth of 185 feet, with an average value of $17 per ton. The east vein along the 85-foot level had a width of twelve feet with a shoot of ore 140 feet long, averaging $8.35 per ton.[2]

It may be assumed that the lower value of $8 or thereabouts per ton is more nearly the average value of the ore shoots and that, as stated, only those parts of the vein, where the width increased to four or five feet, could be classed as ore; that is, that where the drift required the removal of wall rock, values were not sufficiently high in the vein to maintain ore grade with the dilution of vein matter with low-grade rock.

Jubilee

The Jubilee mine is located on claim H.P. 301. Bruce describes the vein as follows:[3]—

The Jubilee vein has been opened at a point a short distance north of the Big Master mill and a shaft has been sunk at a point where it is 4 feet in width. Southwestward, the vein is exposed for about 15 feet, and in that distance it narrows to 3 feet. A large proportion of the material is quartz, which is white, vitreous, and with only a small quantity of pyrite in it. The schistose wall rock, however, contains sufficient sulphide to cause it to weather red. Two hundred feet to the northeast, a pit on the same vein shows a sheared zone 8 feet wide, of which one-half is quartz of a white vitreous variety, somewhat iron-stained. The walls of the vein consist of sericite schist, which is impregnated to some degree with pyrite. A sample channelled across the vein, near the shaft where the width is 4 feet, gave an assay of $5 per ton in gold. Another vein or series of veins occurs on the Jubilee property, just east of the Jubilee dike of granite porphyry. The largest of these is a lenticular mass of quartz 2½ feet wide in a band of rusty-weathering schist 4 feet in width.

Sakoose

The Sakoose mine is located 6 miles south of Dyment station on the Canadian Pacific railway on claims H.W. 416 and 475. It was originally known as the Golden Whale mine. The Sakoose was worked from 1899 until 1902. Carter[4] reports that 7,735 tons of ore were mined and milled from the stopes. A spur line was built to the railway, and the ore was shipped to the Keewatin Reduction Works for treatment.

The writer did not visit the property. The following account of the geology, and the geological map (Fig. 11), is taken from Bruce's report:[5]—

[1]W. E. H. Carter, Ont. Bur. Mines, Vol. XIII, pt. 1, 1904, p. 68.
[2]Ibid, Vol. XIV, pt. 1, 1905, p. 54.
[3]E. L. Bruce, op. cit., p. 37.
[4]W. E. H. Carter, Ont. Bur. Mines, Vol. XI, 1902, p. 255.
[5]E. L. Bruce, op. cit., p. 39.

At the shaft, the main vein occurs in the quartz porphyry. Northeastward, the walls are the rocks classed as sediments and silicified greenstones. The wall rock is sheared slightly in places, but the alteration is not extensive. The vein is very irregular in strike and dip and varies in width from a few inches to 5 feet or more. The quartz is an unusual dull blue colour and rather vitreous. Very few other minerals occur in the vein.

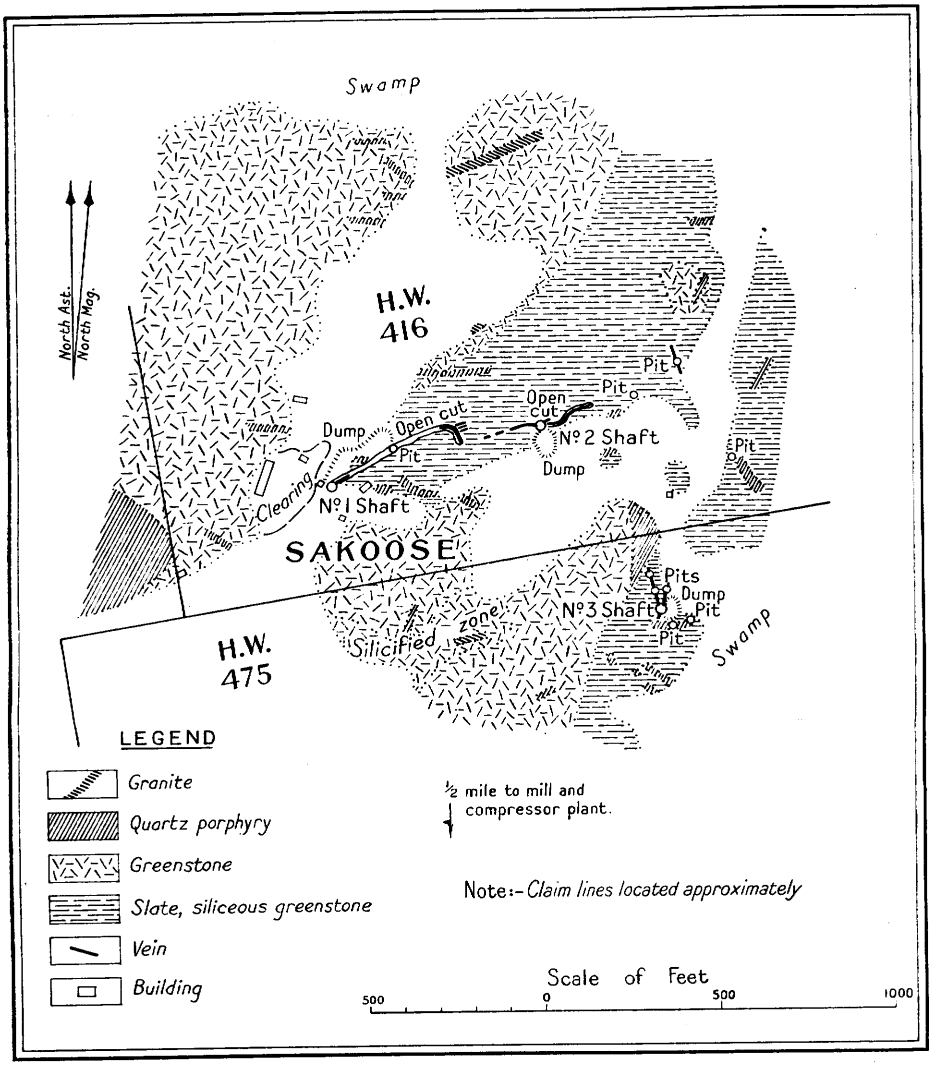


Fig. 11—Geological sketch map of Sakoose mine (after E. L. Bruce[1]).

The mine was examined by Percy E. Hopkins, consulting geologist, in June, 1931, and 500 feet of diamond-drilling was done. Mr. Hopkins has informed the writer that No. 1 shaft averaged $17 per ton in gold across 18 inches to a depth of 120 feet, and sampling of the open cut immediately east of this shaft averaged around $10 per ton in gold. Four short diamond-drill holes were sunk west of the shaft in an endeavour to find the extension of the vein under drift, but it was not located.

[1]E. L. Bruce, op. cit.

Geology of the Kakagi Lake Area

By E. M. Burwash

INTRODUCTION

The region immediately to the east of the Lake of the Woods lies somewhat away from main lines of travel either by rail or water. It is readily accessible, however, from the lake and easily traversed by means of a network of smaller lakes and connecting streams. A railway line that has been projected through has still to be started, but a motor highway is at present under construction along its western margin between Kenora and Fort Frances.

This area attracted prospectors and lumbermen during the last decade of the last century with the result that extensive logging operations were carried out

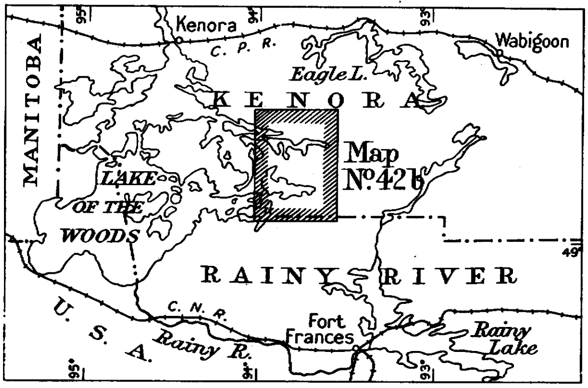


Fig. 1—Key map showing location of the Kakagi Lake area. Scale, 50 miles to the inch.

and numerous mineral claims staked for gold. One property only, the Regina, situated on Regina bay of the Lake of the Woods, continued in operation for more than a short period. The shaft reached a depth of over 500 feet with nine levels, and the ore was treated by stamping, amalgamation, and cyaniding. Work had practically ceased in 1906, after the mine had been operated for about twelve years. The operation of the other properties in the area to the east of the lake was in nearly all cases commenced later than the Regina, and all were abandoned by 1903.

There were some rich openings, but no very satisfactory developments appear to have resulted. A shaft was sunk in one case, the Virginia mine, to a depth of 200 feet, and it was hoped that further development would produce a working mine, but the work was discontinued. Several attempts to resume operation of the Regina have been made since then. After a change of ownership in recent years it was renamed the Horseshoe mine, and as late as 1931 was dewatered for examination by engineers representing several financial interests. More extended studies of the geology of these and other properties will be found in the section on "Economic Geology."

In view of the improvement of mining and metallurgical methods since work was practically abandoned in this region,[1] the present advantageous conditions for gold mining, and the advance in knowledge of the geology of the gold deposits of the pre-Cambrian that has been made during the same interval, the Department of Mines of Ontario undertook a resurvey of the geology of the area concerned in 1930 and commissioned the present writer to perform the work. The field work was continued during the summers of 1930 and 1931 and has resulted in the mapping of an area approximately 20 by 30 miles on a larger scale (one mile to the inch) than that of the existing maps, and in more detail. Previous maps include the Manitou Lake sheet[2] of McInnes, published in 1902, on a scale of 4 miles to the inch. A small part of the area is covered by A. C. Lawson's map, issued in 1885[3] and republished for the Sixth Report of the Ontario Bureau of Mines in 1897, on a scale of 2 miles to the inch. The map of the southeastern part of the Rainy River district,[4] published by the Ontario Bureau of Mines in 1895, on a scale of 2 miles to the inch, which contains work done by Lawson to the southeast of his Lake of the Woods map, covers the southern part of the area.

The present survey was carried out with the object of ascertaining more accurately modes of mineral occurrence and the probability of their successful exploitation, so far as geological data will accomplish these ends. The larger scale of the map accompanying this report, No. 42*b*, has permitted a much greater degree of differentiation of the various rock formations, and particularly of the lavas, pyroclastics, and sediments, as well as more extensive tracing of boundaries, particularly of igneous contacts. Special attention was paid to the granites and other igneous masses that might be metallogenetic. Some study was also given to the apparent stages in the process of mineralization.

General Description of the Map Area

The mapped area extends from the southern part of Dryberry and Populus lakes on the north to the boundary between the districts of Kenora and Rainy River on the south. Its eastern limit passes through Atikwa, Rowan, and Pipestone lakes, at approximately longitude 93° 33′ W. The western margin crosses Lobstick, Regina, Snake, and Sabaskong bays of the Lake of the Woods at about longitude 94° W. The map-sheet lies directly east of Aulneau peninsula, or Grande Presqu'île, which separates the northern and southern expansions of the Lake of the Woods.

On the north side of the peninsula, access to the field is most easily obtained by launch from Kenora to Whitefish bay, which lies between the east side of the lake and the northeast coast of the oval peninsula,[5] separating the peninsula almost completely from the mainland. This route leads most directly to the northern part of the area. The distance by launch from Kenora to Whitefish rapids is about 45 miles. The southern part is more easily reached from Sabaskong bay, which is on the south side of the peninsula and leads by way of Crow portage to Kakagi and its connecting lakes. Access to Nestor falls in Sabaskong bay is gained from Fort Frances by the completed part of the Kenora–Fort Frances highway. The distance is about 75 miles.

[1]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925; republished as Bull. No. 85 in 1932. For a general summary of the geological and economic factors, see pages 1 to 3; for a description of the Regina mine, pages 10 to 13.

[2]Geol. Surv. Can., Map No. 720, 1902.

[3]Ibid, Vol. I, pt. CC, 1885.

[4]Ont. Bur. Mines, Vol. IV, 1894.

[5]For a full description of the topography of the Lake of the Woods, *see* A. C. Lawson, Geol. Surv. Can., Vol. I, pt. CC, 1885.

Population and Industries

Apart from a few white men engaged in trading, prospecting, and the care of tourist camps or mines, there is no permanent population in the area except the Indians who live at Whitefish rapids, Crow portage, and Kakabikitchiwan lake. In whole or in part five Indian reserves are included in the map-sheet, but the total number of persons who live on them is not large. When lumbering operations are in progress there may be over 1,000 men employed. Several crews of the Keewatin Lumber Company were engaged in bringing out pulpwood in 1930, but none in 1931. A few fishermen operate on the lake in the summer, and there are also a number of tourists and the officers of the Ontario Forestry Service. Summer travel in the region is prohibited except by special permit, owing to the value of the timber, which has grown for more than thirty years without serious fires.

Acknowledgments

During the field work in the summers of 1930 and 1931, friendly assistance was extended to the field parties by several persons in many ways. At Kenora, J. D. C. Smith, the mining recorder, the officers of the Department of Northern Development, and Lt.-Col. A. T. Fife are especially mentioned as having afforded indispensable help. The men in charge at the Horseshoe mine and at the Keewatin Lumber Company's depot at Whitefish rapids rendered the party services which saved much time and effort in carrying out the work. At Fort Frances, in 1931, we were also indebted to the Northern Development Department, which afforded us transportation to Nestor falls and saw to forwarding mail and supplies. Owners and caretakers of tourist cottages and of the hotel at Nestor falls also tendered us the use of facilities that saved much otherwise necessary travel.

The writer wishes especially to acknowledge the services of the six assistants who during two seasons were connected with the work. The competent help of W. D. Harding and C. B. Morgan added much to the extent of territory that could be covered. The junior assistants, Messrs. R. A. Young and Walter Sutton in 1930, and C. M. Stanbury and R. J. Beggs in 1931, contributed their full quota to the results by patient and often strenuous work and by the able performance of the technical duties assigned to them.

Climate

The following figures, taken from a publication by the Meteorological Service of the Department of Marine of Canada, indicate sufficiently the range of temperatures and the rain and snowfall of this area:—

TEMPERATURE (AS AT KENORA)—DEGREES F.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean maximum	7	12	26	45	59	72	75	72	63	48	28	15	44
Mean minimum	-12	-12	2	26	37	50	54	50	42	32	14	0	24
Mean.........	-2	0	14	36	48	61	64	61	52	40	21	8	34
Mean ranges...	19	24	24	23	22	22	21	22	21	16	14	15	87

Absolute range maximum recorded 99°.
Minimum recorded −45°.
Absolute range 144°.

PRECIPITATION (AT KENORA)—INCHES

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Rain	.....	.....	0.33	0.96	2.6	3.23	4.86	3.5	3.09	2.04	0.4	0.1	21.12
Snow	10.2	8.2	7.7	3.8	.8	.....	.....	.....	.5	4	7.8	10.2	53.2
Total (as rain)	1.02	.83	1.1	1.34	2.68	3.23	4.86	3.6	3.14	2.44	1.18	1.12	26.44

The climate may be fairly described as an extreme interior continental climate and rather dry. The ice in the Lake of the Woods, according to reliable local information, forms on an average about the middle of November and breaks about the middle of May, which gives clear navigation for six months and ice conditions for an equal length of time. The period during which the ice is safe for travel must be somewhat shorter.

Though the annual precipitation is not high, the summer maximum of precipitation (July, 4.86 inches) renders the climate very good for crops that do not mature too early, and especially for roots.

Flora

The following lists of trees, shrubs, and other plants, while by no means exhaustive, cover those which are commonly encountered.

Forest Trees (common)

White pine (*Pinus strobus*)
Red pine (*Pinus resinosa*)
Grey, northern scrub, or jack pine (*Pinus banksiana*)
Black spruce (*Picea nigra*)
Balsam (*Abies balsamea*)
Tamarac (*Larix americana*)
White cedar (*Thuja occidentalis*)
Juniper (*Juniperus communis*)
American aspen or white poplar (*Populus tremuloides*)
Balm of Gilead or balsam poplar (*Populus balsamifera*)
Large-toothed aspen or poplar (*Populus grandidentata*)
Alder (*Alnus incana*)
Elm (*Ulmus americana*)
White birch (*Betula alba*, var. *papyrifera*)
Maple (*Acer spicatum*)
Ash (*Fraxinus sambucifolia*)
Oak (*Quercus*, probably *macrocarpa*)
Willow (two or three species)

Herbaceous Plants

Wild strawberry in clearings (*Fragaria virginiana*)
Giant water-grass or reed grass (*Phragmites communis*)
Wild rice (*Zizania aquatica*)
Cat-tail flags (*Typha latifolia*)
Reed meadow grass (*Glyceria grandis?*)
Horsetail (*Equisetum arvense?*)
Yellow water-lily or pond-lily (*Nuphar advena*)
White water-lily (*Nymphaea odorata*)
Lesser water-lily (*Nymphaea odorato*, var. *minor*)

Owing to the use of horses and other activities connected with mining and lumbering there are also a great many introduced plants, which thrive without cultivation, including:—

Timothy grass (*Phleum pratense*)
Red top grass (*Agrostis alba*)
White clover (*Trifolium repens*)
Red clover (*Trifolium pratense*)

Shrubs

Saskatoon (*Vaccinium corymbosum*)
Blueberry (*Vaccinium canadense*)
Cranberry (*Oxycoccus vulgaris*)
Labrador tea (*Ledum latifolium*)
Swamp laurel (*Kalmia glauca*)
Meadow-sweet (*Spiraea salicifolia*)
Black currants (*Ribes floridum*)
Gooseberry (*Ribes oxyacanthoides*)
Red raspberry (*Rubus strigosus*)
Cloudberry (*Rubus chamaemorus*)

Mosses

The muskegs here, as elsewhere, and the damp wooded lowlands have a great variety of mosses, including especially *sphagnum* and other swamp plants, and in the woods, liverworts, club-mosses, and the very prevalent soft moss of the shady woods, commonly used for chinking log-houses. On the more exposed rocky surfaces, the so-called reindeer mosses or lichens are also common.

Fauna

This area has been of importance for its fish and game and, owing to the restriction of travel, is at present well stocked with many of the larger game animals.

Fish

Lake trout (*Cristivomer namaycush*)
Whitefish (*Coregonus clupeaformis*)
Pike (*Esox lucius*)
Maskinonge (*Lucius masquinongy*)
Pickerel or doré (*Stizostedion vitreum*)
Perch (*Perca flavescens*)
Sunfish (*Eupomotis gibbosus*)
Black bass (probably *Micropterus dolomieu*)
Sturgeon (*Acipenser rubicundus*)

Reptiles

Snapping turtle (*Chelyndra serpentina*), very large specimens and apparently quite common.
Common striped snakes.

Birds

The following, with several species of plover that were not identified, were the common water birds of the lakes and rivers. They all nest in this locality. The more sought-after game, ducks, were notable by their absence.

Loon (*Gavia imber*)
Herring gull (*Larus argentatus*)
Common tern (*Sterna hirundo*)
Sawbill duck (*Merganser americanus*)
Great blue heron (*Ardea herodias herodias*)

Of the larger members of the carnivorous and other land birds, the more commonly seen were:—

Crow (*Corvus brachyrhynchos brachyrhynchos*)
Red-winged blackbird (*Agelaius phoeniceus phoeniceus*)
Osprey (*Pandion haliaetus carolinensis*)
Great horned owl (*Bubo virginianus virginianus*)
Ruffed grouse (*Bonasa umbellus umbellus*)

Large numbers of birds, assumed to be warblers, chickadees, nuthatches, and smaller woodpeckers, are found in the woods and along the shores, but attention could not be given to accurate determination. The Canada jay (*Perisoreus canadensis canadensis*) is of course common.

Mammals

The following mammals were observed as among those common in the region:—

CERVIDAE

Moose (*Alces americanus*)—quite numerous and as observed appear more strongly marked, with black back and sides, brown head, and pale grey legs, than those seen by the water elsewhere.
Red deer (*Odocoileus virginianus*, var. *borealis*)—very common in this protected area, where little travel is allowed.

RODENTIA

Porcupine (*Erethizon dorsalis*)—extremely common.
Beaver (*Castor canadensis*)—not many remain.
Varying hare (*Lepus americanus*)—fairly abundant.
Red squirrel (*Sciurus hudsonicus*)
Chipmunk (*Tamias striatus*)
Muskrat (*Fiber zibethicus*)
Long-tailed jumping mouse (*Zapus hudsonicus*)
Short-tailed mouse or field mole (*Microtus pennsylvanicus*)

URSIDAE

Black bear (*Ursus americanus*)

MUSTELIDAE

Mink (*Lutreola vison*)
Wolverine (*Gulo luscus*)—one appeared to be present on Kakagi lake, but was not seen.

GENERAL GEOLOGY

Table of Formations

QUATERNARY	
RECENT:	Beach and marsh deposits.
PLEISTOCENE:	Lacustrine—sands and gravels, clays. Glacial—outwash(?); till.
	Great erosional unconformity
PRE-CAMBRIAN	
KEWEENAWAN(?):	Late dioritic dikes.
	Intrusive unconformity
ALGOMAN(?):	Quartz and rhyolite porphyry. Younger granite: Hornblende-muscovite granite. Titaniferous hornblende-biotite granite.
	Intrusive unconformity
HAILEYBURIAN(?):	Lamprophyre dikes. Diorite, amphibolite, and peridotite.
	Intrusive unconformity (?)
LAURENTIAN(?):	Younger biotite gneiss. *Intrusive unconformity* Older hornblende-biotite gneiss.

KEEWATIN:	Fragmental lavas, mainly andesitic. Banded ash and breccia. Flows, andesitic for the most part with some inter-bedded rhyolite (pillow, amygdaloidal, coarse porphyritic, and massive structures), also schists of corresponding composition.
COUTCHICHING(?):	Gneisses, sericite and sericite-chlorite schists, interpreted as mainly bedded pyroclastics, with some possible sediments. Rhyolite at Berry lake.

Coutchiching(?)

Warclub Lake Series

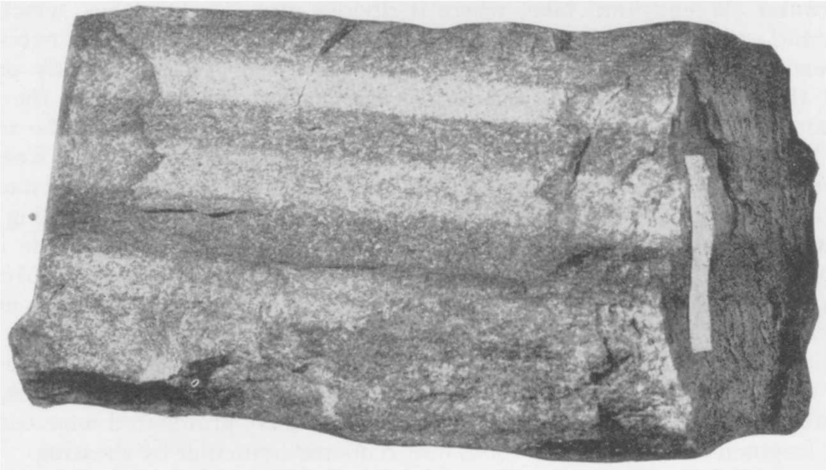
There is a band of schisted and partly fragmental clastic rock in the neighbourhood of Warclub lake and extending thence southwestward beyond Dirtywater (Weenagami) lake, where it divides into two branches, which pass north and south of the Kishquabik granite stock. The southern arm extends to the head of Lobstick bay, where it fingers out to the west, apparently passing under the greenstones. The northern branch, after curving around the north and northwest margin of the granite area, continues west of Berry lake toward Long bay of the Lake of the Woods. This is the upper member of the Keewatin as described by Lawson under the heading of "hydromicaceous schist and nacreous schists with some associated chloritic and micaceous schists and including areas of altered quartz porphyry." An examination of these rocks was made in the summer of 1930 around Warclub lake, where they had been mapped by McInnes in his map published in 1902.[1] They are also exposed on Lobstick bay and on Berry lake and the smaller lakes lying east of it.

Under the microscope the rocks reveal a sedimentary origin for the most part; some are evidently the clastic remains of andesites and rhyolites, now presenting an arkosic character. In some cases a finely granulated mass contains larger fragments of the original rocks now rendered lenticular by shearing. There are also shreds of mica, both biotite and muscovite, generally arranged in parallel. In other cases, hornblende or epidote also occur. These gneissoid arkoses contain fragmental quartz and orthoclase or oligoclase feldspar if rhyolitic in origin. In other cases an andesitic origin is indicated by the presence of more hornblende and andesine feldspar with less fragmental quartz. Both andesine and orthoclase are sometimes present. Secondary quartz pavement is usually present in either case. In other cases, the quartz predominates to such an extent that quartzite seems a more proper designation, and this would appear to indicate a sorting of the material as derived from the original lavas by weathering and water transportation, rather than deposition in the form of volcanic ash. The term "greywacké" would also appear to be more suitable in some cases. Conglomerates are present to some extent. Banded rock, much resembling iron formation, was also noted.

Some mica schists of a steel-grey colour and semi-metallic lustre found on Warclub lake and also in the area around Stephen lake appear to consist largely of sericite with hornblende and grains of iron ore and quartz. The sericite here is probably hydrous, and the hornblende apparently represents more or less calcareous and magnesian content in an otherwise argillaceous sediment. In other cases the schists are more properly described as hornblende schists. A biotite-muscovite schist with garnets and some angular grains of original quartz represents a much altered sandy shale.

[1]Manitou Lake Sheet, Map No. 720, Geol. Surv. Can., 1902.

The origin of these rocks is somewhat in doubt. Two possible hypotheses present themselves: (1) They may be mainly volcanic ash with a few interstratified sedimentaries derived from weathering; (2) they might be explained as disintegrated lavas derived from steep slopes and deposited near the source of the material without time for much weathering during transportation. In either case they are intimately associated with the Keewatin eruptives. In the case of disintegration by weathering, they must be considered as subsequent in time to the Keewatin, representing at least a long interval in the volcanic activity. The first of the two alternatives above given must, therefore, be considered the more probable. In addition to this, they lie below the Keewatin as elsewhere described in this paper, or at least below most of it. They were placed at the top of the Keewatin series of Lawson's Lake of the Woods map, but have been coloured as Coutchiching in a recent map issued by the Geological Survey of Canada.[1]



Specimen (natural size) of banded sediment of Upper Keewatin age (probably volcanic), from the portage between two small lakes, 1½ miles south of Warclub lake.

The latter conclusion the writer believes to be more nearly correct for the following reasons: The structure occurs here as the outer member of a synclinal trough, which is formed by the doming-up of the Keewatin over a granite boss. That the lavas dip away from the Kishquabik granite is demonstrated on the shores of Lobstick bay by the position of the ellipsoid structure. These possibly Coutchiching sediments are, therefore, below the lower member of the Keewatin as described in this report. The Kishquabik granite has been regarded as Laurentian because it displays a gneissic structure and also because of the doming-up of the Keewatin over it. In this it differs entirely from the later granitic intrusions, which have penetrated through the synclines previously formed by this doming process. There are two distinct methods of granitic intrusion here indicated. The "doming-up" method can only occur by a decrease in the area of the domed-up terrain, that is during a period of lateral compression and consequent orogenic movement. On the other hand the large domes could not have been formed without interior support. It must, therefore, be assumed that the intrusion and the horizontal orogenic compression were simultaneous, each supplementing the other in the production of the domed and intruded

[1]T. L. Tanton, Kenora Sheet, Map No. 266A, Geol. Surv. Can., 1933.

structure. In the case of the later granites there was no orogenic movement, at least affecting the lower Keewatin, through which the granites eroded their way by stoping or other assimilative action. The Kishquabik granite boss, therefore, undoubtedly belongs to the older period. This is supported by the fact that we

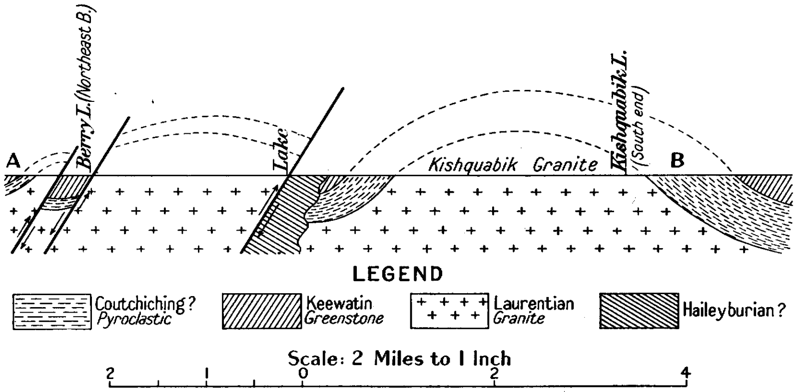


Fig. 2—Section on line A-B (see map No. 42*b* in pocket at back of report), northwest-southeast across Berry lake and the Kishquabik (Laurentian?) granites. The Coutchiching appears doubtful for reasons mentioned in the text.

find the supposed sediments in the same relation to the Dryberry lake Laurentian gneisses.

Another consideration that must be taken into account here is that at the southwest end of the Kishquabik granite oval a rhyolitic formation appears from beneath the banded sediments. The conclusion must be, therefore, that these banded, and in part sedimentary, rocks constitute a pyroclastic member

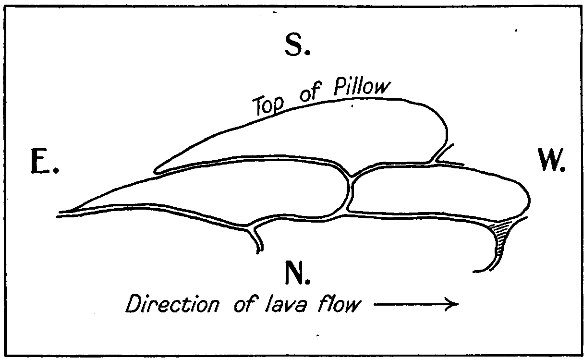


Fig. 3—Horizontal section of closely folded lava showing direction of the upper part of the flow (south) and direction in which the liquid lava flowed (west). The length ranges from two to four feet.

of the lower Keewatin rather than a distinct or in any way unconformable sedimentary terrain of the usual terrigenous character.

Keewatin

The greater part of the oldest rocks present in the area belong to the volcanic formation, to which in this very region the name Keewatin was originally assigned by Lawson.[1] Wherever it occurs it is typically a lava formation, generally closely folded and much affected by both regional and contact metamorphism. It is throughout the province of Ontario somewhat uniform in character, basaltic or andesitic in composition, the basic lavas often interbedded with thinner and less numerous acidic flows. There are also often small amounts of interbedded sediments, including iron formation, conglomerates, and finer schisted sediments. The ellipsoidal or "pillow"[2] structure is very commonly present in the lavas,

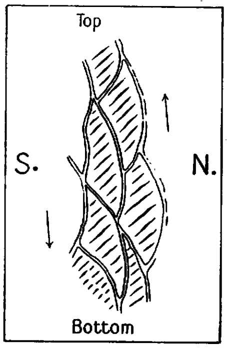


Fig. 4—Vertical section showing fracture cleavage in ellipsoidal lava. The ellipsoids are exposed in an eastward-facing cliff on the north side of Snake bay. The fracture cleavage in the ellipsoids indicates a position on the south side of a syncline with an east-west strike and a dip of more than 80 degrees.

and in several localities the presence of fragmental or scoriaceous tops also aids in distinguishing the structural relations, by determining the upper surfaces of the flows and consequently the direction in which they have been tilted in folding. Amygdaloids are also common.

LOWER (or Middle) KEEWATIN

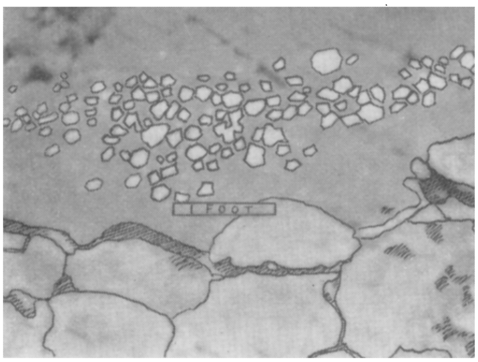
Flows

In the map area now under discussion, which lies immediately to the east of that depicted in Lawson's map of the northern part of the Lake of the Woods, all of these characteristic features are present. For purposes of structural determination, the ellipsoidal and fragmental structures were both found of competent value. Detailed structural mapping was not attempted, but the larger outlines of structure were readily discernible throughout the field, especially by the quite distinguishable character of the upper and lower surfaces of the "ellipsoids" or "gouts," the lower parts of which are fitted into the irregularities of the surface on which the gout came to rest, the upper parts curved by the surface tension of the viscous liquid and often noticeably more scoriaceous than the lower parts. In some cases scoriaceous or amygdaloidal upper surfaces of flows were also found of determinative value. In other cases thick flows or sills contain large phenocrysts

[1]A. C. Lawson, Geol. Surv. Can., Vol. I, pt. CC, 1885, pp. 10-15.

[2]Due to a succession of gouts flowing one over the other, perhaps better called "gout structure."

of feldspar,[1] which have settled toward the lower surface of the flow by gravity, so that the lower part becomes a strongly marked porphyrite while the upper is almost or quite free from phenocrysts.



Porphyrite in contact with pillow lava on road from Emm bay to Bag lake. Above is massive spessartite, with large phenocrysts sunk nearly to the bottom of the flow, where they were stopped by the solidified lower surface before reaching the pillow lava.

Composition.—All of the above types of structure belong to the lavas of the basal part of the Keewatin as developed in the Lake of the Woods area. In the map-sheet here described they are mainly of an andesitic type with few recognized basalts. Macroscopically they are of several varieties: (1) very fine grained black

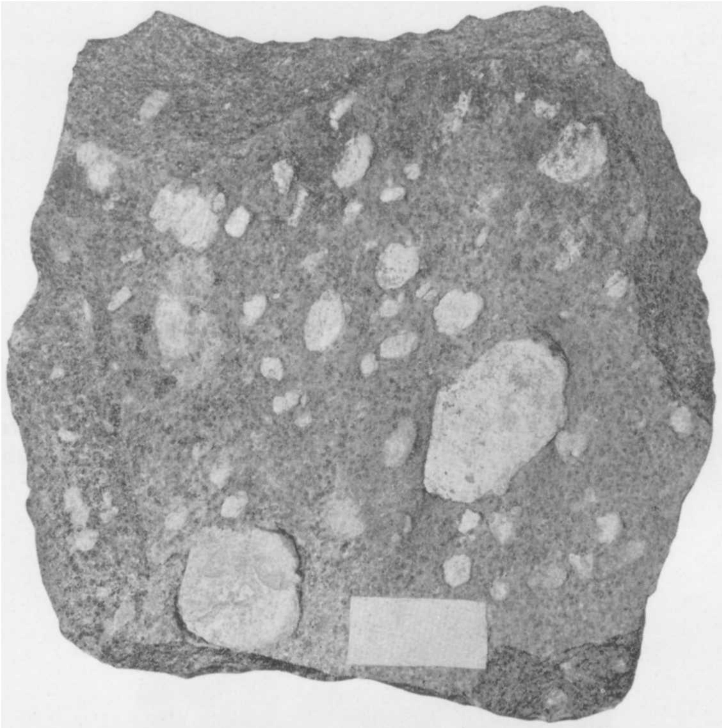
Photomicrograph of andesite porphyry (groundmass only, phenocrysts not shown). The groundmass is a felt of andesine (A) and hornblende laths with dark interstitial material (X31).

lavas; (2) lighter grey lavas, somewhat less fine grained; and (3) "spotted" lavas having a grey to yellowish groundmass dotted with small roundish aggregates of hornblende and biotite. These often contain large phenocrysts of more or less

[1]A. P. Coleman, Ont. Bur. Mines, Vol. VI, p. 102, paragraph on Snake bay, and illustrations A and C.

altered feldspar, which in many cases have caused a differentiation in the thick flows by settling toward the bottom, as above described. These lavas are therefore lamprophyric in type.

All of these lavas are andesitic, the feldspars working out consistently as andesine, except in a very few instances where labradorite was observed. In some cases where the feldspar is andesite, a considerable amount of pyroxene is present in addition to the usual green hornblende. Specimens studied under the microscope were found to fall under the following classifications: doubtful hornblende trachyte; andesite ("light-grey lava"); andesite porphyry; quartz andesite;



Specimen (three-quarters natural size) of spessartite porphyrite (Lower Keewatin). The phenocrysts of feldspar (possibly orthoclase) are, in the main, much altered. The groundmass is feldspar with small round aggregates of hornblende and some biotite.

ophitic quartz andesite; coarse porphyrite, with a groundmass of quartz lamprophyre (spessartite) and large phenocrysts of orthoclase; andesite porphyry, with phenocrysts of both orthoclase and plagioclase; hornblende-andesine lamprophyre (spessartite), with phenocrysts of hornblende and andesine; basaltic porphyry; hornblende diabase; and quartz-hornblende basalt. There are many schistose types representing various members of this series.

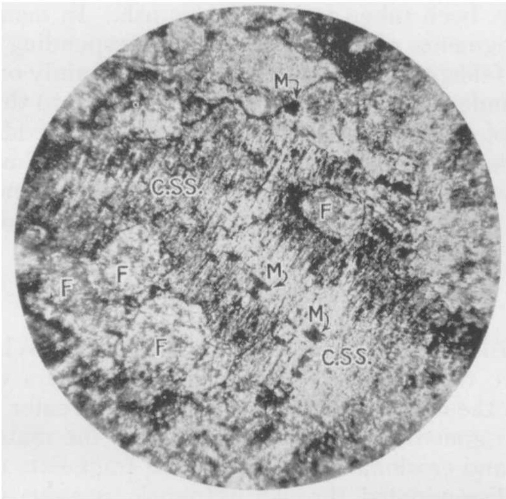
The more acid flows were found to include rhyolite, binary rhyolite, and sheared forms including sericite and sericite-chlorite schist.

UPPER KEEWATIN

Apparently overlying the mainly andesitic and rhyolitic lava beds that have been described, the andesitic types of which occasionally exhibit flows with zones at their upper surfaces filled with fragments, there is a series of banded or coarser bedded breccias, lavas, or ash rocks, overlain by an immense extrusion of fragmental lava of massive structure, which shows very little division into subordinate flows and very seldom even a tendency to parallelism in the fragments.

Banded Ash and Breccia

The lower banded rocks are found along the south shore of Kakagi lake immediately in contact with the great fragmental mass that occupies much of the central part of the lake, and they appear to be interbedded with the lower part of it. At the west end of Kakagi lake they appear again exposed along the margin of the fragmental mass; and the largest exposure of all is found surrounding Stephen lake, extending southwestward along Cedartree lake, and thence southeastward, enclosing a large body of the fragmental lava and in a rough way paralleling the outlines of the Stephen lake granite boss.



Photomicrograph of sericite carbonate schist with decomposed feldspar and altered rhyolite porphyry (×31). M = magnetite. F = kaolinized feldspar. C.SS. = chlorite-sericite schist, with fine grains of magnetite between the micaceous layers.

In this area the structural relations have not as yet been sufficiently worked out to give a locally certain result as to the order of the Keewatin sequence. Assuming with Lawson[1] that the Keewatin as a whole has been domed upward by the Laurentian gneisses, the relations of the different parts of the Keewatin in the field would indicate that the greenstones lie more toward the base of the formation and the banded and fragmental elements above. In that case the Stephen lake granite, like that mapped by Lawson at Red Cliff bay, Lake of the Woods, has been intruded into a synclinal part of the formation at a time much later than the original Laurentian folding and intrusion.

Judging by a disconformity of the strikes of the greenstones and the banded elements of the upper Keewatin, it is possible that there is a marked unconformity between the two parts of this formation, which may account for some of the areal and other apparent irregularities of the Keewatin structures as a whole. Some of these may be local distortions due to the intrusion of the later granites,

[1]A. C. Lawson, Geol. Surv. Can., Vol. I, 1885, pt. CC and map.

as might easily be the case at Stephen lake, where the banded elements are partly cut through by the granite but partly appear to conform to its areal outlines. The parts that are cut, however, while tilted nearly vertically, strike almost at right angles to the trend of the adjacent and supposedly subjacent greenstones. It would appear necessary to assume an overthrust folding of the upper member upon the lower to account for this. Here again, however, complete confirmation is lacking.

Composition.—The banded elements in the upper part of the Keewatin are partly fine-grained and thin-bedded, partly of coarser clastic structure and thicker bedding. The fine-grained often exhibit an alternation of colours in the banding, much like typical iron formation. Microscopically, this banded material appears to consist largely of fragmental quartz and feldspar with some scales of mica or hornblende crystals, and also grains of magnetite, as an important constituent. It has, consequently, been taken for a volcanic ash. In many cases the ash is filled with larger fragments of a uniform type corresponding in composition to the finer part. The feldspars observed in the ash are mainly orthoclase, anorthoclase, oligoclase, or andesine, corresponding quite closely to those of the rhyolitic and andesitic lavas of other parts of the formation. The bedding in all observed cases, whether coarse or fine, was very even and gives the impression of having been laid down in water and cemented there, as there are no evidences of the settling, slumping, and erosional disturbances that would follow subaerial deposition.

Fragmental Lavas.

The fragmental lavas may be in part agglomeratic. Where the fragments are in close contact the finer material between weathers out, leaving them standing in relief on the exposed rock surface. In the greater part of the formation, however, the fragments are not in contact and the material between is of the same character and erosional resistance as the fragments themselves, that is the fragments are disseminated through extremely massive flows of much the same character as themselves. In some cases they are more or less rounded; in most cases, sharply angular. The rounding presumably indicates a fluidal movement of the whole and consequent rotation of the fragments in the liquid. In other cases, especially where flows have been very thick, such movement has been absent and the included fragments have retained their angularity.

The fragments show differing shades of colour and vary in texture, some being porphyritic, some lamprophyric, and others entirely fine-textured. An examination shows that all are either rhyolitic or andesitic in composition. A microscopic examination of material obtained in the northwestern part of Kakagi lake on an island in Emm bay, gave the following results:—

1. The matrix is of porphyritic texture having lath-shaped feldspar crystals with hornblende inclusions, and also much rarer hornblende crystals enclosed in a glassy matrix, which holds microliths of feldspar and hornblende and small grains of iron ore. This is an andesite porphyry or spessartite.

2. A light-coloured fragment included in this matrix has also a porphyritic texture and a fine-grained groundmass of feldspar and quartz, with iron ore grains and small aggregates of quartz and sericite, in which are lath-shaped phenocrysts of feldspar altered to kaolin and sericite. A rhyolite porphyry is indicated.

3. Another included fragment of darker grey colour has a dark-grey groundmass including phenocrysts of acid plagioclase. This is probably an andesite porphyry.

The prevailing composition of the fragmental masses is, therefore, not different from that of the flows of the lower part of the formation, being mainly andesitic.

Laurentian(?)

The granites here included under the term Laurentian are distinguished from those of later age by their prevailing gneissoid structure. The older may well be partially or wholly hybrid, containing, as it does, many inclusions of the older Keewatin rocks, among them the coarse amphibolites. The common occurrence of anorthoclase is also an evidence of this. That this rock is not to be regarded merely as a marginal hybrid phase of the red biotite gneiss is also proved by its contact relations. If these rocks must be correlated with the granites of the eastern part of Ontario, it would appear that the red granite gneiss might be a folded Algoman. The sequence as a whole, however, does not appear to the writer to favour that view. Both types form part of what was originally described by Lawson as Laurentian, but it would seem that the western part of the province as well as the pre-Cambrian of Manitoba requires a somewhat independent treatment.

A matter which distinguishes these gneisses is the manner in which they have intruded the Keewatin lavas by filling large dome-like anticlinal folds from below, rather than by penetration of the rock.

Rocks belonging to this system, as defined by Lawson in the Lake of the Woods region, occur in four distinct areas within the limits of this field:—

Kakabikitchiwan Lake and Sabaskong Bay

The granites and granitoid gneisses here are a southeasterly extension of those of the Aulneau peninsula or Grande Presqu'île. They are well seen near Nestor falls and on the shores of the adjacent lakes and bays. The boundary line between the districts of Kenora and Rainy River was also examined from Sabaskong bay eastward for five miles. The character of the Laurentian here is that of a complex, some of the younger members of which may belong to a distinctly later period than the older members. The series in order of age is: (1) inclusions of grey gneiss, and amphibolite of Keewatin origin; (2) a pinkish-grey gneiss, which has the composition of granodiorite or syenite; (3) pegmatite and granite dikes cutting the first two members; (4) felsitic or aplitic dikelets of a redder colour, which cut the granite.

At Nestor falls the rock (taken for No. 2 above) is a hornblende-biotite gneiss with some oligoclase in addition to orthoclase and carries the accessories sphene and ilmenite.

On the highway at the outlet of Heronry lake the younger granite (No. 3 above), which is found intruding diorite, syenite, and older mica-gneiss, is a hornblende granite with orthoclase, microcline, and oligoclase feldspars, a little muscovite, and leucoxene.

The general facies of granite assigned to the Laurentian in this area is, therefore, markedly basic and titaniferous.

Atikwa Lake

In this area there are two fairly distinct types of gneissic granitoid rock, one of which is undoubtedly younger than the other, as proved by its intrusive relations. The older member, described by McInnes as "evenly foliated hornblende granite gneiss," is exposed on the eastern part of Populus lake, on the western bay of Atikwa lake, on Denmark lake, and on the northwestern bay of Rowan lake. It was found by the writer to extend westward to the east shore of Empire lake and southward to the north shore of Isinglass lake. Microscopic sections taken throughout the area gave the following types as undoubtedly belonging to this rock unit: quartz diorite, granodiorite, hornblende-soda granite, hornblende granite, quartz diorite near amphibolite, titaniferous hornblende granite, and diallage syenite. The feldspars noted as present were orthoclase, anorthoclase, oligoclase, andesine, and in one case labradorite. In some cases quartz is reduced to small amounts. Among the accessories apatite is common, ilmenite less so. Near the north shore of Isinglass lake an ophitic diorite was observed. Other outcrops near by are granodiorite and ordinary quartz diorite.

The red granite of Atikwa lake is classed by McInnes and Smith as evenly foliated biotite granite. In relation to the hornblende granite and hornblende granite gneiss it is described in a note in the margin of their map as composing the central part of granite gneiss masses, while the hornblende granite constitutes a marginal phase due presumably either to splitting of the magma or hybridization by the adjoining greenstones of the Keewatin. In some cases, especially to the south and west of Atikwa lake, the areal relations of the two types seem to warrant these conclusions, but in other cases the biotite granite is seen in immediate contact with the Keewatin, and in still others there are large masses of the hornblende granite included in the biotite granite, notably at Wall-eye lake and north of Atikwa lake.[1] These might indeed represent hybridized roof pendants, but there are quite obvious cases observable on Atikwa lake where the hornblende granite is intruded by the biotite granite. It is also quite true, as stated by McInnes, that the difference in character between the two granites as to the relative amounts of hornblende and biotite present is not always easily distinguishable, and the red biotite type is found penetrating the hornblendic type at some distances from the main line of contact between them.

To the writer these two types seen to represent the more intimately mixed grey dioritic and red biotitic types seen at Kakabikitchiwan lake. This conclusion was first reached on examination of the contact between the two gneisses, which is seen on the east side of Shoulder island of Atikwa lake near the south end. As this point is approached from the south, the grey hornblende gneiss is first observed to be cut by numerous dikes of red pegmatite. These cut older dikes of white pegmatite in the hornblende gneiss, and these in turn are younger than certain aplitic dikes which with the white pegmatite are taken to be phases of the hornblende gneiss. The red biotite gneiss also contains inclusions of the older hornblende gneiss, which is coarser in texture than the biotite gneiss at the contact. The biotite gneiss has feldspars of a markedly red colour as compared with the older plutonic. In places along the south shore of the lake the older gneiss has large leafy aggregates of biotite, which weather out, leaving a pitted surface. Hornblende, however, is the predominant ferromagnesian mineral, and biotite is equally predominant in the younger red gneiss. A thin section of the latter contains quartz, micropegmatite, orthoclase, oligoclase, biotite, and a little hornblende.

Dryberry Lake

In this area the rocks are typically non-titaniferous biotite gneisses containing a little hornblende, with some intrusions of the younger titaniferous granites. It is generally gneissoid and laminated but in some parts more massive and often porphyritic. The minerals present include quartz, orthoclase, and biotite in all cases, with rarer occurrences of microcline and of oligoclase when hornblende is

[1]These localities lie outside of the map-sheet. *See* Wm. McInnes, Manitou Lake Sheet, Geol. Surv. Can., Map No. 720, 1902.

also present. There are also dikes of hornblende-biotite-muscovite granitic porphyry, biotite-muscovite granites, and pyritiferous quartz porphyry of later age.

Kishquabik Lake

This oval area lies between Lobstick bay and the southeastern part of Dryberry lake and has been named from one of the two narrow lakes that lie within it. The granite here is distinctly of the older type, defined by McInnes as granitoid gneiss. Rather coarse in texture, it shows a pitted surface due to the weathering out of small aggregates of biotite. The essential minerals are quartz, orthoclase, microcline, and biotite, with occasional oligoclase and hornblende. The accessories are commonly apatite, epidote, magnetite, and, more rarely, ilmenite and sphene.

The Age of Lawson's Laurentian

The Laurentian formation as at first defined in eastern Ontario and the adjacent parts of Quebec by Logan and his successors was taken to be the oldest member of the Archean or older pre-Cambrian rock system.[1] It consisted essentially of banded gneiss and granitoid gneiss, which was supposed to be metasedimentary. The gneiss was overlain by the metasedimentary Grenville series, which was considered, therefore, to be of a later age and was at first known as Middle Laurentian. Lawson, after studying the Lake of the Woods region in 1885, decided that the gneissoid member of the series there present was intrusive in the Keewatin greenstone formation (Lower Huronian of Logan), which had not as yet been identified in eastern Ontario. The Laurentian was, therefore, younger than the Keewatin, which was itself later declared by the same author to be younger than the Coutchiching sediments of Rainy lake.[2]

In 1907, W. G. Miller identified a lava formation, mainly greenstone, in eastern Ontario as Keewatin.[3] This formation underlay the Grenville with apparent conformity, and both were found to be intruded by the Laurentian. The time sequence, therefore, numbered from the oldest to the youngest, became:—

4. Laurentian.
3. Grenville.
2. Keewatin.
1. Coutchiching.

Meanwhile in the Sudbury-Timiskaming region another series of folded sediments had come under observation and were not found anywhere intruded by the gneiss, but were intruded by massive red granite of less metamorphic appearance and of demonstrably later age.[4] This was named the Algoman granite. The sediments were variously known as Sudburian, Temiskamian, or Middle Huronian. The name Timiskaming series, or Timiskamian, now seems to be generally adopted in Ontario. The table of time sequence would then be:—

[1]Sir William Logan, Geol. Surv. Can., 1863, pp. 22 ff.

[2]A. C. Lawson, Geol. Surv. Can., Vol. I, pt. CC, 1885. *See also* Geol. Surv. Can., Vol. III, pt. F, 1887-88, pp. 21, 99.

[3]W. G. Miller and C. W. Knight, Ont. Bur. Mines, Vol. XXII, pt. 2, 1913, pp. 3, 9, 11, 45, etc. *See also* W. G. Miller, Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, p. 221; and M. B. Baker, Ont. Bur. Mines, Vol. XXV, pt. 3, 1916.

[4]A. P. Coleman, Ont. Bur. Mines, Vol. XXIII, 1914, p. 204.

W. G. Miller, Ont. Bur. Mines, Vol. XVI, pt. 1, 1907, p. 201; "The Principles of Classification of the pre-Cambrian Rocks, etc.," Compte Rendu, XIe Congrès Géologique International, pp. 673 ff.

6. Algoman

Intrusive unconformity

5. Timiskamian

Erosional unconformity

4. Laurentian

Intrusive unconformity

3. Grenville
2. Keewatin
1. Coutchiching

Pre-Algoman (Haileyburian) and post-Algoman (Matachewan) intrusives (dikes) have also been discovered in this region.

Subsequently work was undertaken on the Ontario-Manitoba boundary somewhat north of the Lake of the Woods and in adjacent fields to the east and west of that meridian. This investigation by E. S. Moore[1] and others disclosed a basal greenstone formation overlain by apparently conformable metasedimentaries. Both of these formations are older than any of the granites that intrude them. These in part appear to be three in number instead of two.[2] If, then, these Wanipigow sediments are taken as Grenville in age, it is obvious that the older granites which intrude them and which are sometimes gneissic may be considered as Laurentian. At the Lake of the Woods, however, there are two ages of distinctly gneissic plutonics instead of one, as in the eastern part of the province. The older one is a grey, hornblendic rock, often granodiorite in composition, or slightly more acid. It is found both on the Manitoba boundary and at the Lake of the Woods. It is petrographically much unlike the typical eastern Laurentian, but possibly corresponds to the granodiorite of western Quebec. It is intruded by a biotitic granitoid gneiss, which is petrographically much like the eastern Laurentian. Both of these have been considered as Laurentian by Lawson, McInnes, and Smith in the Lake of the Woods and Manitou Lake areas. A third and generally porphyritic and massive red granite, which is found intruding the folded Keewatin of the Lake of the Woods and Lac Seul regions, might then be regarded as corresponding to the eastern Algoman.

The late W. G. Miller,[3] however, considered the Wanipigow sediments as equivalent to the Timiskaming, which is found similarly folded with the Keewatin in the Porcupine and Kirkland Lake areas. Some evidence of unconformity, however, is here admitted. At Kirkland lake especially, these folded measures have been intruded after folding by a succession of porphyries, the oldest of which is also considerably more basic than the others.[4] Thus a succession of events similar to that found in the western part of the province seems to be established at Kirkland lake, but on a smaller scale. If this criterion be accepted, all the granites, porphyries, or felsites in either region are to be considered as Algoman.

Accordingly, in recent years, many writers who have reported on the western part of Ontario have avoided the use of the name Laurentian and listed all their granitoid intrusions tentatively as Algoman. In the present report the older gneissoid types still retain the name Laurentian, originally assigned to them by Lawson, for the reason that their intrusion seems to have been coincident with the

[1]E. S. Moore, Geol. Surv. Can., Sum. Rept. 1912, p. 262 ff.

[2]E. M. Burwash, Ont. Dept. Mines, Vol. XXIX, pt. 1, 1920, p. 181; Vol. XXXII, pt. 2, 1923, pp. 7, 8, 29.
E. L. Bruce, Ont. Dept. Mines, Vol. XXXI, pt. 8, 1922, p. 36; Vol. XXXIII, pt. 4, 1924, pp. 10, 22, 29 ff.

[3]E. M. Burwash, Ont. Dept. Mines, Vol. XXXII, pt. 2, 1923, pp. 9, 31 (footnote 1).

[4]E. W. Todd, Ont. Dept. Mines, Vol. XXXVII, pt. 2, 1928, p. 25 ff.

original folding of the Keewatin in which they have occupied positions under anticlinal domes, while the later massive granites have cut into the synclinal trough or basins between these domes, at a time subsequent to their formation, in a manner strikingly similar to the intrusion of the granitoid and porphyritic intrusives of the eastern gold ranges.

Haileyburian(?)

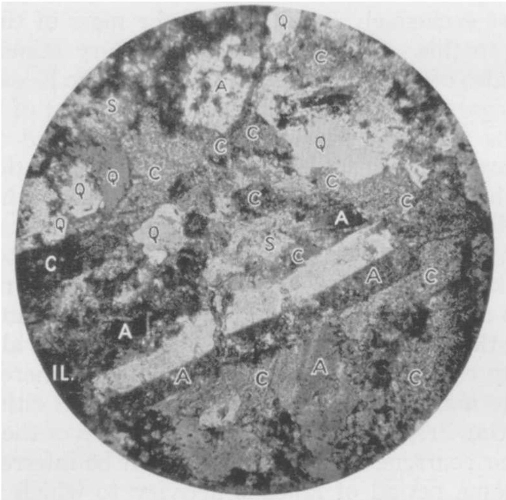
Mainly in the Keewatin, but to a slight extent projecting into the older granites here classified as Laurentian, there are a number of large unsheared crystalline bodies, which in the past have been explained as due to the recrystallization of basaltic volcanics under regional metamorphic conditions. They appear to be included under the heading "altered traps" by Lawson. The fact that they are almost exclusively found within the mass of the Keewatin greenstones lends colour to this. The amount of secondary mineralogical alteration that they exhibit is also often quite as great as that of the Keewatin lavas. These features seem to relegate them to an age much nearer that of the Keewatin than the age of the rocks that in this area have been assigned to the Laurentian. More basic rocks, however, are subject to more rapid alteration than acid.

It has, indeed, been clearly shown in modern instances that large accumulations of lava are seldom without intrusive elements of the same rock type and derived from the same magma as the lava, but intruded into it in the form of dikes, sills, or laccoliths, owing to violent action renewed at a time later than that of the first extrusion of the lava. It is even conceivable that an advancing magma might stope its way through its roof and penetrate the lavas already formed from it above the roof by extrusion through vents. Where, therefore, in an altered extrusive series large masses of plutonic aspect are found either apparently conformable or penetrating irregularly through the mass and of the same petrographic type apart from their coarseness of texture, it might be inferred that they belong essentially to the same period of igneous activity to which the intruded lavas are referred.

But while the greenstones are in large part highly schistose, these bodies are massive and often very coarsely so. If they represent altered traps, the only conception one could form of such a metamorphosis would be that it took place after flowage had ceased and represents a purely hydrostatic condition of pressure. In such a condition there would be (1) no deformative movement of the rock, and (2) no circulation of waters. Elimination or introduction of soluble material would be, therefore, hardly conceivable. On the whole, the author believes these coarse-grained masses to be much more ferromagnesian than the surrounding schists, which are higher in quartz, or than the massive fragmentals and rhyolites which they intersect and which are much higher in feldspars. A very unusual kind of elimination would, therefore, be necessary. Not lime or soda, but quartz and alumina, would have to be eliminated. Alternatively, iron and magnesia would have to be introduced, replacing soda and lime. The principal difficulty would be that introduced iron is found usually in the form of a sulphide.

These bodies are, therefore, to be taken as intrusive, and further evidence of this is not lacking, since small apophyses of the amphibolite were found traversing the upper Keewatin fragmental lavas in the northwestern part of Kakagi lake, near the contact of one of the larger amphibolites. In many places, notably on the east shore of the first small lake north of Kakagi lake on the route that leads to Cameron lake, the amphibolite rocks contain numerous inclusions of the fine-grained Keewatin lavas. As to age then, the amphibolite is subsequent to the shearing of the Keewatin, which it is believed took place at the same time as the intrusion of the Laurentian gneisses. They are, therefore, post-Laurentian. At Stephen lake they appear to be intruded by the Algoman granite. On the south bay of Atikwa lake and on the shores of Denmark lake, which lies immediately to the south, lamprophyric dikes were observed which cut the older phases of the Laurentian and also contain inclusions of it. In the same area also, masses of amphibolite are observed within the older Laurentian. In some cases these were hard to distinguish from inclusions, but in others they were taken without hesitation to be dikes. This would place the lamprophyre and amphibolite in the period that has been assigned to the Haileyburian. They are, therefore, with slight reservation, to be considered as pre-Algoman.

In more detail the principal types of these rocks may be described as follows:—



Photomicrograph of altered ophitic quartz diorite with hornblende, largely chloritized (×26). A = andesine. C = chlorite. Q = quartz. IL = ilmenite. S = saussurite.

Diorite, Amphibolite, and Peridotite

The rocks are of plutonic texture, ranging from medium-grained diorite to very coarse amphibolite and including in some parts minor amounts of peridotite, now largely serpentinized. They are found associated, apparently in an intrusive relation, with great thicknesses of andesitic and occasionally basaltic lavas, interbedded here and there with rhyolitic flows which have shared in the general shearing of the Keewatin formation. The petrographic types of the Keewatin and of these intrusives are therefore parallel, differing mainly in texture. So far, therefore, they fulfil fairly well the conditions required for intrusions contemporary with the Keewatin. There is nothing specific in their forms or relations to the Keewatin that would necessarily indicate a batholithic structure, but their massiveness and more or less lenticular outlines would answer well to the type of the laccolith, and these are often of considerable size.

The main petrographic types may be described more particularly:—

1. A grey diorite or diorite porphyry is well represented along the north shore of Kakagi lake. These rocks have in general a porphyritic texture and correspond in composition to diorite or quartz diorite. This normal diorite has in some cases varied to pyroxene diorite or mica diorite. In one or two places it is of a texture

coarse enough to suggest a pneumatolytic origin and contains large crystals of hornblende and feldspar, and some hornblende spherulites.

2. The amphibolite is sometimes equivalent to quartz diorite, but with the feldspar quartz content much reduced. The hornblende crystals are often large, up to one inch or more in diameter.

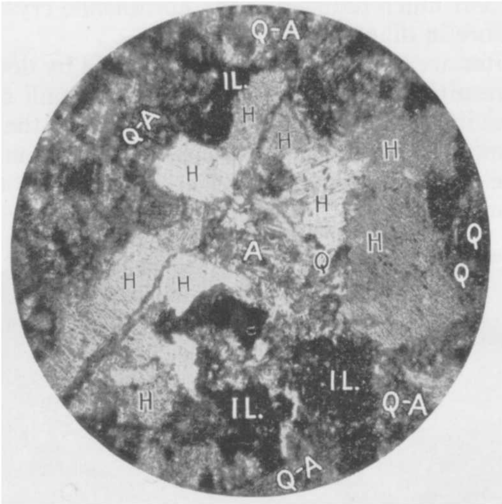
3. The peridotites are easily recognized in the field by deep weathering along intersecting joints resulting in a surface divided into small square blocks. The appearance of olivine in increasing amounts, until it forms the major part of these rocks, which are now largely serpentine owing to alteration, was noted on the Ross river below the outlet of Denmark lake and along the south shore of Kakagi lake near its eastern end.

Specimen (seven-eighths natural size) of coarse amphibolite (Haileyburian?) with hornblende masses outlined, from the east side of the outlet bay of the first small lake north of Kakabikitchiwan lake. The crystals in places have a diameter of 1½ inches.

Lamprophyre Dikes

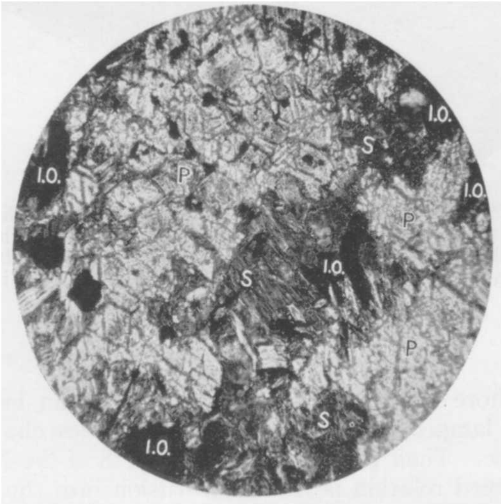
On the north shore of the southwest arm of Rowan lake and elsewhere, rather small dikes of lamprophyre were observed which are characterized by large phenocrysts of biotite. Their position is not far north of the Nolan lake granite, but their only observed relation is that of intrusion into the Keewatin. Their age is, therefore, only determinable as post-Keewatin. Immediately adjacent were intrusions of coarse quartz porphyry, but the two rocks were not observed in contact.

Under the microscope the rock is seen to consist of a groundmass of hornblende and biotite laths embedded in feldspars, which are for the most part striated but undeterminable, probably near andesine. Calcite is present as a decomposition product. The feldspar also contains many needles of apatite and some of rutile altered to leucoxene. The phenocrysts are well-developed, hexagonal books of biotite associated with some large crystals of hornblende, which



Photomicrograph of amphibolite from the north shore near the east end of Isinglass lake (×30). H = hornblende. Q = quartz. A = actinolite. Q-A = quartz with actinolite. IL = ilmenite.

appears older than the mica. The name hornblende kersantite seems to be fairly descriptive of this rock. The micas exhibit typical dark edges and lighter interiors.



Photomicrograph of peridotite showing a much larger proportion of pyroxene than the average for this rock (×31). P = pyroxene. S = serpentine. I.O. = iron ore, and rutile.

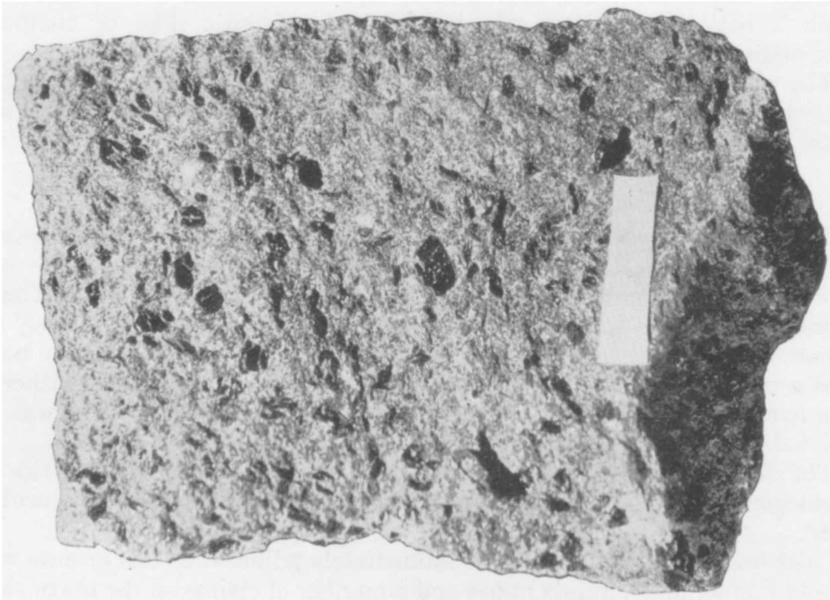
In the absence of more certain determination they are placed with the pre-Algoman on lithological grounds.

Algoman(?)

This division of rocks embraces the unsheared granite bodies of the region, all much less extensive in area than the older granite gneiss and also distinguishable mineralogically and texturally. The unsheared quartz porphyries are distinguished from similar rocks in the Keewatin series by their fresh and massive condition and by intrusive relations. They include small dikes, which traverse the Keewatin areas. These two types of intrusive may be considered separately. Their relation to one another has not been established with certainty.

YOUNGER GRANITE

The younger granite is found in eight localities in this area. In most cases it occurs in rounded bosses of some miles in extent, but in one occurrence, that



Specimen (natural size) of kersantite with dark phenocrysts of hexagonal biotite, north shore of the southwest arm of Rowan lake.

at Isinglass lake, it is represented by a group of dikes. Several of these granite bosses were mapped by Lawson in his map of the northern part of the Lake of the Woods, and recognized as of later origin than the Laurentian gneisses.

A table showing the frequency of occurrence of the mineral constituents of the younger granites will be found on pages 66 and 67.

Titaniferous Hornblende-Biotite Granite

These areas are in most cases hornblende-biotite granites containing oligoclase as well as orthoclase, frequently microcline, occasionally andesine and anorthoclase. Constantly occurring accessories are apatite and ilmenite, and sphene is fairly common. Out of 22 sections, rutile occurs three times, tourmaline once, zircon once, pyroxene once, and magnetite three times. The small area at the northwest bay of Rowan lake differs from the others in the greater predominance of hornblende, while biotite is entirely absent. The commonest secondary minerals noted were kaolin, sericite, chlorite, epidote, and leucoxene. The rutile may also be, at least in part, secondary; and calcite, hematite, and limonite are occasionally found. The limonite probably represents weathered pyrite.

The areas differ somewhat in certain features and may be described briefly as follows:—

Regina Bay

The granite here is mainly exposed along the south side of the bay and extends only a short distance inland. It may also be seen on nearby islands and on the north shore of the bay. It was mapped by Lawson and recognized by him as distinctly later in age than the Laurentian gneisses. It is in the main massive, but contains certain gneissic zones which strike about S. 50° W. where observed. The general colour is grey, and in composition it is a titaniferous hornblende-biotite granite, which contains oligoclase as well as orthoclase. It is cut by pegmatite dikes, which are largely composed of orthoclase and oligoclase and contain a little magnetite, and also by a porphyritic dike of composition corresponding to hornblende-muscovite granite.

The vein of the Horseshoe (formerly Regina) mine cuts across the contact of this granite with the Keewatin greenstone schists to the south, and has produced gold on both sides of the contact.[1]

Hope Lake

This body of granite lying between William bay and Hope lake differs little from the granite of Regina bay except in the presence of microcline in two sections out of three and of hematite in one. It has been subjected to less regional metamorphism and is accordingly red in colour and displays comparatively few of the minerals that are commonly recognized as secondary. With it may be mentioned a small area that lies on the south side of Caviar lake at the southern end of the narrows that connects two large expansions of the lake. This was noted in the field as a hornblende granite.

The dikes associated with the Hope Lake area vary from a porphyritic type, mineralogically similar to the main body, to a coarse titaniferous hornblende syenite.

Gold-bearing properties that lie immediately adjacent to this granite include the Gold Panner and Virginia mines and a number of claims on the north shore of Caviar lake near the mouth of William bay.

Flora Lake

A considerable body of granite previously unmapped was found to lie west of the canoe route that leads from Caviar lake northeastward. The general type of this area also comes under the classification, hornblende-biotite granite, strongly titaniferous, as evidenced by the presence of both sphene and ilmenite. The feldspars are orthoclase with some perthitic intergrowth of plagioclase, probably oligoclase, and microcline. The ferromagnesian minerals are few even near the margin, except where a hybrid condition appears to exist. Porphyritic structure is also found. On the west side, approaching the margin, the percentage of hornblende and biotite is relatively large, especially the biotite, which displays a gneissic parallelism and occurs in large aggregates. Quartz is small in amount and interstitial in position; the feldspars are microcline and orthoclase. The order of crystallization is biotite (brown), hornblende (green), microcline, perthitic orthoclase, quartz. Accessory apatite and magnetite are present. The feldspars show little alteration. Some epidote and chlorite appear to be due to

[1]See page 75.

the decomposition of hornblende. In a fairly central position in the stock, on the west shore of Isinglass lake, there is a very acid phase which has a little brown biotite, with microcline, orthoclase, plagioclase, and quartz constituting the mass of the rock. Accessory sphene, ilmenite, tourmaline, and apatite occur in small amounts. The name alaskite was used in the field for this phase.

The large group of gold claims that lies along Tillie, Empire, and Kathleen lakes, including the Empire and Nina mines, is parallel and immediately adjacent to the eastern margin of this granite. No staking appears to have been done on any other part of its circumference, and its presence was evidently unknown to McInnes and Smith, of the Geological Survey of Canada, whose map was published in 1902. Many of these old claims have recently been restaked.

Isinglass Lake

Red granites of the younger type are represented in the shores and islands of this lake by dikes, which are for the most part of fine texture. The normal mineral content is quartz, microcline, orthoclase, biotite, hornblende, with accessory zircon and ilmenite altered partly to leucoxene. The dikes for the most part are differentiates, including muscovite, syenite with accessory magnetite and hematite, a fine-grained pneumatolytic phase of felsitic texture, porphyritic biotite syenite, and hornblende granite porphyry. Near the northeast shore of the lake a dike of this granite is exposed on a small island, and a small gold property in the dioritic country rock near by was operated for a short time.

Stephen Lake

This body of granite was mapped by McInnes and Smith from an examination of its outcrops on the shores of Stephen lake. It has since been traced southeast to several small lakes that lie north of Kakagi and Mangus lakes. It is throughout essentially a porphyritic hornblende-biotite granite with notable titanium content. It differs from the other stocks here described mainly in the presence of rutile, which is possibly secondary after titanite. This stock exhibits more alteration than any of the others of the same type, though it is approached in that respect by the Regina bay granite. Pyroxene, andesine, and probably anorthoclase, occur in the contact phases, in some of which also quartz is absent. Microcline was the only distinctive mineral noticed in the central part. The contact phases observed were classed as hornblende-biotite syenite, hornblende syenite, granodiorite, biotite granite, and hornblende-pyroxene granite.

Certain dikes that extend northward from this body reach the north arm of Flint lake. In this vicinity there are two old groups of claims. One of these extends eastward from the southeast arm of Flint lake; the other lies along the north side of the north arm. In the latter group some recent work has been done, and gold values of $10 or more have been reported.

Rowan Lake

A body of red titaniferous granite is in evidence on the northwest bay of Rowan lake, near its outlet. It is porphyritic in part and represented by pegmatitic dikes on Denmark lake, on the river that connects it with Caviar lake, and on a small island near the mouth of the river in the east bay of Caviar lake. It differs from the other younger granites in the absence of biotite, and this may be due to the fact that the exposed parts, mainly dikes, are all of a marginal nature. It is possible that they are an extension of the granite seen on Isinglass lake.

MINERAL CONSTITUENTS OF THE YOUNGER GRANITES

Area and location	Essential Minerals									Accessory Minerals								Secondary Minerals							
	Quartz	Orthoclase	Microcline	Anorthoclase[1]	Oligoclase	Andesine	Muscovite	Biotite	Hornblende	Pyroxene	Apatite	Zircon	Tourmaline	Titanite	Ilmenite	Rutile	Magnetite	Sericite	Kaolin	Calcite	Chlorite	Epidote	Limonite	Hematite	Leucoxene
Regina Bay:																									
North shore	x	x	...	...	...	...	...	x	x	...	...	...	...	...	...	...	x	x	x	...	x	...	x	...	...
South shore, near fire patrol station	x	x	x	...	...	...	...	x	x	...	...	...	...	x	x	...	...	x	...	...	x	x	...	...	x
North shore, east of narrows to Lobstick bay (rhyolite porphyry shear zones in granite and porphyry)	x	x	...	...	x	...	...	x	...	...	...	...	...	x	x	...	...	...	...	...	...	...	...	...	...
Total	3	3	1	...	1	...	...	3	2	...	...	...	...	2	2	...	1	2	1	...	2	1	1	...	1
Hope Lake:																									
William bay, west side, dike	x	x	...	...	...	...	...	x	x	...	...	...	...	x	x	...	...	...	...	...	...	...	...	...	...
Southwest arm south of the bay, east side	x	x	x	...	x	...	...	x	x	...	x	...	...	...	x	...	...	...	...	...	...	...	...	...	...
Southeast arm	x	x	x	...	...	...	...	x	x	...	...	...	...	x	x	...	x	...	...	...	...	...	...	x	...
Total	3	3	2	...	1	...	...	3	3	...	1	...	...	2	3	...	1	...	...	...	...	...	...	1	...
Flora Lake:																									
Harding lake, east shore (porphyritic)	x	x	x	...	...	...	...	x	x	...	x	...	...	x	x	...	...	...	...	x	...	...	...	x	x
Harding lake, west shore, near portage to Flora lake	x	x	x	x(?)	...	...	...	x	...	...	x	...	x	x	x	...	...	...	...	...	...	...	...	...	...
Northwest bay of Flora lake	x	x	x	...	...	...	...	x	x	...	x	...	...	...	...	...	x	...	...	...	x	x	...	...	...
Total	3	3	3	1	...	...	...	3	2	...	3	...	1	2	2	...	1	...	...	1	1	1	...	1	1
Isinglass Lake:																									
Trail north to small lake	x	x	x	...	...	...	...	x	x	...	...	x	...	...	x	...	...	...	...	...	...	...	...	...	x
Total	1	1	1	...	...	...	...	1	1	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	1
Stephen Lake:																									
Distant from margin	x	x	x	x(?)	...	...	...	x	x	...	x	...	...	...	x	x	...	...	...	...	...	...	...	...	...
North shore at Keewatin contact	x	x	...	...	...	...	...	x	...	...	x	...	...	...	x	x	...	x	x	x	x	...	...	...	x
East shore (contact phase)	...	x	...	x(?)	...	...	...	x	x	x	x	...	...	...	x	x	...	x	x	...	x	...	...	...	...

North end of lake north of Mangus lake—marginal phase (hybrid?)	x	x	...	...	...	x	...	...	x	...	x	...	...	...	...	...	...	x	x	...	x	x	...	...	x
Total	3	4	1	2	...	1	...	3	3	1	4	...	...	...	3	3	...	3	3	1	3	1	...	...	2
ROWAN LAKE:																									
Porphyritic dike in amphibolite	x	x	...	...	...	x	...	...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...
Island on Speight's line (low in ferromagnesian elements)	x	x	x	...	...	...	...	...	x	...	...	...	...	...	x	...	...	...	...	...	...	x	x	...	...
Dike below Ross chute	x	x	...	...	...	...	...	...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...
Northwest bay, west side	x	x	x	...	...	...	...	...	x	...	...	...	...	x	x	...	...	x	...	...	...	x	...	...	...
Northwest bay, east side (accessory pyrite)	x	x	...	...	x	...	...	...	x	...	x	...	...	x	...	...	...	...	...	...	...	...	...	...	x
Total	5	5	2	...	1	1	...	...	5	...	1	...	...	2	4	...	...	1	...	...	...	2	1	...	1
NOLAN LAKE:																									
Sickle lake on south margin of the granite (porphyritic)	x	x	x	x	...	...	...	x	x	...	x	...	...	...	x	...	...	...	...	...	...	...	...	...	...
South shore of Nolan lake (porphyritic)	x	x	x	x	...	...	...	x	x	...	...	...	...	x	x	...	...	...	...	...	...	...	...	...	...
Small lake east of Nolan lake (porphyritic)	x	x	x	x	...	...	...	x	x	...	x	...	...	...	x	...	...	x	x	...	...	x	...	...	...
Total	3	3	3	3	...	...	...	3	3	...	2	...	...	1	3	...	...	1	1	...	...	1	...	...	...
Grand totals	21	22	13	6	3	2	...	16	19	1	11	1	1	9	18	3	3	7	5	2	6	6	2	2	6

HORNBLENDE-MUSCOVITE GRANITES

WAPUS LAKE:																									
Speight's line, west of the lake, dike in greenstone	x	x	...	...	x	...	x	...	x	...	x	...	...	x	x	...	...	...	...	...	...	...	...	...	...
REGINA BAY:																									
Dike cutting grey granite (porphyritic)	...	x	...	...	x	...	x	...	x	...	...	...	...	...	x(?)	...	...	...	...	...	...	...	...	...	...
KAKABIKITCHIWAN LAKE:																									
Cutting diorite, syenite, and older pitted grey gneiss	x	x	x	...	x	...	x	...	x	...	x	...	...	...	x	...	...	...	...	...	...	...	...	...	x
BETULA-WARCLUB LAKES:																									
Cutting sedimentary (?) gneiss (porphyritic)	x	x	...	...	...	...	x	x	x	...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...
DENMARK-ATIKWA LAKES:																									
Scott bay, point dividing bay	...	x	...	...	x[2]	...	x	...	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...	...	...
Waterfall lake, dike above falls	...	x	x	...	x	...	x	x	x	x	x	...	...	...	...	...	x	...	...	...	...	...	...	...	...
Tillie lake, northeast shore (porphyritic)	x	x	...	...	x	...	x	...	x	...	x	...	...	...	x	...	x	x	...	...	x	...	...	...	x
Tillie lake, northwest shore	x	x	...	...	x	...	x	...	x	...	x	...	...	...	...	...	x	x	x	...	x	x	...	...	...
Total	5	8	2	...	7	...	8	2	8	1	6	...	...	1	5	...	4	2	1	...	2	1	...	...	2

[1]Some albite is probably embedded.
[2]Albite.

Nolan Lake

A large body of red porphyritic granite was found to the south of the southwest bay of Rowan lake. Its southwestern and southern margins lie at no great distance from Otterskin and Brooks lakes. Its surface is considerably above the surrounding country and is dotted by several small lakes, one of which, Nolan lake, marks the west end of the granite and lies more than 100 feet above the present level of Rowan lake. At all points where specimens were taken, the constituent minerals were quartz, orthoclase, microcline, oligoclase(?), biotite, hornblende, apatite, ilmenite, sphene. For the most part little alteration was observed. The porphyritic texture extends consistently through the mass and was observed on both the north and south margins. As no traverse was made across it, any central differentiation remains unknown.

Although this boss was not previously mapped, the Keewatin areas adjacent to it on the west and north were extensively prospected about the beginning of the present century and work was done on a number of properties, especially the Monte Cristo and Sullivan of early discovery, the large veins staked by R. Roy on Shingwak lake, and the system of large veins that can be traced from Cameron lake across Otterskin lake to Brooks lake on the south side of the granite. These veins all carry values in gold. They are of various types, which are described later in the section on "Economic Geology."

Kakabikitchiwan and Heronry Lakes

The younger members of the granitoid complex here, as studied at Nestor falls and on the highway at the outlet of Heronry lake, seem to correspond quite exactly in composition with the other titaniferous hornblende-biotite granites above described, but they have a gneissic structure in some cases like that observable in parts of the Regina bay granite (Sioux Narrows granite of Lawson).

Hornblende-Muscovite Granite

This unusual group of rocks appears to be later in origin than the hornblende-biotite granite. They occur only in dikes cutting the gneisses and granites and possibly represent a late phase of the hornblende-biotite intrusion. They are associated with the various stocks of the later granites throughout the area, possibly as apophyses but certainly as smaller adjacent bodies, and in some cases they penetrate older Algoman granite, as at Regina bay. The dike that crosses the river that connects the eastern bay of Atikwa lake with Waterfall lake just above the fall by which it descends to Waterfall lake consists of quartz, orthoclase, anorthoclase, microcline, muscovite, biotite, and hornblende. Quartz is present in large amounts. Accessories noted are zircon, magnetite, and a little apatite. At the northwest corner of Tillie lake and again on the east side of it, there are outcrops of porphyritic hornblende-muscovite granite containing hornblende in rather small amounts. The feldspars are orthoclase, anorthoclase, and oligoclase near albite. Some of the muscovite is included in the feldspar, and some is younger than the feldspar. The accessories are small amounts of ilmenite and apatite. Quartz occurs in large amounts. On Speight's base line at about 44 chains west from the west shore of Wapus lake, an outcrop of granite with radiating dikes is found which has the following composition: orthoclase, oligoclase, quartz, muscovite, hornblende, apatite, titanite, and ilmenite; and on the north shore of Regina bay a red gneissic porphyritic dike was microscopically determined as a hornblende-muscovite rhyolite porphyry, as described under the heading "Regina Bay" on page 64. The phenocrysts of orthoclase (in Carlsbad twins) and oligoclase are associated with large plates of muscovite. Crystals and aggregates of green hornblende are found also in a quartz-feldspar-sericite aphanitic groundmass, which carries a little iron ore.

LATER QUARTZ PORPHYRY

Traversing the older formations, including the Keewatin, there are numerous dikes and other bodies of quartz porphyry that have not been sheared. They are obviously in intrusive relation to the altered andesites, lavas, and fragmental volcanics, as well as to the sheared interbedded rhyolites and quartz porphyries of the Keewatin proper. Among the largest of these intrusions is that exposed on the north shore of Peninsula bay, Kakagi lake; it is also well seen on a portage that leads north to a series of small lakes from the northeast corner of the bay. This porphyry forms a large dike which lies parallel to the southwest margin of the Stephen lake granite and distant from it about two miles. The width of the body is over 100 yards and its length something over two miles. Several other dikes of smaller dimensions occur on islands in the northwestern part of Kakagi lake, on Rowan lake, and elsewhere. The large body mentioned contains phenocrysts of striated feldspar, which is not certainly determinable but appeared to be oligoclase in the section examined. There are also rounded grains of quartz and cubes of pyrite. The groundmass consists of similar minerals, very fine grained, with the addition of ilmenite largely altered to leucoxene. The alteration renders its identification difficult.

In some of the smaller dikes the feldspar is andesine; much hornblende is present, sometimes as skeletal growths in the feldspar; and the quartz phenocrysts may exhibit good crystal outlines or be rounded and embayed. Pyrite is generally present in cubes much larger than the grains of the groundmass. The name quartz andesite porphyry seems most nearly to fit the case. In some cases the size of the ferromagnesian minerals would indicate the name quartz lamprophyre porphyry.

The small island in the southern part of Regina bay, about a mile east of the Forestry station, consists in part at least of unsheared quartz porphyry; a dike here has phenocrysts of quartz in sharp hexagonal outlines, oligoclase near albite, muscovite in large laths, and a little green hornblende barely distinguishable from the groundmass. The name oligoclase-quartz porphyry is suggested. Of the types above described, the last corresponds quite well with the hornblende-muscovite granite that occurs about two miles south near Wapus lake. The quartz porphyry of Peninsula bay resembles in some respects the Stephen lake granite, which lies about two miles to the north. These porphyries may well be related, therefore, to gold occurrences near their boundaries, since these granites are apparently those from which the gold is derived.

On the southwest arm of Hope lake, on a small island which lies to the west of the granite body, there is an occurrence of quartz porphyry in which the groundmass appears macroscopically spotted with green, like a lamprophyre. Under the microscope the groundmass is seen to consist of quartz and feldspar with microlithic ferromagnesian aggregates, probably hornblende. Small iron ore grains also occur. The phenocrysts are quartz and feldspar, the latter non-striated but having an index of refraction greater than Canada balsam, probably oligoclase or andesine.

Several cases were observed where shrinkage cracks in these dikes were filled with quartz. It may well follow that some of the quartz veins distributed throughout the area are derived from these porphyries.

Keweenawan (?)

Traversing other formations, both Keewatin and granite, and following more northerly directions of strike than most of the enclosing rocks, there are certain basic dikes, in some cases of large size. These can be traced for considerable distances, mainly in a northwesterly direction. They are often discontinuous, apparently from faulting. The best examples are to be seen on Sabaskong bay and Kakabikitchiwan lake near Nestor falls and on Lobstick bay extending southward to the northern part of Dogpaw lake. Petrographically, they are ophitic diorites consisting of a felt of rather small laths of striated andesine with interstitial hornblende and some pyroxene. The accessories are ilmenite, magnetite, and quartz. In many instances feldspars are embedded, even in the iron ore. The general appearance of the rock is quite fresh, and the igneous

View of dissected peneplain looking eastward across the Flora lake granite. Taken from the old peneplain level, 160 feet above the lake in the foreground, it shows an even sky-line and the excavation of valleys and lake basins below. Occasional summits, or monadnocks, occur above the old peneplain, and a few rounded descendants or hilltops are seen below it.

structure is well preserved. The late date suggested for these dikes is mainly dependent on these features. They are evidently at least post-Keewatin and post-Laurentian. Their relation to the younger granites or unsheared quartz porphyries was not observed.

Those near Nestor falls appear to lie in the same strike as the basic dikes mapped by Lawson on Whitefish bay.

Physiography

The erosional sculpturing to which these differing rock areas have been subjected gives them at present the aspect of a dissected peneplain. Level-topped ridges are to be seen everywhere north of Kakagi lake in the more resistant rock-types and, at a height of about 200 feet above the lakes, their summits merge into a level sky-line. Here and there a few rounded monadnocks of slightly greater height can be recognized. Below the peneplain surface there are lower hills, for the most part rounded by glaciation, and occasional areas approaching a level condition above the lake surfaces. The lake basins in most cases must be ascribed to glacial deepening below these levels. In some instances, as in the case of Kakagi lake, they are rock-rimmed basins several hundred feet deep.

The level of the uplifted peneplain is preserved, doubtless with some glacial bevelling, in the tops of ridges in those areas where the rocks are more resistant to erosion. These are mainly the older massive granites, the massive fragmental Keewatin volcanics, and the diorite and amphibolite intrusives. The more gneissic granites are lower in altitude, and the sheared greenstone and rhyolite lavas the lowest of all. The latter occupy a large part of the area.

The larger lakes of the region naturally lie on these lower areas. Berry, Otakus, Dryberry, and Atikwa lakes, however, which lie on the gneiss, are at relatively high altitudes, while the lakes of the schistose areas, including Kakagi, Cedartree, Flint, Stephen, Cameron, Otterskin, Brooks, Isinglass, Shingwak, Dogpaw, Caviar, Denmark, Rowan, and various other lakes are at lower levels, near that of the Lake of the Woods. There is also a decided rise in the lake levels observable as one proceeds eastward from the Lake of the Woods,[1] which is no doubt due to the presence of the large area of batholithic granite between the Kakagi and Manitou Lake areas.

The Kishquabik granite area, which lies north of Lobstick bay (1,060 feet) and rises more than 300 feet above it, has a widely domed upper surface on which a few small lakes and a large area of muskeg are scattered at intervals. The granite is slightly gneissic in structure but not banded. To the north the lower basin of Dryberry lake lies upon more definitely gneissoid rocks. To the east Atikwa lake also lies on a lower gneissic area of less erosional resistance. Between is a large synclinal basin of the Keewatin.

This synclinal basin is intruded by the Flora lake granite, near which there are certain areas of greenstone on the granite contact that rise to the peneplain level and exhibit flat tops. The high area of folded pyroclastics that lies between Cedartree and Stephen lakes also shows flat summits in a marked way. In the region around Kakagi lake, the banded and fragmental volcanics of the upper Keewatin and in part also the amphibolitic and dioritic rocks rise into prominent hills with level summits. Along the south shore of Denmark lake certain rocks of the contact zone between the granite and Keewatin form a series of level-topped ridges.

Where well-defined this topography appears to include four stages: (1) The lowest, and latest, consisting of the basins of lakes and river courses; (2) a lower level of erosion, or low hilly surface, which lies above the lakes, but considerably below the higher peneplain, with which it is connected by many descendant peaks of intermediate heights; (3) the upper planation, represented essentially by flat-topped summits, benches on the sides of monadnocks, and ridges having even crest-lines; (4) occasional summits rising above the peneplain level.

Pleistocene and Recent Deposits

Till

The higher hills and surfaces in general exhibit glacial markings, mainly but not entirely referable to the Labradorean glacier of Wisconsin age. Erratic boulders and till are deposited over these surfaces in varying thicknesses. The boulders are for the most part entirely pre-Cambrian in origin, but a few of limestone were observed on Dogpaw lake. As this area was covered to a considerably greater depth than now by the waters of Lake Agassiz, it is possible

[1]The mean level of the Lake of the Woods is about 1,060 feet. (Low-water level, 1,056 feet; high-water level, 1,062 feet.)

that these boulders should be regarded as transported by floating ice to their present positions from the western shores of the lake. Whether this is true or not, there is a great probability that both the Keewatin and Labradorean ice occupied this area at different times. Heavy deposits of till were observed, especially on the north shores of Rowan lake, where morainic hills occur, and on the hilly country east of Kakagi lake as far as Brooks lake.

Lacustrine Deposits

Overlying the till, from an altitude in the neighbourhood of 1,100 feet and downward, deposits of sand and gravel, which undoubtedly represent the beaches and shallow bays of Lake Agassiz, were frequently found. These were especially noted on the northwest shores of Kakagi lake, in the southwestern parts of Rowan lake, and on the north shores of Cameron lake extending across to Beggs lake. The top of the ridge between Regina and Snake bays has also a considerable

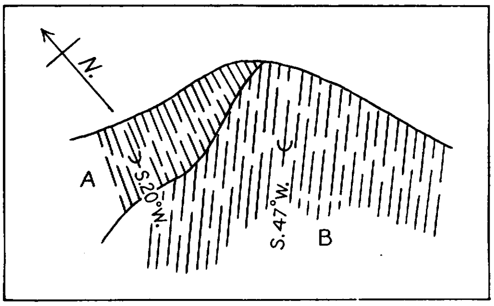


Fig. 5—Faceted rock on an island in Kakagi lake. "A" represents the general direction of the Keewatin glacier movement. "B" may show the Labradorean ice movement, prevailing for the time over the Keewatin; or, more likely, a local change in direction due to nearby vertical rock.

area of sands overlying till. At lower levels sands of considerable extent occur, which may be partly if not entirely referable to rearrangement by the waters at the present level.

Extending southward from the small lake north of Mangus lake another large deposit of sand was observed, and similar deposits form banks along the shores of the lake east of Mangus. These may be in part or altogether outwash plains. No kames or eskers were recognized.

At a lower level a little varved clay was observed on an island in the northwestern part of Dogpaw lake. It was not of great thickness, and the lower part was hidden owing to the raising of the lake level by a dam at its outlet. Most of these deposits of stratified sand, gravel, and clay are no doubt referable to the waters of Lake Agassiz, the surface of which stood at levels that are now somewhat above 1,100 feet in this locality. Above a contour at approximately 1,150 feet, the till is everywhere exposed.

Peat

Deposits of peat have been formed in shallow basins at many levels above the Lake of the Woods (1,060 feet) but, owing to the hilly and deeply dissected nature of the rock surface, are not of very great extent in the area here surveyed. The largest were seen at the southern margin of the field along the boundary between Kenora and Rainy River districts, where the surface of the country appears to be sinking to lower levels. A muskeg of considerable area also lies on the top of the high plateau of granite to the north of Lobstick bay.

Drift Modification along Lake Shores

The wave action of the present lakes has already produced considerable changes in the terrain along their shore lines. Where rocky surfaces slope steeply at the water level, they have been denuded of whatever cover they had and present rock exposures useful to the geologist and often of large lateral extent. In the case of the more schistose rocks, the combined action of water and frost has undermined cliffs by wedging off slabs of the fissile rock and in some parts has produced benches several feet wide at water level.

Where the gradient of the rocky slopes is gentler and covered by till, the finer parts of the till have been washed out leaving behind a boulder shore line. Where the surface consisted of sand or gravel deposits, these have been washed down and rearranged as sandy or gravelly beaches, bars, and spits at the present water levels. Rocky islets are often connected with the shore by such deposits. In this way sandy flats bordering lakes are being reworked and deposited at slightly lower levels.

Ice has produced considerable effect on the shores of many modern lakes by its expansion forcing gravel or peaty deposits backward from the shore line and piling them in steep banks. This is especially noticeable where the beach faces a fairly large width of lake, presumably because the larger sheet of ice expands to a greater distance up the beach. Conditions of this kind were especially observed on the south shores of Isinglass lake.

Glacial Striae

The following is a list of glacial striae (bearings astronomic-azimuth) noted throughout the area:—

Regina bay, south shore, opposite Indian village		37°
Regina bay, south shore, opposite faceted rock	stoss	37°
	lee	177°
Regina bay, at former Hudson's Bay post		37°
Snake bay, narrows at Camp No. 12		37°
Lobstick bay		27°
Lobstick bay, south shore near east end		42°
Dogpaw lake, island near Speight's line		22°
Denmark lake, west end		25°
Rowan lake, northwest bay, a faceted rock	stoss	62°
	lee	172°
Rowan lake, west shore		29°
Rowan lake, north shore		22°
Rowan lake, north shore, faceted rock	stoss	27°
	lee	177°
Atikwá lake, north end of Shoulder island		22°
Dryberry lake, central part of south bay		37°
Lake northeast of Kenu lake	stoss	29°
	lee	130°
Berry creek, near quartz porphyry contact		29°
Kakagi lake, southwest bay		42°
Kakagi lake, point east of southwest bay, faceted rock	stoss	62°
	lee	57°
Otterskin lake, north shore		22°

The variations in direction appear most marked at those places, such as faceted rock surfaces, where two sets of striae can be read. The bearings at such places on the lee sides of the rocks represent apparently a time when the Keewatin ice invaded the area, probably before the full development of the Labradorean glacier. The figures representing this condition are, as above noted, 177°, 172°, 130°. In one case observed on the south shore of Kakagi lake, there are two sets (62° and 57°), both relating perhaps to the Patrician glacier of Tyrrell.[1] A list of striae that may represent this phase of glaciation reads 37°, 37°, 37°, 37°, 42°, 62°, 37°, 42°, 62°. A third set, indubitably representing the Labradorean, reads 27°, 22°, 25°, 29°, 22°, 27°, 22°, 29°, 29°, 22°.

In each of these three groups the reader's attention must be attracted by the recurrence of at least two sets of figures exactly repeated. The proper inference would seem to be that the direction of the ice movement throughout the area was extremely uniform at any given time, but shifted from time to time during the advance or retirement of the various ice-sheets.

ECONOMIC GEOLOGY

Gold[2]

Horseshoe (Regina) Mine

This mine, formerly known as the Regina or Black Eagle, was discovered in 1894, began producing in 1895, and was worked continuously until October, 1899. It was again operated for short periods in 1902 and 1905.[3] It has been dewatered for examination on several occasions since then. The last time was in 1931, so far as our information goes. It was one of the large producers of the Lake of the Woods group, at a time when that group constituted the major part of the gold-mining industry of Ontario. At the last dewatering the workings were found to have a depth of over 700 feet. The total production has been variously reported as from $200,000 to $500,000.[4] The number of veins on the property has been stated by Parsons[5] as eight. They vary from a quartz-injected shear zone to a fine fissure type. The vein on which the actual development of the mine was carried out is said to be of the latter type. The strike, which lies between 110° and 130° azimuth, corresponds to that of many shear zones throughout the adjoining country.

The country rock at the mine is greenstone and granite, and the veins cross the contact between these nearly perpendicularly. The greenstone, which forms the main mass of the peninsula between Regina and Snake bays, is part of the southern limb of a synclinal trough folded between the old granite massifs of the Aulneau peninsula to the southwest and of Berry and Kishquabik lakes to the northeast Its structural strike is quite near that of the veins, and is includes sheared bands of rhyolite, which were observed to have similar strikes. Shear zones were also observed in the adjoining granite at a few points east of the mine along the shore of Regina bay. Inasmuch as the granite is subsequent in age to the original folding, it appears that the sheared zones in the greenstone, though nearly parallel to the folding, are much later in age. In addition to the sheared rhyolite bands there are also irregular dikes and larger bodies of unsheared

[1]J. B. Tyrrell, "The Patrician Glacier, South of Hudson Bay," Compte Rendu, XIIe Congrès Géologique International, pp. 523-534; Ont. Bur. Mines, Vol. XXII, pt. 1, 1912, p. 205; E. M. Burwash, Ont. Dept. Mines, Vol. XXXII, 1923, pt. 2, pp. 24-26.

[2]All gold values given in this section of the report are on the standard basis of $20.67 per ounce.

[3]For further information as to the mine in its earlier stages, *see* Ont. Bur. Mines, Vol. V, 1895, p. 180; Vol. VI, 1896, p. 91; Vol. VII, pt. 1, 1897, pp. 41, 114; Vol. XX, pt. 1, 1911, p. 173; Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, p. 10.

[4]Ont. Bur. Mines, Vol. XX, pt. 1, 1911, p. 175.

[5]Ibid.

quartz porphyry, observable especially on the bay where the Whitefish Bay Trading Company's post is situated and also on islands adjoining.

On the north side of Regina bay, opposite the mine, there is a fine-grained porphyritic dike that represents in its composition the hornblende-muscovite granite already described on pages 68 and 69. This dike cuts the Regina bay granite, which is penetrated also by the auriferous veins. The relation between the hornblende-muscovite dike and the intrusive quartz porphyry was not established, but both are younger than the granite, and they may account for two distinct stages of mineralization in the fissures and shear zones of the granite and greenstone. This might be consonant with considerable development of gold-bearing veins in the granite.

The greenstone appears to be in the main andesitic in character and is to a considerable extent of ellipsoidal primary structure, which has helped largely in determining the main foldings of the secondary structures.

The granite has been often described in previous reports[1] and has already been studied in this report.[2] It was determined as titaniferous hornblende-biotite granite. In some phases oligoclase is present, notably in a pegmatite dike on an island to the south of the houses formerly occupied by the Hudson's Bay Company. Out of five specimens examined microscopically, the occurrences of primary minerals are: orthoclase, 4; microcline, 2; oligoclase, 2; quartz, 4; hornblende, 2; biotite, 4; ilmenite, 3; magnetite, 2; titanite, 2. The hornblende-muscovite rock consists of orthoclase, oligoclase, muscovite, and hornblende. It may be taken for a syenitic phase of the granitoid rocks of the same type, the nearest occurrence of which is about four miles to the southeast, near Wapus lake.

The massive quartz porphyry that is also present is presumably younger than the granite, since it does not exhibit shear zones so far as known. It has phenocrysts of quartz, oligoclase, and muscovite in a groundmass of hornblende, feldspar, sericite, and probably quartz. In other parts the quartz porphyry contains notable amounts of pyrite in cubes. Here again the combination of muscovite and hornblende is indicative of a relation to the hornblende-muscovite granites.

The intrusion of the Regina bay granite and of the subsequent porphyries into the Keewatin syncline formed earlier between two masses of older and now gneissic granite appears to be somewhat characteristic of the gold occurrences throughout the region. The synclinal axis appears to pass along the axis of Regina bay and through the northern part of Dogpaw lake to the east, continuing thence toward the northeast. It is marked to the east of Regina bay by an infolded strip of the upper Keewatin fragmental volcanics, which are seen in greater quantity on Kakagi lake, where a large basin-like structure occurs. This syncline is also intruded by the older coarse amphibolite and the younger Stephen lake granite.

Mascotte and Trojan Mines

Other gold properties discovered about the same time as the Regina or slightly before include the Mascotte and the Trojan mines, which are situated about two miles north of South Narrow lake and about a mile from the west end of Kakagi lake. The veins, which were of good size, were in green schists and showed fine gold. A considerable amount of work was done in tunnels and shafts, but apparently the values obtained were not great enough to warrant the

[1]Ont. Bur. Mines, Vol. V, 1895, p. 103; Vol. VI, 1896, p. 91; Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925 (or Bull. No. 85), pp. 10, 11.

[2]See page 64.

expense of erecting a mill. Other properties were actively prospected at Sioux narrows at the entrance to Regina bay.

Virginia Mine

This property, known at the beginning of its history as the Lizzie mine,[1] is situated on Eliza lake, which is the first of a chain of small lakes lying along the route northeast from Caviar (Sturgeon) lake to Eagle lake. Other lakes in succession northward are Waterfall, Muscovite, Tillie, Empire, Kathleen, and Populus. They receive the drainage of Atikwa lake from the east and of a number of smaller lakes to the west in an intrusive granite area named the Flora lake granite. This series of lakes occupies the southeastern edge of a wide synclinal area of Keewatin lavas, pyroclastics, and older sediments, which is infolded between the Atikwa lake gneisses on the southeast and the Kishquabik and Dryberry lake gneisses on the northwest. The central part of this syncline has been intruded by two bodies of massive granite of a later age than the gneisses, called the Hope lake and Flora lake granites. These lie parallel to the axis of the syncline toward its eastern edge. The narrow belt of the Keewatin lying between them and the gneisses to the southeast has apparently received its mineralization from these granite bodies. The Virginia mine lies in the southwestern part of this mineralized zone, opposite the Hope lake granite from which, or from its subordinate dikes, the gold present almost certainly originates. Farther to the northeast, opposite the larger Flora lake area, a series of properties were staked, of which the Nina and Empire appear to have been the most promising.

The mineralization of this zone is mainly but not exclusively found in the more acidic members of the Keewatin, which have been variously described as felsite, rhyolite, or quartz porphyry schists. It is probable that these rocks under shearing forces were fractured to a greater extent than the greenstones and thus presented a better channel for percolating waters and the deposition of quartz. The quartz has again rendered the sericitic schists more brittle, and therefore more receptive of subsequent mineralization following further shearing.

At the Virginia mine there is a wide belt of sheared quartz porphyry on the western side, followed by two minor ones farther southeast, which are separated from the main flow by more basic interbedded lavas. The shaft has been sunk in the main acidic body, whose composition is that of a titaniferous hornblende granite; its texture was originally that of a quartz porphyry. Some of the feldspar phenocrysts are striated and were determined as oligoclase. The sheared condition of this rock has permitted injections of quartz, parallel to the schistosity. The vein on which a shaft was sunk and the greater part of the work done lies parallel to the schistosity and in a direction along which these injections assume larger proportions than usual. Two pits, which lie in a direction roughly 30° S.W. from the shaft at intervals of 450 and 320 feet, appear to represent independent veins at different horizons. The pit nearest to the shaft is sunk in a grey felsitic rock. The strike of the vein exposed in it is from N. 32° E. to N. 37° E. A foot of quartz shows on its southwestern face and about 4 inches on the opposite side. Assays of from 80 cents to $2.00 were reported here. The vein dips about 80° S.E. The larger pit farther southwest is cut in quartz porphyry, which appears sheared on the hanging-wall side and more massive on the footwall. Across a width of about 5 feet there are five or six veins of quartz

[1]For early accounts, *see* Ont. Bur. Mines, Vol. VIII, pt. 1, 1899, p. 59; Vol. IX, 1900, p. 46; Vol. X, 1901, p. 75.

exposed, ranging from an inch to a foot in width. Over this width the rock is said to assay $13.50.

The main shaft follows the dip toward the southeast at a steep angle and could not be descended at the time of our visit on account of the decay of timbers and the presence of water. Assays as high as $20.00 per ton were found here at the surface, and at a few feet depth an extremely rich pocket was encountered which yielded assays of $2,000.00 per ton over 5-foot widths. These values decreased rapidly and practically disappeared at a depth of 30 feet. No report is available of the values in the open cut and drift, which run southwest from the mouth of the shaft a distance of 72 feet into the hillside. The shaft, 6 feet by 8 feet, was sunk approximately 198 feet. At 100 feet the vein had narrowed

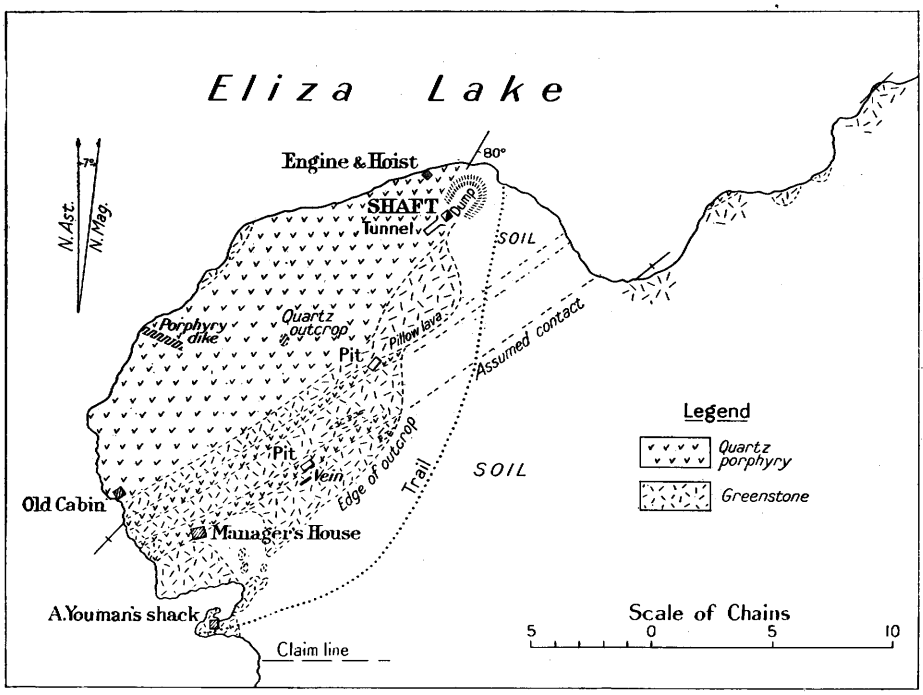


Fig. 6—Plan showing geology at the Virginia mine.

to one foot in width and was practically barren. Here a drift was driven 12 feet northeast, and from the end of it two crosscuts were run One toward the northwest, 102 feet long, ran for about 60 feet through the quartz porphyry schist and for about 40 feet through "grey granite," which from the description given by S. H. Brokunier, the engineer in charge, appears to be an intrusion of diorite or amphibolite of late post-Keewatin age and may be correlative to the Haileyburian of the eastern gold fields. The southeastern crosscut was about 38 feet long and ended at what is described as a hanging wall, probably at the contact of the quartz porphyry with a more basic member of the Keewatin series. This crosscut would require extension for about 360 feet to intersect the horizons of the veins seen in the two southern pits above described. Across the whole width (presumably that of the quartz porphyry), assays showed an average value of $2.00, which was richer in the parts where more quartz was in evidence.

Near the 200-foot level the vein was reported widening and yielding assays as high as $10.00. Assays of quartz samples from the surface of the dump collected by the writer gave a negative result. This probably represents the lower part of the shaft. A thin section shows quartz much stained and shattered and full of minute particles of iron ore. The cracks in the quartz are filled with a ferruginous carbonate with some small crystals that appear to be magnetite. Little or no sulphide and no gold was recognizable in this section. The blue

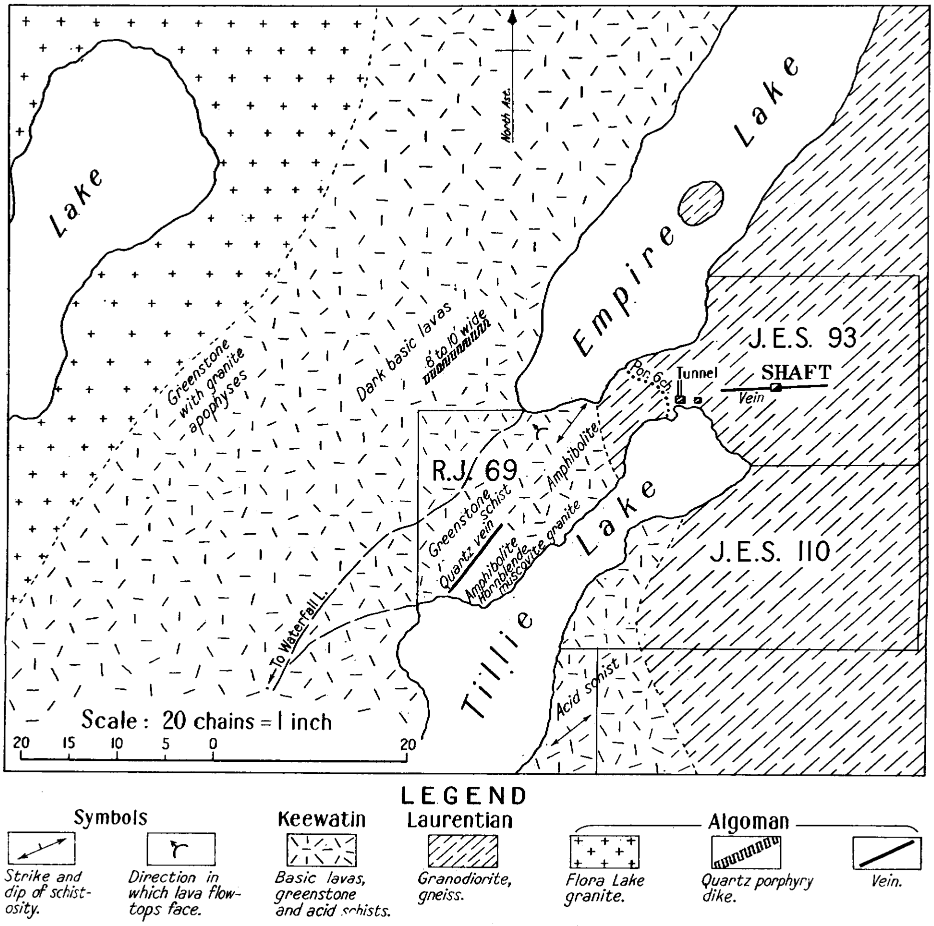


Fig. 7—Plan showing geology at the Nina mine.

colour of the quartz is due to strain, and the darker shades to the presence of finely disseminated iron.

The last work reported was done on this property in 1903. The gold may have been deposited more in the schist than in the quartz. The rich ores formerly obtained here are described as containing spectacular amounts of native gold.

The Virginia mine was reported closed down in the latter part of April, 1900,[1] but was reopened in 1903, as stated above. All the buildings and works are now in a state of complete disrepair.

[1]J. A. Bow, Ont. Bur. Mines, Vol. X, 1901, p. 75.

Mines near the Flora Lake Granite

Claims have been staked almost continuously from the neighbourhood of the Virginia mine as far northeast as Populus lake, and gold in quantities more or less pronounced has no doubt been detected on many of them. Only two properties, however, have been developed sufficiently to indicate a serious belief in their ultimate successful operation, namely the Nina and Empire mines.

Nina Mine.—The Nina is situated at the portage between Tillie lake and Empire lake. It was originally known as the Scovil-Moore property and was operated by the Great Granite Gold Mining and Development Company of Ontario. Reference to it appears in the reports of the Inspector of Mines, the first in 1899. The shaft on the property was then 60 feet deep; and a tunnel of 24 feet had been driven. These are still in evidence but not available for sampling without preliminary work.

The geology, as shown in the accompanying sketch map, Fig. 7, is quite different from that of the other gold properties near by, inasmuch as the shaft is sunk in what appears to be the older type of the Laurentian gneiss. Its final depth when the work was abandoned in July, 1900, was reported as 123 feet. Fifty-six feet of drift had been cut at 73 feet depth, and the tunnel extended to 70 feet. When examined in August, 1930, water in the shaft was within about 40 feet of the surface. The vein dips almost vertically for part of the distance and for the rest slightly toward the north. It is in a sheared zone in the gneiss, which is here considerably mineralized and weathers rusty. The vein consists of several quartz stringers, the widest about 20 inches across and the whole about 4 feet. The quartz has a granulated or "sugary" appearance and seems on the whole not highly mineralized. A picked sample showed a somewhat coarsely granular quartz with muscovite, chalcopyrite, and bornite. It assayed only 40 cents in gold.

On the northwest side of Tillie lake a dike was observed of the hornblende-muscovite granite described elsewhere. This and the occurrence of the vein in granite indicate a similarity between the mineralization here and that at the Horseshoe mine.

Machinery purchased for use at this mine appears never to have been installed, and the work was abandoned in September, 1903.

Empire Mine.—This property lies at the north end of Empire lake and is the most northerly of the properties near the Flora lake granite on which any development work was done. No reports mention this property previous to 1902,[1] when work was first commenced and the name "Violet mine" was used. No subsequent reports are available. When it was visited in 1930, there was found evidence of a considerable clearing, now largely reforested with young poplar, a number of camp buildings beside the lake, and a 5-stamp mill built of logs set farther back at the foot of a slope, on which were two shallow shafts, which had been put down without power machinery. The south shaft, situated about 180 feet north of the mill, was sunk on a rusty sheared zone in greenstone, which has a strike of about S.75° E. The vein-stone as seen on the dump consisted of schist injected with quartz of a fine granular texture. Much pyrite is present but no visible gold. An assay of a fair sample from the dump yielded $6.40 in gold per ton. At the north shaft, which is about 540 feet farther north, the vein is an injected part of a sheared porphyry of more acid appearance and has a strike of N.40° E. The quartz as before has a "sugary" texture and is mineralized with

[1]W. G. Miller, Ont. Bur. Mines, Vol. XII, 1903, p. 96.

pyrrhotite and chalcopyrite in cracks in the quartz or replacing the schisted porphyry. An assay of a fairly mineralized sample yielded $11.60 per ton in gold. Neither of these samples could be taken by channelling across the vein, and it is assumed that samples so made would show considerably lower gold content. The north shaft is 12 and the south shaft about 15 feet in depth. An open cut was made from the latter westward along the vein for a short distance. The mill was operated for a brief period on these surface ores, but it is now in a much dilapidated condition.

It appears that for the most part the mineralization that can be inferred as being derived from the Flora lake granite lies mainly along the eastern margin

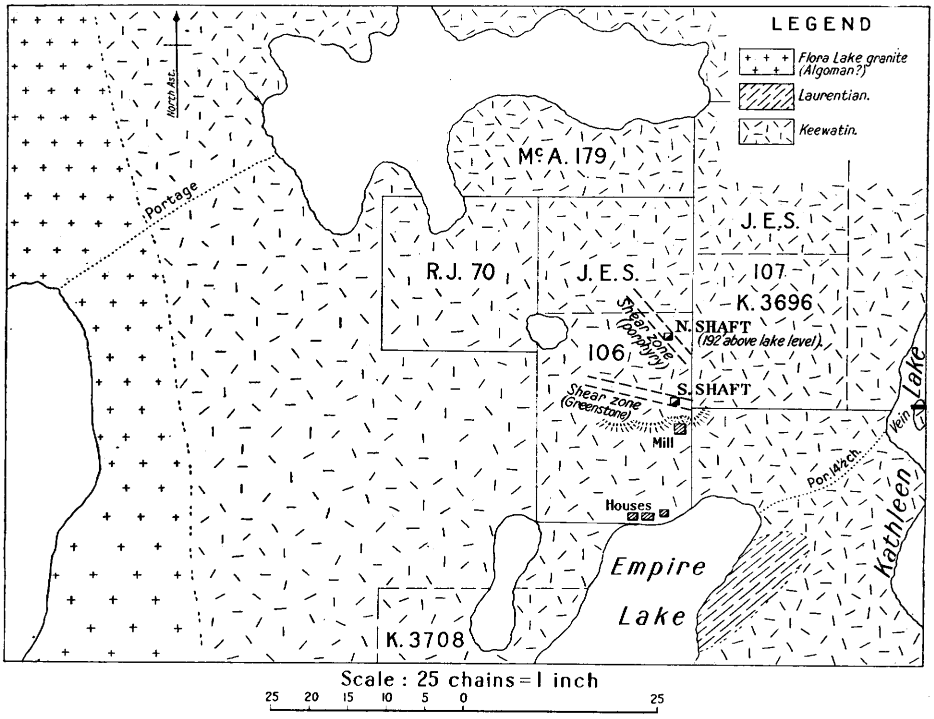


Fig. 8—Plan showing geology at the Empire mine.

of that body. A few claims, however, were staked along a line extending north-eastward from the head of Lobstick bay and lie to the west of the granite but at a greater distance and nearer to the Kishquabik gneiss, which is older than the granites to which most of the mineralization is here referred. These claims undoubtedly indicate some appearance of mineralization along this axis, but this was apparently of little importance. A reason for the greater mineralization on the east side of the granite might be found in the fact that that side lies near the edge of the synclinal basin, where certain structural planes that might act as conductors of the mineralizing solutions have there an upward direction.

Gold Panner Mine

This property was opened in 1899 and worked for a short time. It is situated on an island in Caviar (Sturgeon) lake about 4 miles south of the Virginia mine. The island, which contains 22 acres, is traversed by alternating bands of greenstone and quartz porphyry, which have a strike curving from east by north at the western end to near northeast at the northeastern end of the island. The schistosity is not parallel to the strike of the beds, which would imply that the structure plunges towards the southwest if the schistosity is contemporaneous with the original folding. There are also shear zones which bear N. 25° E., crossing the original schistosity, and the mine appears to be associated with one of these. The gold values are confined, so far as could be judged, to the part of these shear zones that cuts the quartz porphyry in which the shaft was sunk to a reported depth of 100 feet. This would agree with observations of the mineralization of the sheared quartz porphyries or felsites of this region noted on other

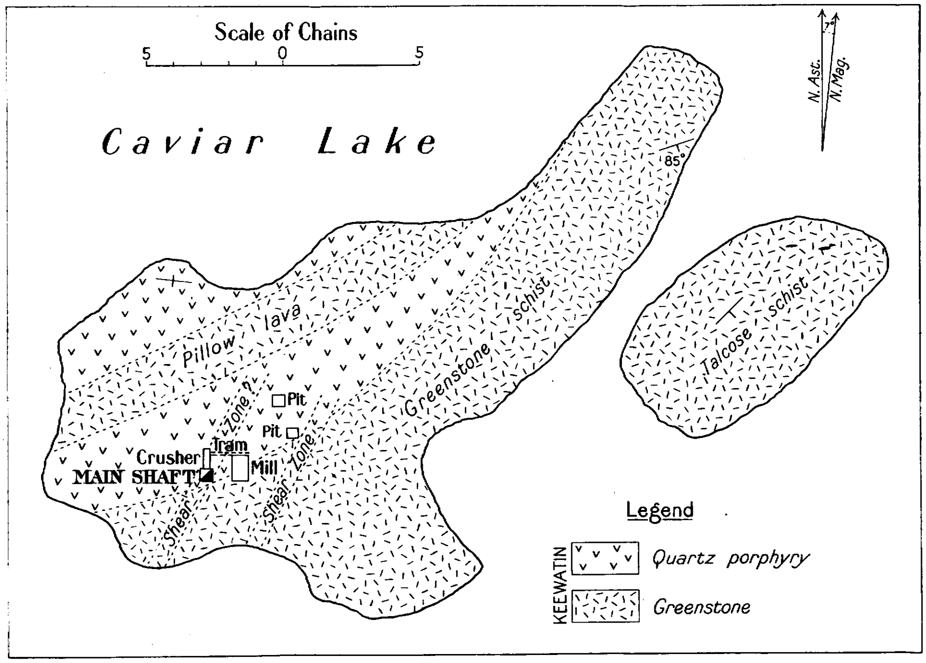


Fig. 9—Plan showing geology at the Gold Panner mine.

properties, inasmuch as the original shearing allowed the injection of quartz in small veinlets along the shear planes, while the later shearing, here seen to be in a transverse direction, probably resulted in a fracture cleavage which admitted the carbonate and gold mineralization. The sulphides are largely pyrite with a little chalcopyrite and molybdenite. The carbonate is ankeritic. Microscopically, the porphyry is seen to consist of orthoclase with some oligoclase or andesine with fractured quartz. Not much ferromagnesian silicate is present, but pyrite crystals and ilmenite grains altered to leucoxene are common. The feldspars are largely altered to sericite and kaolin, and much of the mica is arranged in the plane of shearing.

The well-sheared porphyry is a sericitic schist, but the shearing appears to have been strong only along certain zones of weakness, leaving intervening plates of massive rock. These with the injected quartz formed a brittle mass, which yielded to a later cross-folding shearing by fracture rather than flowage. The idea of cross-folding as the cause of the later shearing would agree with the present plunging attitude of the original structure.

The mine was provided with a crusher and rolls housed with the headframe and connected by a short tram with a 10-stamp mill. A forge, hoist pump, and assay office completed the equipment. Some ore was treated, and it is said that a small amount of gold was produced. Water in the mine caused great difficulty. The vein was reported[1] as 8 feet wide, and rich samples of ore containing native gold were said to be obtained from it. The last work reported on this mine was done in 1903.

The following assays were secured by the writer: (1) Mineralized quartz porphyry somewhat sheared and injected with quartz, which here appears subsequent to the mineralization in cracks penetrating the rock at a different angle, gave $4.20 per ton in gold. (2) Quartz stringers, carrying carbonate, penetrating the mineralized schist gave 40 cents per ton in gold. A complete solution of the mineralization is not indicated in these two samples.

It is not clear from which of the various bodies of intrusive granite in the synclinal basin of Caviar lake the mineralization of the Gold Panner vein has been derived. A small granite outcrop to the east lies in a line between the Hope lake and Stephen lake stocks and suggests that there is a deep-seated connection between these intrusions and the Flora lake granite, which accounts for the similarity of their composition. Two granite bodies that lie to the north and south of Rowan lake are of like composition.

Flint Lake Mine

In the year 1901 the Flint Lake Gold Company, of Philadelphia, in which Thomas A. Edison was said to hold an important if not the principal interest, acquired the claims numbered McA. 285 and McA. 286 from the discoverer.[2] At that date a little surface trenching had been done on the property, which is situated on the northeast shore of Flint lake. It lies about 2¼ miles north of the northeastern end of the Stephens lake granite stock and about 2 miles south-southwest of the small granite area on Caviar lake. A number of dikes of quartz porphyry, probably referable to this granite, are exposed on the south shore of the same bay, and on the islands farther west and north.

The first work on the Flint lake property consisted of two shafts situated 25 chains inland from the north shore of the east bay. These were sunk in 1902. At the same time a plant was erected, which consisted of a 125-horsepower boiler, slide-valve steam engine, Allis-Chalmers Blake crusher (not installed), Krupp ball mill, Fairbanks duplex pump, ore bin, and wooden vats for cyaniding. Other buildings on the property were dining and sleeping camps, blacksmith shop, assay office, and a powder-house situated at a distance from the other works. A graded road about 25 chains in length connected the mine with the mill. As the outcrop stood about 20 feet above a swamp, it was decided to quarry the upper part and mill it as an initial operation. The mill, however, was never used, and the work was abandoned in 1903, probably because the assay values were too low. In this initial work the advantages of cross-trenching seem to have been entirely overlooked, and the plant was prematurely installed.

The ore, as mined at first, was mainly quartz, which occurred in a vein differing slightly in strike from the surrounding schists. The strike of the vein is given as S. 70° E., that of the schist as S. 80° E. The vein also appears to dip toward the southwest, while the planes of schistosity dip north. The vein was, therefore, described as a fissure vein. It undoubtedly contained a good deal of schist mingled with the quartz. The schists contain sericite and chlorite

[1]Ont. Bur. Mines, Vol. IX, 1900, p. 49.
[2]Ibid, Vol. XI, 1902, p. 255.

and represent the more acid types of lava of the area. A selection of ore taken from a pile at the mouth of the tunnel and open cut, which extend west from No. 1 shaft, assayed $3.20 per ton in gold. The ore from the shaft is a white

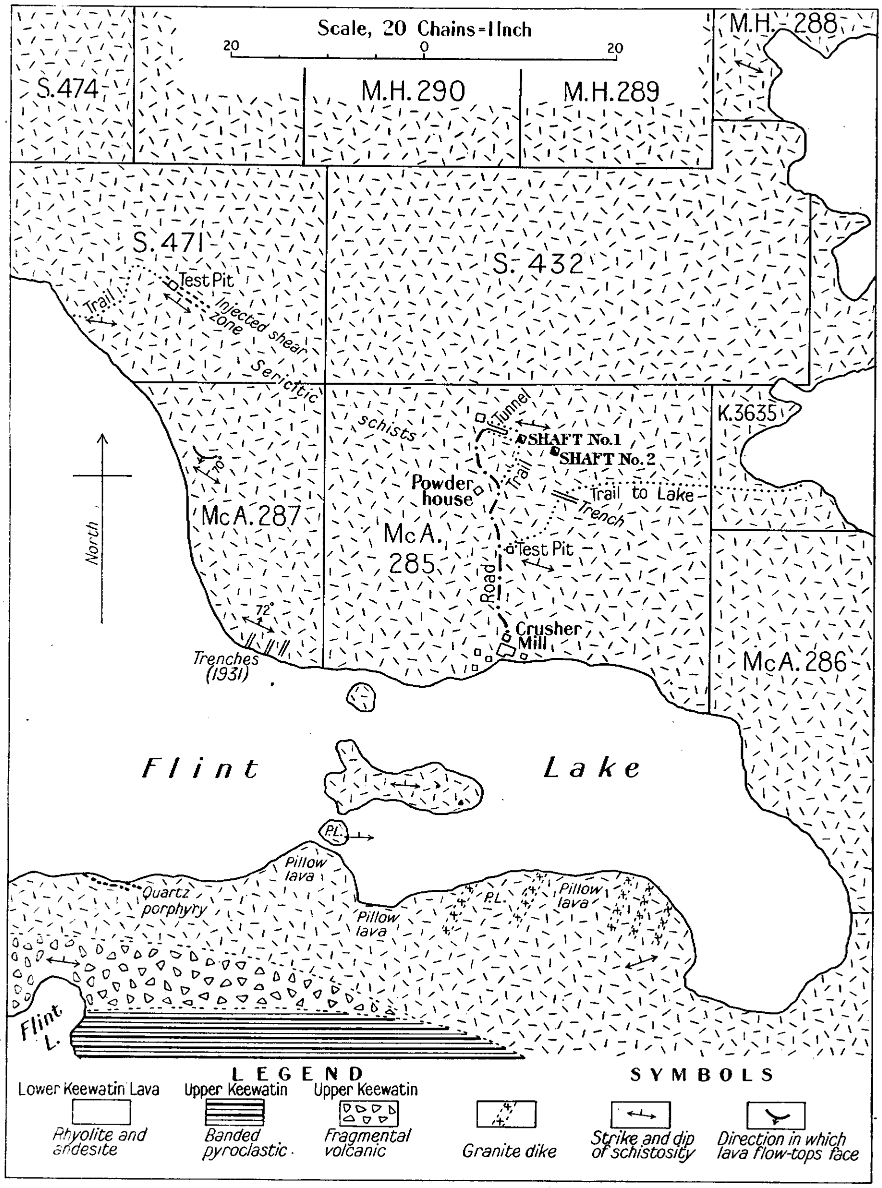


Fig. 10—Plan showing geology at the Flint Lake mine.

glassy quartz with inclusions of sericitic schist and ankeritic carbonate filling cracks. There was no visible gold observed, but a little pyrite was noted. In the original reports,[1] however, fine visible gold is said to occur in the quartz.

[1]Ont. Bur. Mines, Vol. XIII, pt. 1, 1904, pp. 63.

About 35 chains northwest, on claim S. 471, there is a small test pit in chlorite-sericite schist, which is injected with glassy quartz in lenses, sometimes a foot in thickness, carrying pyrite grains. Cracks in the quartz contain veinlets of magnetite and pyrite with a little chalcopyrite. The pyrite is possibly later than the magnetite. A certain amount of carbonate is also present in the schist. It occurs in layers up to an eighth of an inch in thickness interleaved in the schist, but was not noted in the quartz. A sample from this pit yielded $4.40 in gold.

On the second visit to this mine in 1931, it was found that the mine had changed hands and some work had been done, including several trenches cut across a band of the acidic schists 100 feet wide on the south end of this western claim near the lake shore. The work extends about 500 feet along the strike, to which the trenches are transverse. Mr. Findlay McCallum, of Winnipeg, who was in charge of the work, reported that two trenches 100 feet or more apart

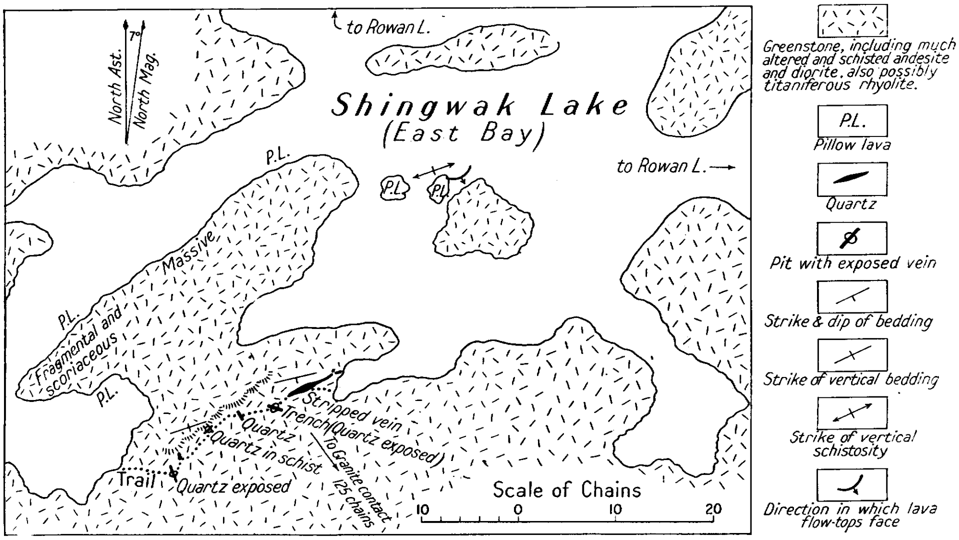
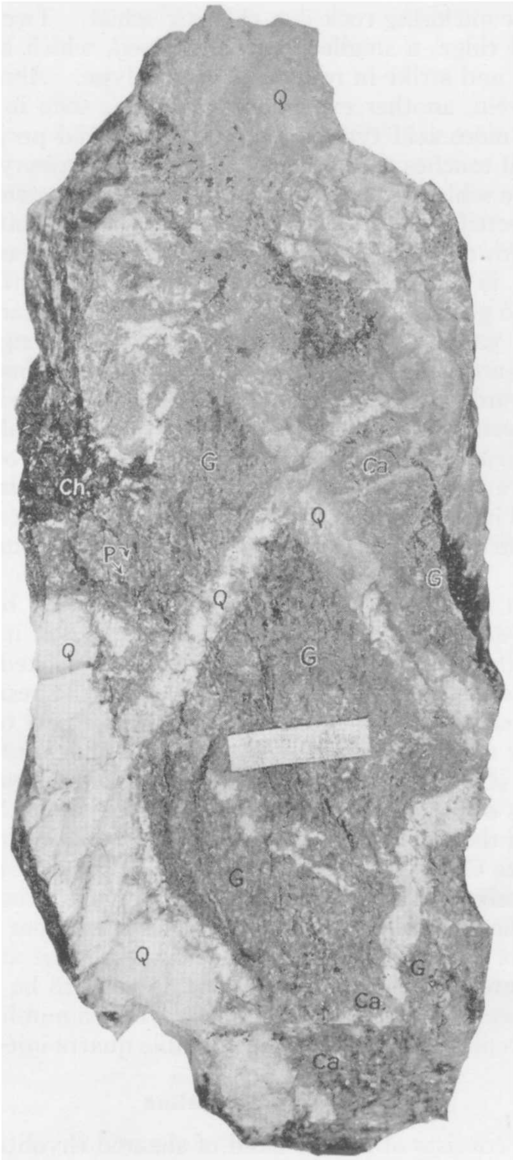


Fig. 11—Plan showing geology on the property of R. Roy.

have yielded values of $10.60 and $8.00 over a width of 5 feet in each case. In the first-mentioned trench there is also another section of several feet that assays $8.00. Here, as elsewhere, the schist is injected with quartz that varies in colour from white to almost black, the dark colour seeming to be due to the presence of finely disseminated magnetite. The veinlets of quartz do not always follow the schistosity, but in some cases break across it. Native gold is visible in the quartz, and other mineralization consists of pyrite and chalcopyrite. The strike of the schistosity here is approximately S. 64° E. (S. 57° E., astr.) and the dip 71° to 74° N.E. It has also horizontal shear zones at intervals. The general structural dip is to the south, which would make it appear that the quartz, in some parts at least, follows fractures parallel to the bedding, while the schistosity traverses the planes of the bedding at an angle inclined opposite to the structural dip. This agrees with the general structural position as indicated by the map, which shows that the beds to the south are of higher horizon and fill a synclinal basin, on the northern edge of which Flint lake is situated.

Roy Claim

At the mouth of the east bay of Shingwak lake on a trail leading across the base of a peninsula that partly closes the entrance, a number of exposures of



Specimen (three-quarters natural size) of carbonated greenstone schists mineralized with pyrite and chalcopyrite and penetrated by gold-bearing quartz veinlets, Roy claim, Shingwak lake. Q = quartz. G = altered greenstone. Ca = ferruginous carbonate. Ch = chalcopyrite. P = pyrite.

quartz are seen in small trenches or pits, and near the east end a wide vein of lenticular form is exposed by stripping for about 250 feet. At its widest part the quartz measures 29 feet, and the average width for the 250 feet was estimated at 8 or 10 feet. This property is known as the Roy mine.

Commencing at the western end, the first vein matter seen is exposed in a pit 6 chains from the landing. The quartz, which has a width of from 4 to 5 feet, represents a vein with a strike of S. 10° E. It is massive and appears to be little mineralized. A few cracks are filled with black magnetite and a little ankerite and pyrite, and the enclosing rock is a chloritic schist. Twenty yards north in the side of a small ridge, a smaller vein is exposed, which has quartz of quite similar appearance and strike in rock of the same type. About 60 yards north-east of the small vein, another exposure of quartz is seen in a schisted rock of lighter colour and more acid type, apparently a sheared porphyry. Ten yards farther on, the trail touches a trench cut in sheared porphyry which has several veins parallel to the schistosity. At the north end of the trench there is a 6-foot vein of quartz, injected by veinlets of ankerite, pyrite, and later small magnetite dikes. This is followed (see Fig. 11) a little farther on by another quartz vein, striking N. 32° E., in a schist that strikes N. 62° E. Farther along the trail the rock changes to greenstone schist again and another quartz outcrop is to be seen. Seventy-six yards farther east a trench 20 feet long across the strike, which is near east-northeast, exposes 15 feet of quartz veins in schist, carrying ankerite; and 29 yards farther in the same direction the stripped part of what may be the same vein was reached. It was uncovered for about 250 feet when the property was visited and showed a maximum width of 29 feet near the central part of the exposure. Offsets branching into the schist on the north side were observed, and in several parts large amounts of fragmentary greenstone were included in the quartz. These fragments shown a certain amount of carbonate replacement.

Mineralization occurs both in the quartz and in the brecciated material. It consists mainly of pyrite and chalcopyrite, and much of it is in cracks subsequent in age to both the quartz and the carbonate. A picked sample gave $1.60 gold and 6.2 per cent. copper. For another sample the result was $4.40 gold and 0.23 per cent. copper, but a channel sample over a part of the vein 6 feet in width yielded only 60 cents in gold. The vein continues some distance farther east on the same strike to the shore of the bay. On about the same strike, mineralization was observed in sheared rhyolitic rocks on the shore of Rowan lake to the north of the bay on which the Sullivan mine is located. The mineralization of the Monte Cristo property appears also to be on a prolongation of the same structural horizon. This belt of mineralization is roughly parallel to the northern edge of the Nolan lake granite. The distance from the granite contact is over 1½ miles at the Roy property and nearly the same at the Monte Cristo.

The Roy–Monte Cristo mineralized zone appears to be at its strongest, as far as quartz is concerned, at the Roy property, where a number of veins differing in strike are seen, representing a very considerable quartz injection in large veins.

Monte Cristo Mine

This prospect consists of a wide band of sheared rhyolitic rock crossing the north end of a peninsula that projects from the south shore of Rowan lake, near the eastern boundary of the mapped area. It lies, as already stated, about 1½ miles north of the northern edge of the Nolan lake granite and is in the immediate vicinity of a number of the unsheared rhyolite porphyry dikes carrying pyrite in cubes, which are taken in this report to be of approximately the same age as the granite. Eight trenches have been cut across the mineralized zone. Six of these were opened in 1900 and sampled by Charles Brent. They were cut at intervals along the strike over a length of about 400 feet. The entire length of the exposure, which crosses the point, is about 600 feet from water to water.

The maximum width of gold-bearing rock was determined by J. G. Cross as being nearly 200 feet, including that exposed on a small island off the point. The most thorough sampling was done by Brent in 1900. Some of his figures for channel samples are shown on the diagram (Fig. 13) of the trenching. He reports that an average of the assays of 54 samples indicated a gold value of \$3.72. Of this, \$2.55, or about 70 per cent., was recoverable by amalgamation. Later sampling by J. G. Cross in 1931 yielded smaller values on assay, which he

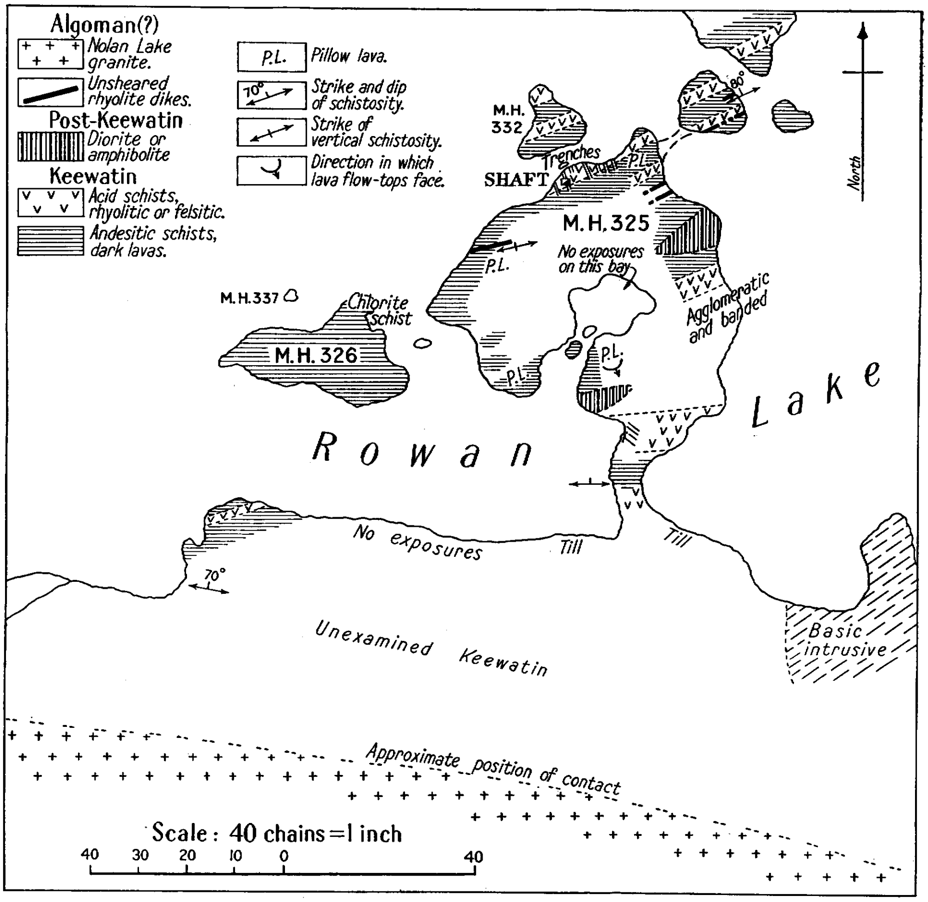


Fig. 12—General plan showing geology at the Monte Cristo mine.

attributed to his not having cleared out the old trenches and to not pulverizing his samples sufficiently.

Here, as in other deposits of the same kind in sheared quartz porphyry or rhyolite porphyry, there is a large body of very low grade average value containing irregularly placed and shaped lenses of higher values. Cross notes that joints may cut off the gold deposition. The schists are crossed in many places by transverse shear zones and presumably joints, having a bearing of about S. 60° E. The strike of the schists is N. 60° to 70° E., and the dip approximately vertical.

As compared with the Virginia and Flint lake deposits, which are similar in being in sheared rhyolitic flows, the Monte Cristo shows less concentration of quartz in large veins, but the wide distribution of low values over considerable widths is common to all. A study of the mineralization in the rock exposed on the point opposite shows that the sheared porphyry was injected parallel to the schistosity with small veinlets of quartz; crossing this in cracks of a later age are veins of ankerite; pyrite and chalcopyrite, which probably contain the gold, appear to be still later in age. The history that is indicated would, therefore, be: (1) shearing of the Keewatin lavas by folding, producing schistosity in both the greenstone and more acid flows; (2) the quartz injection mainly but not entirely confined to the acid schists, possibly due to their greater solubility, but producing in them a much greater rigidity and brittleness owing to the extensive deposition of quartz; (3) renewed shearing producing a fracture cleavage in the acid zones but not in the greenstones; (4) injection of carbonates into these fractures; (5) subsequent mineralization by solution and replacement of the carbonates.

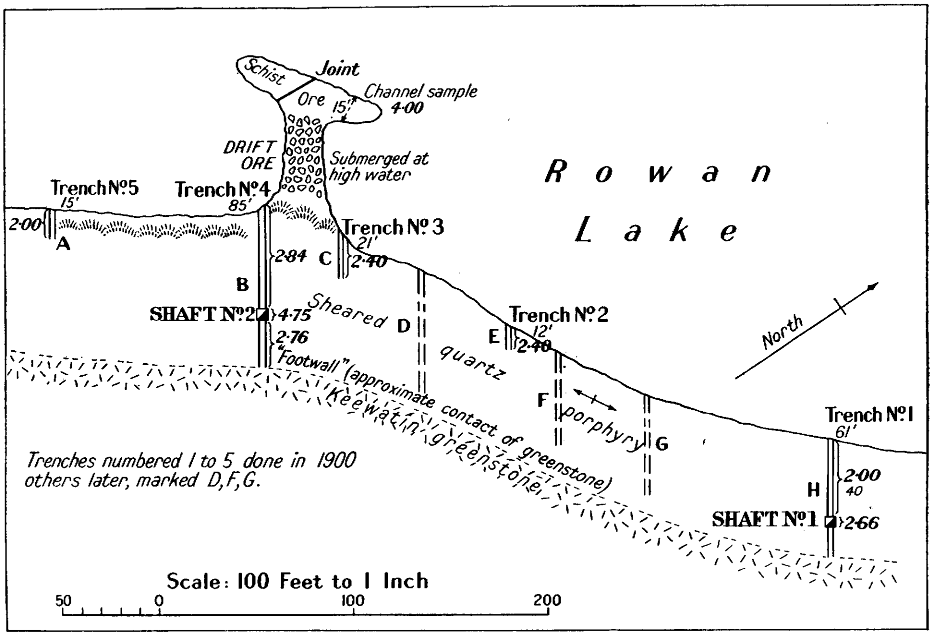


Fig. 13—Detailed sketch of the Monte Cristo mine (after J. G. Cross).

The first folding appears to have been coincident in time with the older granites, provisionally called here Laurentian. The quartz injections may have taken place at a later stage of the same intrusive period when the granites were hardening and could give siliceous solutions into the surrounding formations. If, then, the mineralization by metallic ores is referable to the later granites, it must have occurred at a period very much later than the original quartz intrusion. The intermediate carbonate deposition might be Haileyburian and derived from the diorite-amphibolite intrusions if these are assignable to that age. They are not sheared enough to produce schistosity and, therefore, are younger presumably than the folding of the highly schisted lavas of the lower Keewatin. They are also seen to be intrusive in the massive fragmental upper part of the same formation. The three stages of mineralization here seen might then be accounted for by three different intrusions, of Laurentian, Haileyburian, and Algoman age, respectively. These considerations are, however, advanced only tentatively. It appears certain that the intrusions of the carbonate and later sulphides took place after a cross-shearing, which could not have been contemporaneous and may have been very long subsequent to that which produced the original schistosity, and also subsequent to the quartz injection that occurred after the

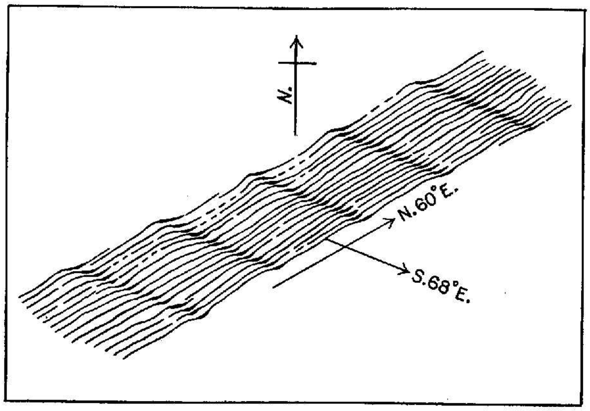
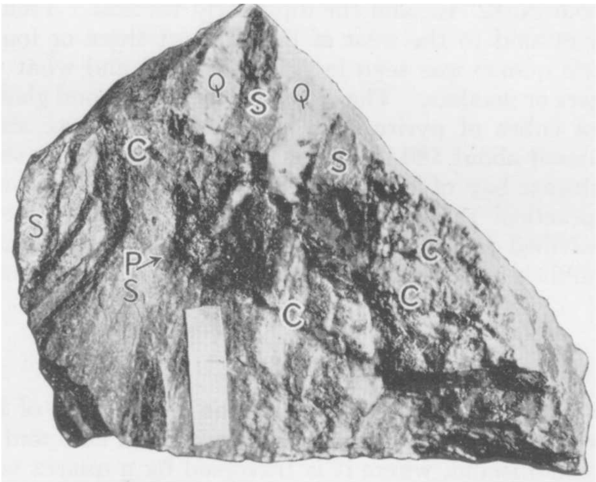


Fig. 14—Rhyolite schist on the Monte Cristo property, Rowan lake. Strike of schistosity, about N. 60° E.; direction of transverse drag folds, S. 68° E.

schistose condition was established. It will be remembered that the gold mineralization appears to be due to cross-shearing in the Gold Panner and Flint Lake properties, both of which are also in sheared zones of rhyolite or quartz porphyry.



Specimen (three-quarters natural size) of gold-bearing injected acid schist, Monte Cristo mine, Rowan lake. Q = quartz injected parallel to the schistosity. S = sericite-chlorite schist. C = ankeritic carbonate later than the quartz, injected transverse to the schist and quartz stringers. P = pyrite in the ankerite or carbonate, which it probably replaces.

Sullivan Mine

This property, at first known as the Reliance mine,[1] is situated at the southwest corner of Rowan lake (then known as Denmark lake), on Timber

[1]Ont. Bur. Mines, Vol. IX, 1900, p. 47.

Berth No. 1, east of Kakagi lake, which had been leased to the Anglo-Canadian Gold Estates, Limited, of England, together with four other blocks, the whole aggregating 117 square miles. The company, which was organized early in 1899, had exclusive prospecting and locating rights in these areas for a limited time. In August of that year, the Reliance property was located in Timber Berth No. 1, and another property, called the Elizabeth, on another area known as Timber Berth No. 61, north of the Seine river. Alan Sullivan, the company's manager, reported on February 13, 1901, that a shaft 94 feet deep had been sunk. At the 60-foot level about 80 feet of drifting had been done, and at the bottom there was a crosscut of 30 feet. The latter was said to be exploratory work due to a dislocation of the vein at that depth. Work was then discontinued pending the arrival of the company's diamond-drill from the Elizabeth mine.[1] As reported by the Inspector of Mines in 1900, the principal shaft had reached a depth of 110 feet. The drill had been used to discover the displaced vein without success.

When visited in the summer of 1931 the buildings were in ruins and the headframe of the shaft had collapsed. As the surrounding surface is largely covered with a deposit of sand and gravel, little could be done in the way of examining the vein. To the west of the shaft an irregular open cut about 45 feet in length had been made, with an offset of 24 feet northward at its western end. The shaft appeared to be only about 25 feet deep and on an incline of about 70° W. Its cross-section was 5 by 8 feet. This shaft, if originally 110 feet deep, may have been filled up with material from the open cut. The dump just west of the shaft would certainly indicate that depth had been reached considerably greater than that now visible.

The vein matter is a sheared porphyry that is practically a sericite schist. The strike is about N. 82° E., and the dip nearly vertical. Trenching had been done in the low ground to the west of the shaft at three or four points widely separated. Little quartz was seen in these trenches and what was visible was in narrow stringers or veinlets. The quartz is very white and glassy. Mineralization consists of cubes of pyrite with some massive pyrite and chalcopyrite. The shaft is situated about 580 feet west of the houses on the shore at the west end of the southwest bay of Rowan lake. Another shaft is said to be 33 feet deep. As no practical samples were obtained, no assays were made. The deposit was described in early reports as having an important gold content, which was not publicly reported in detail. The work was abandoned about 1901.

Mineralized Zones Not Previously Described

Gold occurs at the following points:—

Flora Lake Granite.—On an island near the central part of Kathleen lake a band of sheared quartz porphyry is seen crossing the lake and appears in the north end of a small island, where it is traversed by a quartz vein about 6 feet in width, partly of glassy and partly of a fine granular appearance; its strike is nearly east and west. The glassy part was mineralized with carbonates, pyrite, and sericite. It assayed from 20 to 40 cents.

Isinglass Lake.—On the north shore of Isinglass lake, on claim S. 473, near an outcrop of the felsitic granite that occurs on the claim, there is a mineralized zone in the gneissoid rocks that is sheared, highly oxidized, and mineralized with pyrite and a little chalcopyrite. This zone strikes about S. 64° E., and contains a vein of quartz following the same strike. In appearance the

[1]Ont. Bur. Mines, Vol. X, 1901, pp. 40, 74.

quartz is "sugary" and carries cubes of pyrite, especially in the altered inclusions of the wall rock. An assay from a selected sample yielded 80 cents in gold. A small stamp mill and gasoline engine were at one time erected here. The excavations were rather shallow cuttings on the oxidized zone.

Rowan Lake.—On an island near the north shore of Rowan lake about 4½ miles southeast of the portage from Denmark lake to the north bay of Rowan lake, there is an oxidized zone cutting across the strike of the schists. The general strike is N. 87° E. The lavas are greenstones, ropy or fragmental in the upper part of the flows. They are penetrated along the strike by a rhyolite porphyry dike, which is unsheared. The oxidized zone that is seen on the eastern shore of the island has a strike of S. 28° E. It extends northwestward over a quarter of a mile, crossing a point and the small bay beyond. At the southeast end it contains an irregular body of quartz, distributed in several lenses, which is mineralized with pyrite and possibly a little chalcopyrite. Its mineralization may be traced to an outcrop of granite on a small island half a mile southeast along the strike of the shear zone. This zone was at one time staked and a little work done on it. A sample taken at the time of our visit yielded no values in gold.

South and Southwest of the Nolan Lake Granite.—This area is traversed by a remarkable number of quartz veins, some of them very large, equalling that exposed on the Roy claims northeast of the same granite body.

Several of these veins cut across that point that projects northward in the southeastern part of Cameron lake. They traverse the point in a northwest-southeast direction and cross to a point on Otterskin lake, where their bearing is nearly due east. On the point that divides Otterskin lake into two bays, they are again exposed with a southeasterly strike. The total length of this vein system is about 3 miles. Many of the outcrops studied were of massive quartz, which appears to have undergone no fracturing since it was first deposited and shows no signs of mineralization. These veins are in greenstone lavas. In one case, however, near the northern side of the system, a heavy vein of pyrite traversed by quartz is found running parallel to the schistosity of a sheared rhyolitic flow. The quartz at the first discovery point seems younger than the pyrite, which itself forms a considerable body totalling over 6 feet in width. The vein was also observed on the west shore of Otterskin lake, where the pyrite forms stringers in the rhyolite schist, and not much quartz is visible. At the first point the pyrite assayed 60 cents a ton in gold, but at the Otterskin lake exposure there was no gold content, though a heavily oxidized zone of 10 feet or more in width occurs there. The veins in the eastern part of Otterskin lake appear to be unmineralized.

Following almost on the strike of these veins southeastward, a number of smaller quartz veins in greenstone and sheared porphyry are to be seen on the south bay of Brooks lake and on the point immediately east. Three assays from these veins yielded no gold in two cases, and only 20 cents a ton in the third sample, which was taken from the south bay. The largest vein, which is on the point, had about 2 feet of clear quartz. The strike is S. 63° E., and the wall rock is massive greenstone. The other veins are injected bands of sericite schist with ankerite, apparently older than the quartz, which contains cubes of pyrite.

General Conclusions

It appears in general to be true that the pyrite does not carry much gold, which occurs in promising amounts only where chalcopyrite is present. Judging by observation duriug the progress of the present work, it would appear that the Empire and Flint Lake mines are those which give visible evidence of possibly profitable results. The very wide dissemination of gold throughout the area seems so far to have raised expectations that have not been realized. The question of exploiting successfully somewhat large and very low grade deposits is that which presents itself most obviously.

The origin of the mineralization has been largely dealt with in passing. Little doubt remains that the later granite bodies, now known to be much more numerous than before, account for the presence of gold with almost entire certainty.

Iron Formation and Ankerite Dikes

A dike of rusty-weathering siliceous carbonate was examined near the southwest end of a bay that forms the most southerly extension of Kakagi lake and opens a few miles east of the Crow portage. From a point on the north shore of the bay near its western extremity a dike of this material, which has a width of 8 or 10 feet in some parts, extends on a bearing of N. 50° W. for a distance of 24 chains to a small lake, underneath which it disappears. It contains no visible sulphides, has a banded structure parallel to its length, and includes fragments of the chloritic schist in which it is bedded parallel to the schistosity. Replacement of the schist by the carbonate on a large scale appears to explain the data observed. On analysis the following composition was revealed:—

	Per cent
Silica	8.10
Alumina	.71
Ferric oxide	.43
Ferrous oxide	8.14
Lime	29.95
Magnesia	12.22
Carbon dioxide	40.71
Sulphur	.06
Water	.15
Total	100.47

This composition corresponds to an ankerite low in iron and high in silica. The silica also is only slightly referable if at all to native quartz. It may be a phase of the iron formation. On the southern and western shores of Schistose lake, iron formation occurs again. At a point in the western end of the lake there are exposures of iron ore with many large fragments of black chert irregularly distributed in it. The fragmentation may be accounted for by the folding to which the bed has been subjected. Another band carrying visible sulphide is exposed on the south side of the point. Its width, though undetermined, exceeds 30 feet, and it appears to be a siderite ore with fragments or bands of white chert and carrying sulphides of iron. Keewatin lavas occur along the south side of the lake, disappearing opposite a point on the north side, where the banded cherts with ore are again encountered. Farther east another band occurs in which the amount of ore is much reduced relatively to the chert. This appears to lie at a lower horizon than the other two exposures.

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