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Greer, L. 1931. Geology of the Shoal Lake (West) area, District of Kenora; Ontario Department of Mines, Annual Report 1930, v.39, pt.3, p.42-56.

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THIRTY-NINTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

1930

PART III

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

THIRTY-NINTH ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

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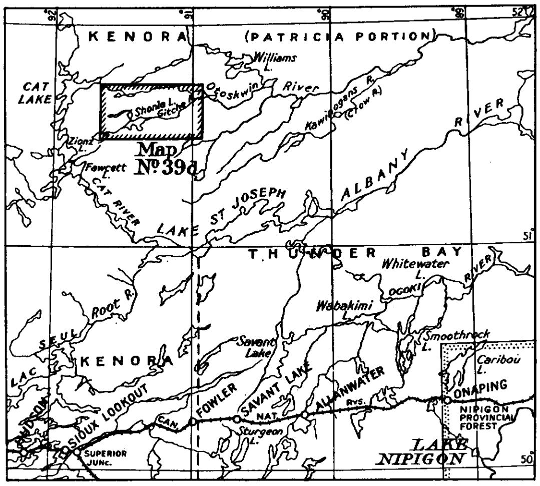
Geology of the Shonia Lake Area, District of Kenora (Patricia Portion)

By H. C. Laird

INTRODUCTION

Shonia lake is situated in the Patricia portion of the district of Kenora some 65 miles north and east of the Woman Lake area and 20 miles southeast of Cat lake. Although the lake is one of the smallest in the region, it lends its name to the whole area, owing to the fact that it was the scene of the original mineral discovery.

"Bill" Smith, a well-known prospector, was the first to appreciate the possibilities of a heretofore unknown belt of Keewatin rocks in this area.



Key map showing location of the Shonia Lake area. Scale, 60 miles to the inch.

In August, 1928, he and Stanley Watson staked a small group of claims between Shonia lake and the eastern part of McVicar lake. The news of the discovery of a new mineralized belt soon reached prospectors, and in a few weeks the whole Keewatin area surrounding Shonia lake was staked solidly. Before the snow fell prospectors already had a general idea of the nature of the rocks, and much useless staking in unfavourable areas was avoided.

The possibility of a new gold field gave much importance and publicity to the whole area. On the authority of T. W. Gibson, Deputy Minister of Mines, the writer was assigned the work of making a geological reconnaissance. This was carried on during the summer of 1929.

The writer takes this opportunity to thank all those who gave useful information and courteous assistance during the summer. In this connection special thanks are due to W. G. Woods and A. A. Beatty of the

Hudson's Bay Company; to A. E. Dumond, G. Younger, C. S. Johnson; to Major Nicol and staff of the Ontario Forestry Branch, Sioux Lookout; and to Angus McMillan and John Stoughton, prospectors. G. G. Duncan of the Northern Aerial Minerals Exploration, Limited, very kindly gave valuable information on the sampling of the Smith property. In the preparation of this report, many thanks are due to members of the staff in the Department of Geology and in the Department of Mineralogy, University of Toronto, for helpful suggestions.

Much of the success attained is due to the efficient and willing co-operation of three assistants, W. T. Boyes, University of Western Ontario; G. A. McVicar, Toronto University; B. I. T. Breakey, McMaster University.

Access and Canoe Routes

The Shonia Lake area occupies a central position with regard to prospecting activities in the Red Lake mining division. It lies 104 miles in a straight line north of Sioux Lookout on the Canadian National railway, 65 miles northeast of Woman lake, and 60 miles west of the Pickle Lake–Crow River area.

The Western Canada Airways, Limited, provides excellent service, making the trip from Sioux Lookout to Shonia lake in one hour. The more arduous task of paddling requires at least seven days. The advantage of the aeroplane in this country needs no further comment.

The most direct canoe route is from Hudson or Sioux Lookout, via Lac Seul, the Root river, and the Cat river. The Hudson's Bay Company has used this route for many years in the transport of winter supplies to the Cat Lake post. Large gas boats make the trip from Hudson to Perch ripple, at the east end of Lac Seul, in one day. Previously a portage was necessary here but the Ear falls development at the head of the lake has raised the water to such an extent that the ripple has disappeared, allowing the large boats to reach Nattaway falls without difficulty. Between Perch ripple and Lake St. Joseph there are 9 portages, all of which are short and well travelled. Root portage, the longest, is over the height of land between the English and the Albany River systems. The upper Root river is quite narrow but navigable with small canoes at all seasons. The stream leading to Lake St. Joseph is wide but shallow, and outboard motors are used with difficulty especially in the autumn. The Cat river flows into the northwest corner of Lake St. Joseph. For the most part this river is nothing more than a long chain of lakes connected by short steep rapids and waterfalls. The route to Shonia lake leaves the Cat river by a long narrow arm extending eastward from a point between Fawcett lake and Zionz lake. It is necessary to make three short portages before reaching the creek that leads into the Gitche river. In low water considerable distance is added to the last of these portages. There are three more short portages before reaching Shonia lake.

Good canoe routes connect Shonia lake with Savant lake, Pickle lake, Woman and Birch lakes, and with Gold Pines at the head of Lac Seul. A short route from Gold Pines, via the Wenasaga river, to Gull lake and Fawcett lake, is an old travelled one. From Woman lake there are two possible routes: one via Swain lake and Springpole lake to Gull lake; the other via Shabumeni and Birch lakes to Zionz lake. The route from the Pickle Lake–Crow River area traverses Kawinogans lake, Wright lake, and Dobie lake to the Gitche river.

The Topographical Survey of Canada has issued four aerial map sheets that cover the routes mentioned above, namely, Sioux Lookout, Lac Seul, Trout lake, and Lake St. Joseph.

History and Development

Mackenzie's map[1] shows the Cat river route from the trading post on Lake St. Joseph to the Cat Lake post. At this early date any interest in the country beyond that of pure exploration was in the fur trade.

In 1885, Thomas W. Fawcett, D.T.S., made a survey[2] from Lake St. Joseph to Cat lake by way of the Cat river. His description of the route is mainly topographical.

In 1902, A. W. G. Wilson and J. F. E. Johnson made a survey of Cat lake and the Cat river. Wilson's report[3] accompanied by map 9A (No. 1089) was published in 1910.

In 1904, Charles Camsell[4] reached Cat lake by way of the Wenasaga river. He was joined here by J. Williams of Osnaburgh House, who "had come straight across to Cat lake by a route hitherto only travelled by Indians." This route is shown on map 9A, accompanying Wilson's report. His traverse took him across the northern part of the present Shonia Lake map-sheet. Long lake on map 9A has been renamed Morris lake on the present map.

In 1912, W. G. Miller made a compilation[5] of all the exploration work up to that time in the district of Patricia, including the reports of Camsell and Wilson.

There is no record of the knowledge of a Keewatin belt of rocks in this area previous to Smith's discovery in 1928, but there is evidence that the Cat lake Indians knew of the mineralization because they had already given the name "Onamun" lake to Shonia lake (meaning "money" lake in their language). It is said that Smith learned of the "find" through one of the Cat lake Indians. The value of the native cannot be overestimated with respect to prospecting. Some of the larger prospecting companies are already making efforts to train our native Indians in the knowledge of rocks and in prospecting methods.

Nearly five hundred claims were staked along the strike of the greenstone belt between August and December of 1928. From then on the prospectors adopted a "watch and wait" plan. The Northern Aerial Minerals Exploration, Limited, took an option on the Smith-Watson group and immediately took in a winter camp by 'plane. During the winter they did considerable clearing, channel sampling, and shooting into the mineralized quartz. Results were very disappointing and in the spring work was discontinued.

Bracton Limited, a subsidiary of Dominion Explorers, actively prospected a group of claims under the direction of A. E. Dumond. They found three zones of interesting mineralization, but none were of economic importance. The representatives of several syndicates examined other groups and reported that they found nothing of interest. Kenora Prospectors, Ventures Limited, Cyril Knight Prospecting Company, Bunker Hill Extension, Beverly Syndicate, and the Lyman Exploration Syndicate, were among those who had prospecting parties in the area.

[1]A map of America between latitudes 40° and 70° North and longitudes 45° and 180° West exhibiting Mackenzie's track from Montreal to Fort Chipewyan and from thence to the North Sea in 1789 and to the West Pacific Ocean in 1793. Accompanying Voyages from Montreal through the continent of North America to the Frozen and the Pacific Oceans in 1789 and 1793, by Alexander Mackenzie, London, 1801.

[2]Thomas W. Fawcett, Dept. of Interior, Ann. Rept., 1885, pt. 11.

[3]A. W. G. Wilson, Report on a Traverse through the Southern Part of the North West Territories from Lac Seul to Cat Lake in 1902, Geol. Surv. Can., Publication No. 1006, 1909.

[4]Country around the Headwaters of the Severn River, Geol. Surv. Can., Vol. XVI, pt. A, 1904.

[5]Reports on the District of Patricia, Ont. Bur. Mines, Vol. XXI, pt. 2, 1912.

Physical Character and Drainage

The Shonia Lake area is typical height-of-land country. It presents a monotonous picture of many low rounded hills, interspersed with small lakes and wide areas of muskeg and alder swamps. It has an elevation of approximately 1,330 feet above mean sea-level. A comparison with other nearby areas can be made from the following compilation[1] of elevations above mean sea-level:—

	Feet
Cat lake	1,330
Woman lake	1,315
Red lake	1,146
Shabumeni lake	1,330
Windigo lake	1,200
Lake St. Joseph	1,185
Lac Seul	1,153
Savant lake	1,308

The sky line is remarkably even in all directions, indicating that this area is a part of an old peneplain of wide extent. Glaciation was the principal agent in bringing about the present topography and drainage system. The highest hills seldom rise more than 150 feet above lake-level, and the maximum relief is probably never more than 250 feet. Small sluggish streams drain the muskegs. Very few are navigable for more than a few chains but meander for long distances. There are many examples of small lakes in the last stages of development, a condition quite typical at the height of land. Some show the debris and vegetation creeping from the shore toward the centre, and others are nothing more than a mass of organic ooze. The final stage shows grasses taking root and a scattered growth of small tamarac and jackpine.

Scratches, grooves, fluting, and chatter marks on the rocks indicate that the glacier moved in a southwest direction. It gouged and scoured the deeply weathered rocks of the old peneplain, rounding off the more resistant knobs and completely removing many of the softer rocks. The eroded material was removed to the lower places, severely altering the original drainage system and giving rise to a great number of small shallow lakes. At the same time a thin mantle of glacial sand and boulders was deposited on the slopes.

Many of the long narrow lakes have their origin in the rock structure. The map shows that, in general, the trend of these follows the strike of the rocks. Whenever this is not the case, glacial material has interfered with the original structural channel.

Many of the low areas are due to the erosion of the soft rocks. An example of this is found in the area north of Cannon lake. The paragneiss here is crumbly and easily eroded, giving rise to wide areas of low spruce.

Although the area has been described as having little relief, nevertheless there are some hills that stand out prominently. Those south and west of Sor lake are probably the highest, forming a more or less continuous ridge extending from Gitche lake at the west to Dobie lake at the east. In the area between Sor, Gitche, and Bertrand lakes there are many high parallel ridges that trend a little south of east and conform to the gneissic structure of the granite. East of McVicar lake the ridge is less prominent until the area north of Dobie lake is reached, where it is again outstanding, breaking the monotony of the low country along the Gitche river.

The area between Lang lake and Cat lake lies directly on the divide, some streams flowing into the Cat river, others into the Otoskwin river. It has a very low relief and an imperfect drainage, presenting a monotonous

[1]James White, Altitudes in the Dominion of Canada, Commission of Conservation of Canada, Ottawa, 1915, p. 454.

tract of sand plain, muskeg, and low hummocky granite hills interspersed with many small kettle lakes. Immediately north and east of Cat lake the topography is very similar, being mostly sand plain with wide areas of open muskeg.

In the region of Morris lake brulé granite hills up to 150 feet in height skirt the north shore and form prominent ridges inland. Similar ridges occur in the south arm and to the east, where steep cliffs dip sheer into the water in many places. Covered hills of moderate elevation surround the basin of Upturned Root lake. The shore is largely sand and boulders with not a single rock outcrop. It is clearly of glacial origin. Between this lake and the Otoskwin river several high ridges and isolated hills rise above the general level.

The Gitche, Otoskwin, and Morris rivers provide the main features of the drainage system. The first two unite just beyond the eastern boundary of the map-sheet and thence find their way into the Attawapiskat system. The Morris river flows north.

The waters from the larger lakes to the west flow into the Gitche river. Bertrand lake lies within an irregular rock basin surrounded by high granite ridges. Its waters reach Lang lake after falling several feet over long shallow rapids. Boyes lake likewise flows into Lang lake by way of a wide creek that is navigable at all seasons of the year. Lang lake empties into Shonia lake by two small chutes, and the latter in turn empties into McVicar lake over a 6-foot rapids. Gitche lake lies near the source of the Gitche river, which is an extremely meandering creek between Gitche and Stoughton lakes. Both arms of Gitche lake are very irregular in outline with low rocky shores and many small islands. The Gitche river for the most part flows through a low sandy area with a few low rock outcrops along the shore. It is narrow and has a gradient eastward of about 4 feet to the mile, giving it a fairly strong current. Most of this grade is taken up by several chutes and rapids.

The Otoskwin river forks at the west and drains the country between Lang lake and Cat lake. It consists of a series of small lakes connected by long swift rapids and low waterfalls; the gradient is much steeper than on the Gitche river. High ridges are prominent, especially on the way to Baggy lake and to the east. In this respect it differs markedly from the Gitche river.

The Morris river is similarly a chain of lakes, but on the whole they are larger than those on the Otoskwin river. Beyond Upturned Root lake it widens considerably and can be compared with the Cat river in size.

Timber, Agriculture, and Power

Much of the area near Shonia, Lang, and Gitche lakes is heavily covered with virgin forest consisting chiefly of spruce, jackpine, birch, and poplar. Where the trees are thinned out, the spruce grows to pulpwood size. Stands of large jackpine are common. Jackpine up to 2 feet in diameter were noticed on sandy ridges to the south of McVicar lake, and also west of Boyes lake. Red pine appears to have failed at this latitude; there is also an unusual scarcity of the Canada balsam. White cedar grows to a large size along the rivers. Tamarac is gaining a foothold in the open muskegs.

There is evidence that forest fires sweep the country intermittently every few decades. A few isolated spots of virgin forest remain south of McVicar lake and northwest of Lang lake. The northern part of the area between Baggy lake and Upturned Root lake has not yet recovered from a devastating fire that swept the country a few years ago. Forest fires have recently swept the Morris and Baggy Lake sections leaving scarcely any green timber. The tree stubs still stand on the otherwise bare granite ridges, displaying a most desolate picture of the ravages of forest fire. The potential wealth in timber lies to the south of the area rather than to the north.

During the season, the Ontario Forestry Branch established a flying base and radio station on a point on the south shore of Kapikik lake in the Cat river. This will give more adequate protection to valuable tracts of timber in this area.

Good soil, suitable for agriculture, is almost entirely absent. Occasionally arenaceous clays. The mantle material is largely sand and gravel of glacial origin.

There are no waterfalls in the area of sufficient size to produce electric power.

Fish and Game

The lakes and rivers are well stocked with the usual types of fish, namely, pike, pickerel, perch, suckers, and whitefish. There are no clear-water lakes; hence the trout does not occur. The Indians have built many weirs along their routes of travel to insure them of a fresh supply of fish.

The small fur-bearing animals are becoming scarce, but big game is still fairly plentiful. During the summer, members of the party saw the following fur-bearing animals: black bear, rabbit, skunk, beaver, mink, ermine, wolf. No doubt others of the more timid types, such as fox, lynx, and otter, can be taken.

It is noteworthy that the larger game, moose and deer, are much scarcer here than 100 miles to the south. Especially is this true of deer, only four being seen during the entire summer, probably because of the character and scarcity of food. This latitude may be regarded as the northern boundary of a zoological province for moose and deer and the southern boundary of a zoological province for caribou, which are occasionally seen this far south.

Waterfowl nest here in great numbers, while the ruffed grouse and partridge appear to be less numerous than usual. This latter fact may be only a seasonal characteristic and contrary to the rule.

Mapping

The Lake St. Joseph aerial map-sheet, published by the Topographical Survey of Canada, was used as a base on which to plot the geology of the map that accompanies this report. The aerial sheet was correct in all except a few minor points, and the extraordinary detail is to be commended.

The map extends to Dobie's meridian and base line on the east and north, respectively, and to a line just east of Cat lake on the west. A large part of the work in the outlying areas was simply a reconnaissance, done largely from the canoe. An attempt was made to show some of the main topographic features along the routes, but this must be regarded as sketch work. In the schist belt, traverses were run at regular intervals across the strike of the rocks by pace and compass methods. The presence of many small lakes greatly increased the accuracy of mapping, since they served as fixed points to which traverses could be tied.

GENERAL GEOLOGY

The consolidated rocks of this area are all pre-Cambrian in age, and consist of intrusive, extrusive, and sedimentary types. The extrusive rocks form the basement schist series and are commonly known as greenstones because of their highly metamorphosed nature. They occupy a synclinal basin, roughly rectangular in shape, extending from the west end of Lang lake to the portages leading from the Gitche river to Dobie lake, and some distance east. The total length is more than 25 miles, and the maximum width is about 5 miles. The series is completely surrounded by great masses of granite, and smaller bosses occur within it. Gabbro-diorites and amphibolites of pre-granite age probably form as much as 40 per cent. of the total schist area. Sediments of great thickness occur at Cannon lake and to a lesser extent on Lang lake. Diabase dikes, so common in most pre-Cambrian areas, are completely absent.

A great unconformity exists between the consolidated rocks and the more recent sands and gravels of the Pleistocene. No rocks of Paleozoic or post-Paleozoic age occur *in situ*, but limestone float, presumably transported by the glacier from the Paleozoic areas to the north, was seen.

The following table indicates the chief types of rock and their probable age relationships:—

QUATERNARY	
RECENT:	Sand beaches, peat, and other organic deposits.
PLEISTOCENE:	Glacial sands and gravels.
	Great unconformity
PRE-CAMBRIAN	
POST-ALGOMAN:	Trachyte dikes, lamprophyre dikes, and other basic dikes.
	Intrusive contact
ALGOMAN:	Older granite, younger granite, feldspar porphyry.
	Intrusive contact
PRE-ALGOMAN:	Gabbro-diorite and gabbro porphyrite.
	Contact not observed
TIMISKAMING (?):	Conglomerate, greywacké, quartzite, paragneiss.
	Slight unconformity
KEEWATIN:	Altered basic lavas, acid lavas, and their schistose derivatives, iron formation, conglomerate, slate.

Keewatin

The Keewatin rocks are the oldest in the area. They are essentially a much sheared and metamorphosed series of basic and acidic volcanic lavas, some of which can scarcely be recognized except by analogy with rocks of a similar nature. Their volcanic origin is strongly suggested by ill-formed pillow structure and the general scoriaceous nature of the surface.

Basic Lavas

These rocks, commonly known in the field as greenstones, consist of fine-grained andesites and basalts, their schistose derivatives, and coarse-grained to porphyritic phases. They are dark-green in colour and have a characteristic weathered surface of soft chloritic substance up to a quarter of an inch in thickness. Under the microscope they show a fine aggregate of chlorite, hornblende, and epidote.

Pillow structures are fairly common as in many other parts of Ontario, but there was no place suitable for their study with a view to learning the tops and bottoms of the flows. As a rule they are so ill-formed that they scarcely suggest pillows at all. This fact indicates that these lavas flowed over the surface rather than beneath the water. In several of them good amygdules are seen, some completely filled with quartz, others only partly so. On the north shore of the largest island in the eastern part of McVicar lake an amygdaloidal andesite occurs. This rock has a pitted appearance due to the weathering out of the amygdaloidal substance, making it particularly conspicuous. Directly north from this island, on the mainland, and on the north shore of Lang lake near the creek flowing from Boyes lake, the lavas are characterized by a great abundance of quartz blobs, which are almost chalcedonic in aspect. These structures are irregular or almond-shaped, sometimes an inch or more in length, and arranged in a parallelism that is accentuated by the shearing of the rock. Owing to differential weathering the soft basic material wears away, leaving the surface quite rough. The upstanding blobs are in turn worn down to a common plane and usually show glacial scratches on their hard but otherwise smooth surfaces. These are not amygdaloidal rocks and differ from the rhyolite agglomerate mentioned below. They are known as basic volcanic fragmentals or agglomerates and have a pyroclastic origin.

A peculiar type of spotted lava[1] occurs at several places, notably to the north of the Smith-Watson group. It consists of a fine-grained basaltic rock, with many round light-coloured spots of various sizes up to an inch in diameter; two or more often unite to form a patch of considerable size. The rock weathers to an earthy green colour, the light spots standing out

Specimen (natural size) of "variolitic" lava from the northern part of the Smith-Watson group.

in high relief. The microscope shows that hornblende is the principal constituent of the rock, but the crystals are smaller and fewer in the light-coloured spots than in the darker spaces. The remainder is so fine-grained and altered as to preclude certain identification of any other mineral except calcite. It is thought that these spots are of secondary origin in the upper vesicular portion of a basaltic lava flow, and somewhat akin to amygdaloidal structure. This rock is similar in appearance to variolitic lava[2] seen by the writer at the Potterdoal mine, Munro township, and to specimens from the Amulet mine, Quebec, where it is known as dalmatianite[3] or spotted dog. Thin sections of the latter show that the spots may be composed of either fine-grained quartz, single crystals of cordierite with inclusions, or hornblende needles. It is therefore concluded that the spotted lavas here stand in close relation to the hornblende varieties of dalmatianite found elsewhere and that they have a common origin. In Quebec, some economic significance has been attached to this rock, but it would appear that no such importance is to be placed on a similar type found here.

The basic lavas throughout the area are characterized by coarse-textured and porphyritic phases, resembling gabbros or diorites. They are often found to grade from a fine-grained basalt to a coarse gabbro within short distances, sometimes not more than a few inches. This led to consider-

[1]For want of a better term, "variolitic" lava is retained on the map. Strictly speaking, the term suggests a spherulitic or radiating structure that is not present in this rock.
[2]T. L. Gledhill, Ont. Dept. Mines, Vol. XXXVII, pt. 3, 1928, pp. 39, 51, 52.
[3]H. C. Cooke, Geol. Surv. Can., Sum. Rept., pt. C, p. 41, 1925.

able difficulty in mapping, owing to the fact that one outcrop might be typical basalt with pillow structures, while the next would be partly gabbro. This variance in texture is somewhat difficult to explain. The lower parts of the flow would cool more slowly than the upper, and consequently have a coarser texture. This would account for the gradation from fine to coarse grained types on a large scale, but often there appear to be small centres of gabbro crystallization within the fine-grained basalt, quite independent of its position in the flow. An outcrop on the west shore of Shonia lake, just above the portage, shows this feature very well.

Hornblende is developed to an extraordinary degree in every type of basic rock, and many of them are composed almost entirely of this mineral. These rocks are known as amphibolites. On the freshly broken surface they show many dark-green to black glistening crystal faces of hornblende. Sufficient evidence was gathered to show that amphibolite is the alteration derivative from basic Keewatin lava and is due to recrystallization processes attending the granitic intrusions, with consequent development of heat and pressure. Whenever these rocks were found at some distance from a known granite intrusion, it was assumed that granite was not far beneath the surface. The widespread occurrence of this rock, north of Lang lake, on McVicar lake, and on the Gitche river, is evidence that the whole greenstone basin is shallow and underlain by granite masses; this has a considerable bearing on the economic possibilities mentioned below.

Many of the fine-grained greenstones have been silicified to a large degree. The silica, derived from granitic intrusions, is secondary after the consolidation of the lava. These siliceous rocks are not uncommon and occur widely on the shore of Lang lake, between the eastern part of McVicar lake and Andy lake, and south of the Gitche river.

Serpentine is a minor constituent in most of the basic rocks, but assumes massive proportions at the southeast corner of the second largest island in the eastern part of McVicar lake. It is thought to be a further alteration after amphibolite.

Acid Lavas

The rocks in this group are chiefly rhyolites and rhyolite fragmentals. The former is a hard fine-grained rock, usually yellowish-green in colour but sometimes black. It breaks with a good conchoidal fracture, and gives the characteristic resonance when struck with a hammer. The surface weathers dark-grey and shows the rough fractures common to this rock when it has been subjected to shearing stresses. The megascopic specimen often shows scattered phenocrysts of quartz. In the field, it so resembles a greenish quartzite at Cannon lake that it might easily be mistaken for it, except for the fact that flow structures are indicative of its volcanic origin.

Rhyolite fragmental occurs at the southeast corner of Lang lake. It can be traced from some distance along the strike and grades into pure rhyolite to the south of it. It is composed of rounded to elongated fragments of rhyolitic material or almost pure quartz, sometimes as much as an inch in length, placed in a darker matrix of rhyolite. The fragments are squeezed out in the direction of the shearing, being rounded at one end and tapering toward the other. They are white and stand out prominently on the weathered surface. The fragmental rhyolites are considered to be acidic extrusions at times of great volcanic activity. They are common to the pre-Cambrian rocks of Ontario.

The rhyolites are not nearly so extensive as the basic lavas. The principal belt extends from Andy lake westward across the Goodfellow group of claims to the chutes joining Lang lake with Shonia lake. Westward there are a few low scattered outcrops extending to the Dumond group, where they are cut off by the granite. On both the north and south shores of the western part of McVicar lake narrow bands of rhyolite are interbedded with greenstones. At one point on the north shore, an irregular ankerite vein, a foot wide, cuts the rhyolite and gives rise to a prominent gossan zone. Other outcrops of rhyolite occur along the Gitche river between the eastern part of McVicar lake and Cannon lake. It is now largely sericite schist, sheared at N. 75° E. and dipping slightly to the north.

Schists

The Keewatin rocks have all been subjected to severe shearing stresses and gentle folding. They are sheared at N. 80° E., with minor variations, and stand almost vertical. The basic and acidic lavas are equally well sheared, giving rise to chlorite and sericite schists, respectively. The green colour of the rhyolite is largely due to the development of sericite along planes of movement.

Carbonate Rocks

Massive carbonate rocks are comparatively rare in this area. One outcrop, on the south shore of Cannon lake, shows where the calcite has been weathered out, giving the surface a pitted appearance. Minor carbonization is found in nearly all the sediments in the form of calcite. The ankerite veins on the western part of McVicar lake have been mentioned above. Ankerite is also the common carbonate in the quartz stringers of the altered granite, which will be referred to later.

Iron Formation, Conglomerate, Slate

Two narrow parallel strips of typical banded iron formation occur on the northeast shore of Lang lake, interbedded with conglomerate and amphibolite. They are somewhat lens-shaped or discontinuous, and sometimes attain a width of 12 feet. One could be traced for a few hundred feet, gradually becoming narrower and finally giving out. Associated with this termination were several small pebbles and one large boulder, clearly indicative of sedimentary conditions. Except for this scanty but nevertheless certain evidence, this rock would never be regarded as other than a fine-grained amphibolite. Coarse amphibolites stand close by. The strips follow the usual strike of the greenstones at N. 80° E. and dip at high angles to the south. Other bands occur near by in the lake as shown by the strong attraction in that direction. In the drift-covered areas to the north of Lang lake and Andy lake strong attraction was noted in several places, due no doubt to similar bands of iron formation. Another outcrop was noted on the south shore of a small lake southeast of the mouth of the Gitche river.

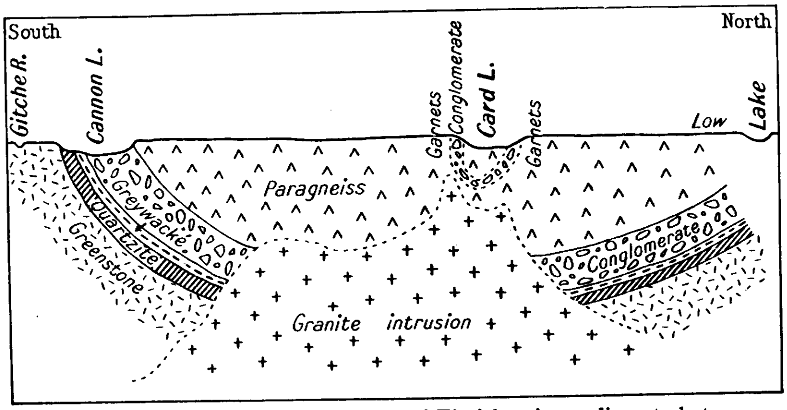
The banding consists of thin alternating layers of silica and magnetite, not more than a quarter of an inch in width but usually much less. The silica bands, formed of either jasper or chalcedony, stand out on the weathered surface in a manner characteristic of this rock. Minor subsequent movements fractured it slightly, allowing the introduction of sulphides along fracture planes. No quartz veins cut this formation as far as observed.

Directly opposite the iron formation, on the south shore of Lang lake, there are low outcrops of greenish to dark-coloured slate; this rock is also regarded as Keewatin in age, although there is no means of proving this point. It would, however, appear that the slate is intercalated with volcanics, which outcrop very close to the south. The slate is well banded in light and dark shades of green, the individual layers varying up to an inch in width. Certain layers are marked by the development of pyrite cubes, while others are absolutely devoid of them. The beds strike at N. 80° E. and dip at high angles to the north. From these facts it is assumed that the east arm of Lang lake is largely underlain by sedimentary rocks of Keewatin age.

Timiskaming(?)

A great series of sedimentary rocks at Cannon lake is considered to be Timiskamian in age, although there are scarcely any facts to support the conclusion other than analogy to similar rocks in other areas.[1] There is a remarkable scarcity of contacts with the Keewatin, and the Algoman granite was not observed in intrusive contact with the sediments, although a more careful search to the north might reveal this relationship. The great development of garnet indicates that igneous rocks are not far below the surface. At one point on the west side of Cannon lake the Keewatin-Timiskaming contact is exposed for a few hundred feet. The unconformity appears to be slight and much less marked than in other parts of the province. Although an attempt was made to pick up the contact farther west, low ground always intervened.

The sediments, all of which are exposed on the shores of Cannon lake, show a remarkable sequence from the south to the north. They are composed of quartzite, greywacké, conglomerate, and paragneiss, in order of



Theoretical section to show sequence of Timiskaming sediments between Cannon lake and Card lake.

deposition. The beds strike slightly north of east and dip at very high angles to the north; local variations are due to close folding and other structural features that were not studied in any detail. The quartzite lies unconformably on the Keewatin. It is a fine-grained, yellowish-green rock resembling to a marked degree the rhyolite on Lang lake, but the microscope shows that it is a true quartzite, composed largely of a fine matrix of quartz grains with subordinate amounts of hornblende. Greywacké lies between the quartzite and the conglomerate. It was not possible to observe the contacts with these rocks owing to the heavy overburden. It is a dull-grey fairly coarse-grained rock with alternating bands of hard and soft material. The waves wash away the soft layers and leave the siliceous ones standing as much as 6 inches above the general level.

The main conglomerate band is about 12 chains wide and at least 3 miles long. It is in the nature of a basal conglomerate composed of water-worn boulders and pebbles of granitic, rhyolitic, and basic rocks in a dark matrix of impure quartzite, the whole of which has been subjected to considerable metamorphism. The larger boulders are as much 2½ feet in diameter at the base, but toward the top (i.e., toward the north) they become smaller. The microscope shows that the matrix is composed of fine-

[1]E. S. Moore, Keewatin-Timiskaming Boundary, Bull. Geol. Soc. Amer., Vol. 40, Sept., 1929, pp. 547-556.

grained quartz with much hornblende, actinolite, biotite, magnetite, and calcite. Often the magnetite is so concentrated as to show spots with strong local attaction.

Outcrops of rock are very scarce north of Cannon lake, owing to drift and low ground. Nevertheless sufficient information was gathered to show that the conglomerate grades into a typical paragneiss. This rock is well exposed on Card lake. It is composed of thin layers of sugary quartz and biotite, giving it a distinctly gneissic appearance. On the south shore of the lake small red garnets are developed in great numbers, the surface being literally covered with them. Pebbles and small boulders occur in the paragneiss on both the north and south shores. Since some are angular, it would appear that they have not been transported far. They are probably intraformational in origin. Other outcrops are composed chiefly of

Specimen (natural size) of paragneiss from the north shore of Card lake, showing typical banding and garnets above and below the pebble.

quartzite, with flecks of mica here and there, but lacking the gneissic appearance.

The total thickness of this series is estimated at 13,000 feet, but this figure may even be exceeded if the series continues beneath the low ground to the north. Lack of time prevented the further exploration of this interesting part of the area.

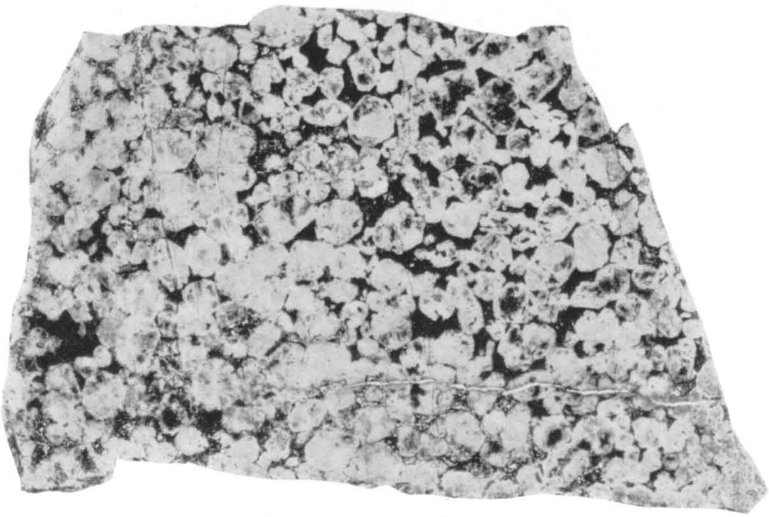
Pre-Algoman

Small bosses and dikes of igneous rock occur at many places in the area. The former are referred to as gabbro-diorite and the latter as altered gabbro-porphyrite.

Gabbro-diorite occurs along the north shore of the western part of McVicar lake, on the Dumond claims, and on the Smith-Watson claims. As mentioned above, some difficulty was encountered in distinguishing this rock from the coarse-grained varieties of the Keewatin. On this account there may actually be more of this type of rock than has been indicated on the accompanying map. The absence of pillow structures was used as one criterion with which to make the differentiation, but this cannot be relied upon since the presence of these structures in the coarse Keewatin rocks is often the exception. Evidence of the pre-Algoman age of the gabbro-diorite was seen on the Dumond group, where blocks of it were caught up in the later granite intrusion. The relationship to the Timiskaming can only be surmised, since these rocks are widely separated in the area.

The microscope shows that the rock is composed of severely altered plagioclase feldspars, hornblende, augite, epidote, and chloritic substances. Very often augen quartz can be seen, and the rock is known as quartz gabbro or quartz diorite.

At many places an extraordinary type of basic dike rock intrudes the greenstone or gabbro. It is coarsely porphyritic, with large phenocrysts of light-greenish porcelain-like feldspars in a dull-green matrix. It has a striking appearance and differs from any rock previously seen by the writer



Specimen (natural size) of altered gabbro-porphyrite near No. 6 showing of the Smith-Watson group.

in the field. The fact that it occurs widely in the area shows that it is of more than passing geological interest. The results of chemical and microscopic studies indicate that this rock is an altered gabbro-porphyrite.

An analysis of gabbro-porphyrite from No. 6 showing of the Smith-Watson group, made by W. K. McNeill, Provincial Assayer, is as follows:—

Chemical composition	per cent.
Silica	45.75
Alumina	26.02
Ferrous oxide	3.64
Ferric oxide	1.33
Phosphorus pentoxide	.01
Titanium oxide	.12
Manganese oxide	.05
Lime	11.67
Magnesia	4.11
Soda	2.42
Potash	.66
Carbon dioxide	.59
Water (+)	3.58
Water (−)	.06
Sulphide of iron (FeS_2)	.13
Total	100.14
Specific gravity	2.977

Theoretical composition (norm)	per cent.
Calcite	1.40
Corundum	1.53
Ilmenite	.15
Magnetite	1.85
Orthoclase	3.89
Albite	21.43
Anorthite	53.93
Serpentine	14.46
Water	1.85
Total	99.49
Plagioclase	75.36
Serpentine	14.46

The above chemical and theoretical analyses indicate that this rock was originally a gabbro-porphyrite, containing as much as 75 per cent. of a variety of labradorite feldspar close to anorthite and 15 per cent. pyroxene. The remainder was composed of subordinate minerals. The microscope now shows that the phenocrysts of labradorite have been completely altered to a fine aggregate of chlorite, zoisite, grossularite, collectively known as

Photomicrograph of gabbro-porphyrite showing the alteration of a phenocryst to saussurite (dark) and the serpentine-chlorite matrix (light). (×30.)

saussurite. The serpentine that makes up a large part of the matrix was derived either directly from the pyroxene, according to the following equation,

$$\underset{\text{Diopside}}{3MgCaSi_2O_6}+3CO_2+2H_2O=\underset{\text{Serpentine}}{Mg_3H_4Si_2O_9}+3CaCO_3+4SiO_2$$

or it was preceded by the uralitization of the pyroxene to amphibole. The chloritic substance is so intimately associated with the serpentine that neither can be distinguished with ease under the microscope. Nevertheless, the great excess of serpentine is indicated on the surface where the white-weathering material from it usually pervades the rock.

Gabbro-porphyrite was exposed by stripping on No. 6 showing of the Smith-Watson group. It consisted of two parallel dikes, each about 10 feet wide, cutting the greenstone. Other outcrops occur on a small island at the extreme west end of Lang lake, locally on the Dumond claims, and at several places in the eastern part of McVicar lake. Some of the islands here show a variety that appears to be fresher and less porphyritic than is usually the case. It is almost completely composed of greyish-blue plagioclase feldspar of the labradorite variety.

This rock is thought to be of pre-Algoman age, and a late phase of the gabbro intrusion. As far as could be ascertained it did not cut rocks younger than the gabbro. Evidence of a fragmentary nature further supports this conclusion. A large slab picked up in some debris showed a stringer of granite with an inclusion of gabbro-porphyrite, indicating its earlier origin. As with the gabbro proper, the relation of this rock to the Timiskaming sediments is not known.

Algoman

Rocks of Algoman age are widespread in this area. The greenstone belt is surrounded for many miles by gneissic, porphyritic, and massive varieties of granite, and several small bosses of a fresher type approaching a granodiorite occur within it.

Older Granite

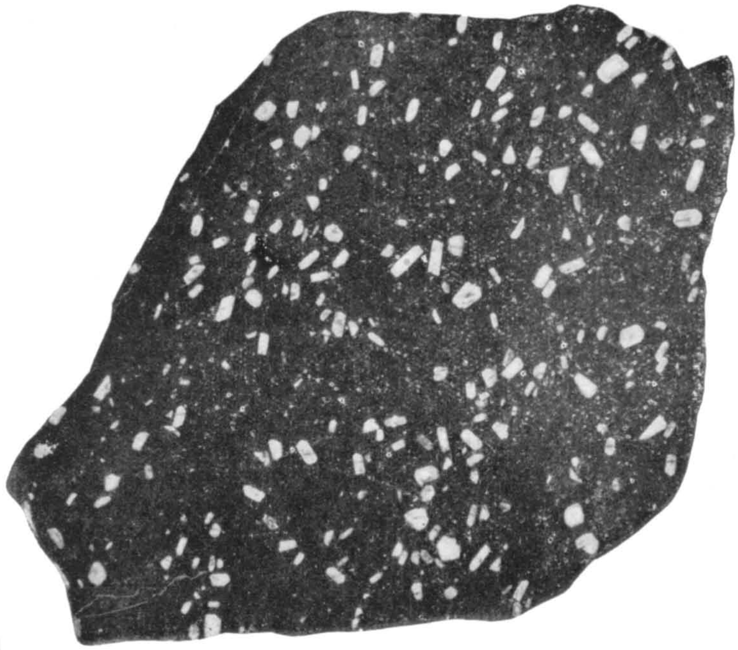
South of Sor lake, near the contact with the greenstone, the granite develops a gneissic and porphyritic arrangement that is more or less characteristic of this contact throughout the whole area. It is composed of small pinkish-white phenocrysts of feldspar, biotite, and abundant blobs of quartz, all oriented in one direction; this accounts for the banded or gneissic appearance. At the west end of Lang lake, dikes of granite interfingering with the greenstone are sheared and contain much assimilated basic material. The granite on Bertrand and Gitche lakes varies from the massive to gneissic type with the development of either hornblende or biotite. *Lit par lit* injection, narrow bands of mica schist, discontinuous aplite and pegmatite dikes up to 4 feet in width, characterize this granite. The same can be said of the granite on Baggy lake, Morris lake, and the Otoskwin river. In addition, sheeted granite and granite with large phenocrysts of pink or grey feldspars occur south of Upturned Root lake and on the south shore of Stoughton lake.

Younger Granite

Small bosses of granite occur on the Dumond claims between Sor lake and Lang lake, on the peninsula between Shonia lake and the eastern part of McVicar lake, and south of this. These are of some importance since the mineralized quartz veins on both the Dumond and Smith-Watson groups are associated with an altered phase of this intrusive. It differs so much from the granite surrounding the greenstone area that a difference in age is quite apparent. The former is considered to be younger but as still belonging to the Algoman period of intrusion. It is a fresh-looking rock with abundant pink and white feldspar, quartz, and hornblende, and tends to be porphyritic in places. The microscope, however, shows that it is not as fresh as it appears, the feldspars being much clouded with alteration minerals. There is some variation in colour from place to place, especially near the contact with the basic rocks, where there has been an assimilation of the basic material. In this case, the rock appears more like a granodiorite than a granite. The following analysis, by W. K. McNeill, Provincial Assayer, of a type specimen from a point just east of No. 1 showing on the Smith-Watson group, places it in the granodiorite class.

	Per cent.
Silica	61.80
Alumina	16.33
Ferrous oxide	2.67
Ferric oxide	2.26
Phosphorus pentoxide	.40
Titanium oxide	1.26
Manganese oxide	.10
Lime	7.85
Magnesia	1.63
Soda	4.05
Potash	.58
Carbon dioxide	.08
Water (+)	.94
Water (−)	.02
Sulphide of iron (FeS_2)	.10
Total	100.07
Specific gravity	2.977

Altered granite is a part of the main intrusive and grades into it. It is usually light-green in colour, but iron compounds often give it a reddish to brown appearance. It is especially characterized by the great development of augen quartz, which makes up nearly 75 per cent. of the rock in some instances. The microscope shows that quartz and sericite are the chief constituents, with minor amounts of secondary siderite or ankerite crystals along fracture planes. It would appear that this rock is the result of hydrothermal alteration in the granite near the contact with basic rocks, attended by the introduction of much secondary quartz, the development of sericite, and impregnation by pyrite and carbonate.



Specimen (one-half natural size) of feldspar porphyry from a dike on the west shore of the eastern part of McVicar lake.

South of the eastern part of Gitche lake there are a few outcrops of feldspar porphyry believed to be closely related to the younger granite. The phenocrysts are yellowish-green in colour, being largely altered to epidote. They attain a length of a quarter of an inch and stand out prominently on the weathered surface, giving it a somewhat speckled appearance. Some phenocrysts of quartz were also observed in this rock.

Post-Algoman

There are a few basic dikes of post-granite age, but they are narrow and on the whole less significant than those in other parts of the pre-Cambrian. At the Smith-Watson showing, a lamprophyre dike 15 feet wide cuts the altered granite at N. 55° E. This is later than the quartz veins since it cuts them off sharply. On the south shore of the Narrows, Lang lake, another basic dike occurs. It was not picked up on the north shore because there is a fault of considerable displacement at this point.

On the west shore of the eastern part of McVicar lake, a feldspar porphyry dike cuts the granite. The phenocrysts, somewhat scattered in a basic matrix, show good zonal arrangement and some Carlsbad twinning.

The microscope shows that the matrix is chiefly composed of hornblende, epidote, and small apatite crystals, and the original orthoclase feldspars are largely clouded with alteration minerals. The rock is close to trachyte in composition. Small cubes of pyrite are common.

Pleistocene and Recent

The glacier moved over this region in a general southwest direction, covering a large portion with a thin mantle of sand, gravel, and boulders. High sand ridges occur to the south and north of the west part of Lang lake, but on the whole sand plains predominate. The area between Lang lake and Cat lake is largely a sand plain, broken only by kettle lakes, muskeg, and low rock outcrops. There was little or no evidence of stratified sands or gravels in the area.

Recent deposits consist of long sand beaches on nearly all the lakes of any size, and organic deposits in those lying on the height of land.

Structural Features

The district of Patricia is characterized by a great terrain of granite, broken here and there by small patches of greenstones and sediments that have been preserved on its floor. The greenstone belt of the Shonia Lake area is of this general character. A study of the dip and strike of the rocks indicates that it occupies a synclinal basin, with the major axis slightly north of east. The top and bottom of the lava flows could not be ascertained with any degree of certainty. The sediments on Lang lake support the theory of a synclinal basin. On the north shore they dip toward the south at high angles, and on the south shore they dip toward the north at high angles. The whole lake basin is probably underlain by sediments standing almost vertically. Similarly, the attitude of the Timiskaming sediments at Cannon lake points to the same conclusion, although based on somewhat theoretical grounds. The fact that conglomerate occurs in the paragneisses on Card lake, dipping at high angles to the south, suggests that there is a northward repetition of the series, conglomerate, greywacké, and quartzite, similar to that on Cannon lake. These rocks form the rim of the basin, while paragneisses occupy the central portions.

There appears to be little evidence of major crustal movements, with the possible exception of a fault occupying the length of Lang lake. The rocks are for the most part sheared at N. 80° E., but this varies to E. 30° S. between McVicar lake and Cannon lake. The variation is caused by a gentle fold that is well illustrated on the map by the course of the Gitche river. A complementary set of fractures at E. 30° S. appears near Shonia lake and Lang lake. On the south shore of the latter, several small dragfolds occur, some of which are on the point of faulting. These fractures are much later than the original shearing and are attributed to disturbances attending the granitic intrusion.

ECONOMIC GEOLOGY

Gold

Gold occurs at Shonia lake, but up to the present time no deposit of economic importance has been found. The original discovery on the Smith-Watson group proved to be disappointing, with the result that prospecting in the area decline.

The writer saw no gold other than that on this group; but similar conditions exist elsewhere, and its presence may be inferred.

Native gold occurs in a stockwork of quartz veins in a hydrothermally altered granite. It is associated with pyrite and subordinate amounts of other sulphides. The gold solutions appear to have been introduced by the intrusion of the younger granite and to have followed the quartz in the altered portions. The mineralization occurs in both the wall rock and the quartz, but it is usually more extensive in the latter.

The country rock is all more or less mineralized with pyrite, but there appears to have been a general lack of conditions favourable to the deposition of gold. Quartz veins are abundant in almost every type of rock, but they are small, irregular, discontinuous, and for the most part quite barren. They are thought to be the last phase in the differentiation of the younger granite.

There are several factors that have a bearing on the possibilities of finding gold in this area: (1) Gold was found at one place only, and here the values were not promising. (2) The concentration of sulphides is nearly always associated with altered granite, a type of rock in which one would not expect to find gold in paying quantities. (3) There is a general lack of structural "breaks" and shear zones, suitable for the deposition of gold. (4) The great number of barren quartz veins points to the general scarcity of mineralizing solutions. (5) Much of the greenstone is recrystallized to amphibolite, testifying to the shallow nature of this belt of rocks and to the proximity of the underlying granite. It is possible that veins, which may have been of value, located higher up on the granite batholiths, have since disappeared during the processes of erosion. The veins of low value near the base of the batholith intrude the shallow amphibolite rocks.

Other Minerals

It would appear that there are no other minerals of economic importance in the area. The narrow bands of iron formation on the north shore of Lang lake cannot be regarded as a source of iron or gold. Gold-bearing solutions did not penetrate them as in some parts of Ontario. Small quantities of molybdenite were seen in a quartz vein on the north shore of Lang lake. Zones of heavy gossan are common, and in some cases might bear further investigation. One of these lies on the shore of the eastern part of McVicar lake, on the line between the Smith-Watson and the Goodfellow groups. The gossan, which is several feet thick and exposed over a considerable area, appears to be due to the breaking down of pyrite in a silicified greenstone. Other gossan zones can be traced to the weathering of ankerite veins. West of Lang lake several rusty zones in sheared granite at some distance from the greenstone contact were investigated; they were of little importance.

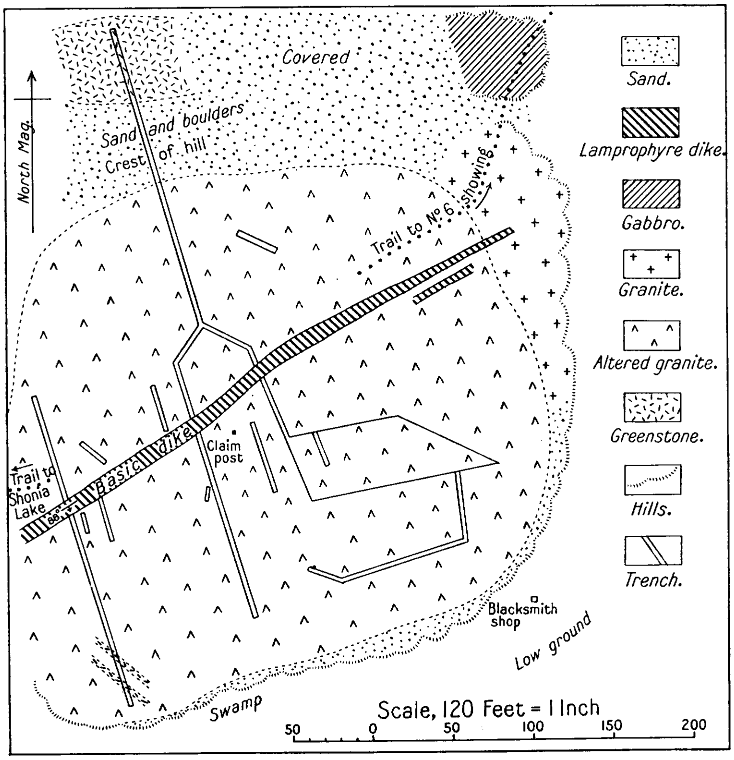
Description of Prospects

Smith-Watson Group

Gold was discovered on this group in August, 1928, by "Bill" Smith. Shortly after, the Northern Aerial Minerals Exploration, Limited, took an option on the group of 9 claims and during the winter stripped and sampled two promising showings. The results were disappointing, and in February the camp was abandoned. No further work had been done up to the time of writing.

The gold occurs in a stockwork of quartz veins in a hydrothermally altered granite. The veins range from half an inch to 2 feet in width, trend in a northeast direction, and dip steeply to the south. A lamprophyre dike 15 feet wide strikes across the hill at N. 55° E. cutting off the veins sharply. Smaller parallel basic dikes stand close by. The altered granite grades into a fresh-looking pink granite that has been described above. Similar conditions are found about 15 chains to the northeast on what is known as showing No. 6. A well-mineralized quartz vein up to 2 feet wide was traced for several feet in the altered granite. An attempt to pick it up farther to the east was without success.

The minerals commonly associated with the gold are coarse pyrite, chalcopyrite, ankerite, limonite, arsenopyrite, and galena, in order of decreasing abundance. They usually follow small fracture planes in the quartz, but they also disseminated in the altered granite. The gold is



Geological plan showing trenches on the No. 1 showing of the Smith-Watson group. Assays gave low values in gold, ranging from a few cents to $5.40 per ton.

likewise found in the altered granite as well as in the quartz, although the values are more often higher in the quartz.

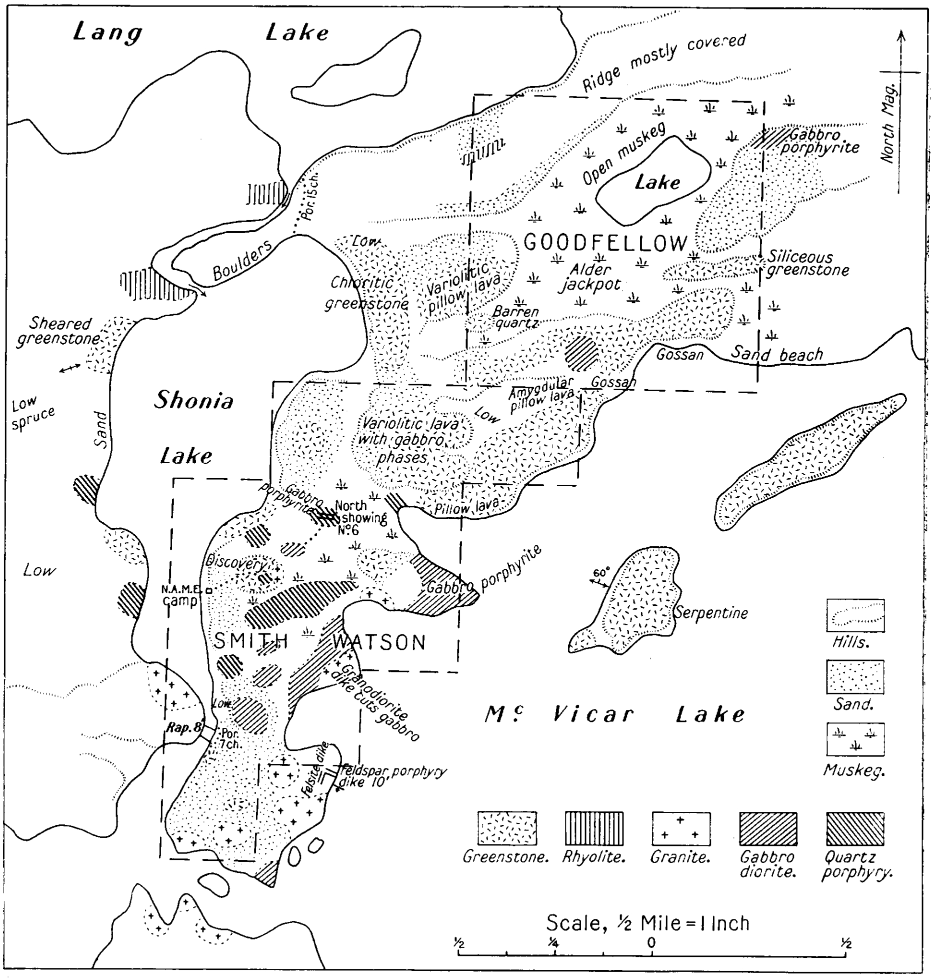
The following sketch map of the main showing indicates the consistently low values obtained from a thorough sampling by channel methods. The samples in nearly every case include altered granite with the quartz. The highest values were obtained from a pit on No. 6 showing, where one sample gave $8.60 in gold per ton over a channel length of 3 feet. Other samples from this showing gave almost negligible values. It is reported that gold can be panned from certain rusty pockets at the main showing, but this could not be verified by the writer.

Goodfellow Group

This group of 9 claims adjoins the Smith-Watson group on the north. The central part is occupied by a shallow kettle lake surrounded by muskeg.

High hills of greenstone and "variolitic" lava rise on the south and west, and a high ridge of rhyolite occupies the northern portion. Gabbro-porphyrite occurs at the north side of a high covered hill, east of the small lake.

There are many small gash veins of barren quartz; these are common to all rocks in the area and are of no importance. As mentioned above, a heavy gossan zone was seen on the south boundary of the group, on the



Geological sketch map of the Smith-Watson and Goodfellow claims.

shore of the eastern part of McVicar lake. There was no investigation of this, although it appeared to have interesting possibilities.

Dumond Group

In the autumn of 1928, A. E. Dumond staked a number of claims between Sor lake and Lang lake. Bracton Limited, of Sioux Lookout became interested in this group, which comprises 27 claims. They thoroughly prospected it and found three mineralized quartz veins. The results of sampling were disappointing, with the result that nothing further was done. This work was done under the direction of A. E. Dumond.

The veins are well defined, occupying definite "breaks" or shear zones in a reddish to greenish altered granite, a metamorphic phase of the more extensive pinkish granite in the northwestern portion of the group. The geological conditions are very similar to those on the Smith-Watson showings, with regard to the type of rock and mineralization.

The mineralization consisted of pyrite, chalcopyrite, ankerite, limonite, and pockets of galena. The writer saw no visible gold, and a grab sample from a very promising part of one vein, rich in sulphides, gave no values in gold or silver.

Beverly Syndicate

Three groups of claims, 27 in all, comprise the holdings of this syndicate. One group is located on Lang lake near the creek connecting it with Boyes lake. The rocks consist chiefly of coarse greenstones and amphibolite, with a few narrow bands of iron formation, and small rusty zones. A rusty quartz vein 3 feet wide was followed inland from the shore by stripping, but

The Dumond camp at the west end of McVicar lake.

it soon narrowed down to nothing. The other groups lie northeast of Andy lake and near the mouth of the Gitche river. The former is largely occupied by muskeg, while the latter has a few scattered outcrops of greenstone, showing nothing of interest.

Kenora Prospectors and Miners, Limited

The 72 claims prospected by this syndicate consist of several groups staked by Mosher, Radford, and others. One group lies south of the Narrows of Lang lake, and the others are somewhat scattered north of Lang lake and east of Angus lake. High hills of basalt occur on the claims at the Narrows. The other groups show few rock outcrops, being largely covered by either muskeg or sand.

Lyman Exploration Syndicate

This syndicate prospected 14 claims north of the Narrows of Lang lake. There are high hills of basalt and coarse greenstones with disseminated pyrite. A few gossan bands were seen, but they were quite small. There was little to warrant further work on this group. They also prospected 4 claims in the sediments at Cannon lake, but discovered nothing of interest.

APPENDIX

Cat River

In 1885, Thos. W. Fawcett, D.T.S., made a survey[1] of the Cat river from Lake St. Joseph to Cat lake. His impressions are as follows:—

> I had been informed several times previous to this that the route to Cat lake was a difficult one to find, and that the Indians themselves often missed the way after they had been over the route several times. This I found to be the case, as the guide had to stop and study sometimes before he would advance and would occasionally change his course. The route is made up of a succession of lakes joined by narrow channels, assuming the form of a river only at these places and for but a short distance at a time. The lakes are full of islands, and their extent could not be determined without making a survey of their shores. . . . the largest of these lakes are Black Iron [Blackstone] lake, Cross [Bamaji] lake, Quill [Kezik] lake, Smoothrock [Fawcett] lake, Gull lake, Pine [Zionz] lake, Channel [Kapikik] lake, and Cat lake. . . . The land so far as I could judge, with the exception of a little around Gull lake, was exceedingly rocky, and the water full of boulders—some round and smooth, in consequence of transportation, others angular and deposited at a more recent date or detached from some neighbouring rock. The rocks were all granitic and gneissoid; iron and mica were scattered throughout the rocks but not in such quantities as to deserve special note.

The rocks on the Cat river are largely pink and grey granite gneisses, with frequent pegmatite and aplite dikes, *lit par lit* injections, and inclusions of mica schist, which assumes massive proportions on Blackstone lake and is often more extensive than the grey granite in which it is included. The lake derives its name from the occurrence of this rock, which is a massive, jet-black, crumbly type and has been mistaken for coal by the natives.

Slate Falls

A short time was spent in the examination and delimitation of a belt of Keewatin greenstones and associated sediments, occurring at Slate falls, at the head of Bamaji lake. Wilson's report[2] on his traverse of the Cat river in 1902 mentions a belt of basic schists at this point and attaches little importance to it other than the occurrence of molybdenum in doubtful economic quantities.

The belt is 1½ miles wide and at least 4 miles long, narrow at the east but widening toward the west. The rocks consist of greenstone, amphibolite, sericite schist, and sedimentary iron formation or quartzite. The magnetite layers in the latter gives strong local attraction. It is evident that this belt occupies a very shallow synclinal basin, since the beds on the north dip south at 45 degrees, those on the south dip north at 60 to 80 degrees, and those in the centre are horizontal. Near the Tivy camp site the beds are heaved up from their horizontal position by underlying granitic masses, and in some places these have broken through, exposing small patches of granite porphyry and feldspar porphyry, presumably of Algoman age. The rocks are highly sheared at N. 80° E. at the rapids and are now largely sericite schists. Small rusty quartz veins are common, but of little significance.

In 1927, Philip Tivy staked several claims on a west bay of the Cat river above Slate falls. When visited, the camp was abandoned, but there was evidence that a great deal of work had been done in stripping, cross-trenching, and shooting into a promising-looking quartz vein that was traced for more than half a mile to the point where it dipped into the low ground to the west. A good trail leads from the camp site to the main showing. The vein is 3 feet wide in places but often narrows to a few inches. It strikes directly east and dips at high angles to the north. It occupies a sheared zone in the Keewatin rocks, 6 to 10 feet wide. This zone is now

[1]Thos. W. Fawcett, op. cit.
[2]A. W. G. Wilson, op. cit., p. 19.

largely a soft iron-rich gossan; in places it has been removed with a shovel, leaving the vein standing 2 feet above the general level. A 20-foot pit has shown the downward extension of the vein. The country rock is largely basalt or amphibolite. An intrusion of greyish feldspar porphyry stands close to the vein at one point.

The vein is well mineralized with pyrite, chalcopyrite, and pockets of sphalerite, and these extend into the wall rock for some distance. A grab specimen from a promising section gave no values in gold or silver. The copper and zinc are not present in economic quantities.

At the camp site some work has been done on a heavily pyritized gossan zone in flat-lying rocks, probably an old quartzite. A grab specimen likewise gave no values in gold or silver.

The fact that the camp is now abandoned indicates that the results of the work were not satisfactory. Picked specimens assayed for the writer by the Provincial Assay Office gave no gold values. These features, supported by the fact that the whole belt is narrow and thought to be very shallow, points to the improbability of finding gold in economic quantities.

Photo by Topographical Survey, Dept. of Interior, Ottawa.

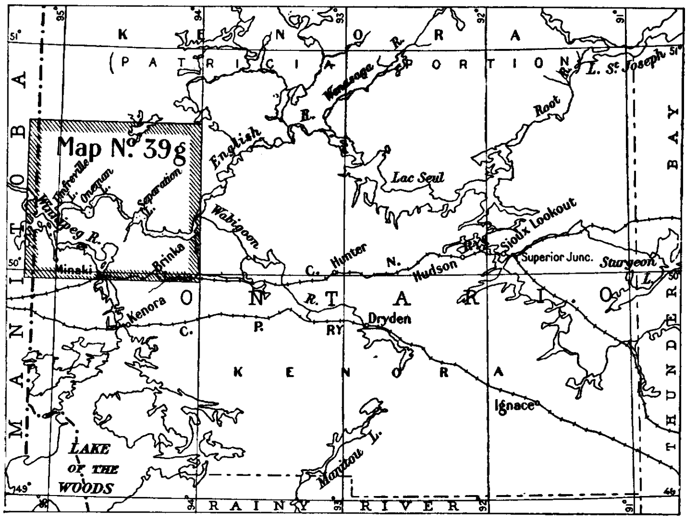
Aerial view of Rex lake looking east. To the left can be seen ridges and valleys following the strike of sedimentary gneisses and schists.

Geology of the Area from Minaki to Sydney Lake, District of Kenora

By D. R. Derry

INTRODUCTION

During the summer of 1929, a reconnaissance survey was made of the geology of the area from Minaki, on the Canadian National railway, north to Sydney lake at the head of the Sturgeon river. The area examined lies in western Ontario, the part north of the English river being in the Patricia portion of Kenora district, and that to the south in the district of Kenora proper. The western limit is the Ontario-Manitoba boundary; and the work was extended to the east as far as Ball lake (meridian 94 W.) on the



Key map showing location of the Minaki–Sydney Lake area.
Scale, 60 miles to the inch.

English river. The geology was also mapped along several routes south from the English river to Minaki.

The adjoining area to the north has been described in a report by G. Gilbert,[1] and that to the east up the English river to Lac Seul, by E. L. Bruce.[2] On the west, E. S. Moore[3] first made a reconnaissance survey in 1912 from Lake Winnipeg to the Interprovincial boundary. E. M. Burwash[4] has described the geology along the Interprovincial boundary, and J. F. Wright[5] has covered the adjoining area in Manitoba in his report on "The Oiseau River Area."

[1]G. Gilbert, Ont. Dept. Mines, Vol. XXXVI, pt. 3, 1927, pp. 73-84.
[2]E. L. Bruce, Ann. Rept., Vol. XXXIII, pt. 4, 1924, pp. 1-11.
[3]E. S. Moore, Geol. Surv. Can., Sum. Rept., 1912.
[4]E. M. Burwash, Ont. Dept. Mines, Vol. XXXII, pt. 2, 1923, pp. 1-48.
[5]J. F. Wright, Geol. Surv. Can., Sum. Rept., 1924, pp. 51-104 B.

Acknowledgments

Credit is due to G. R. Gibson for excellent services as assistant in all the field work.

The writer is also indebted to the officials of the Manitoba Tin Company, Jack Nutt Mines, Limited, and Kenora Prospectors and Miners, Limited, for their hospitality and help when their properties were visited.

Means of Access

From Manitoba the district may be reached by travelling from Lac du Bonnet by the Winnipeg City Power Tramway to Pointe du Bois. From here travel is by canoe up the Winnipeg River for about 30 miles, at which

Falls on Sturgeon river, below Right lake.

point it crosses the Interprovincial boundary. The English river joins the Winnipeg river 8 miles east of this point.

The English river may also be reached from Minaki, Ont., by three routes: (1) Down the Winnipeg river to the mouth of the English river, a distance of 26 miles; there are three portages on this route, totalling 63 chains. (2) Down the Winnipeg river to a point two miles below lower Whitedog falls, and thence north through Whitedog and Goshawk lakes to Oneman lake on the English river. (3) North from Minaki across Sand lake and thence by a series of lakes and portages (totalling 125 chains) into Separation lake.

Topography

In general the country is level, but it rises gently towards the north and northeast. Sydney lake, in the northern part of the area, is 175 feet above the level of the Winnipeg river at the Interprovincial boundary. In detail the topography is rough, particularly in the region of sedimentary or volcanic rocks where sharp ridges, in places rising vertically 100 feet from the lakes, run parallel to the general east-west strike of the formations. Outcrops are numerous in most parts, though some of the lower ground near the English river is covered with a good clay soil.

The English river, with its tributary the Sturgeon river, drains most of the area and joins the Winnipeg river just east of the Interprovincial boundary.

Lakes are exceedingly numerous, particularly in the northern and western part of the area, so that most of the reconnaissance travel can be done by canoe.

Falls are frequently caused by dikes or lenses of hard red granite cutting the faster-weathering intermediate intrusives (see photograph on page 26). They often occur also where sedimentary belts cross rivers. This is due not so much to the sedimentary material itself as to the very hard white granite that occurs abundantly, cutting the sediments parallel to the strke.

Timber

Very little timber of commercial size for lumber was seen. The granite areas are covered with a small growth of jackpine, black spruce, and birch; on sedimentary-volcanic areas, in the valleys between ridges, white poplar is abundant, though not of any great size. A few Norway and white pine were seen, apparently remnants of stands on areas that have been burnt over and since grown over with spruce and jackpine.

Game

Red deer were extraordinarily abundant in many parts of the area. It was noticed that they were most numerous on land underlain by sedimentary-volcanic rocks, probably owing to the long deep valleys in these parts, where grass grows well.

Moose were also common all over the area, and one bull caribou was seen. Black bear were seen several times. Wolves seemed very scarce, which may account, in part, for the abundance of deer.

Both spruce and birch partridge are common. The smaller varieties of duck were seen nesting along the large rivers and lakes, and the wild rice in the eastern part of the area attracts large flocks of mallards on their way south in September.

Sturgeon are very abundant both in the English and Winnipeg rivers, particularly near the falls. They were not noticed in the Sturgeon river except near the mouth. Of smaller fish, pike and suckers seem most numerous, but black bass, pickerel, and golden-eye may also be caught.

GENERAL GEOLOGY

The consolidated rocks of the area are all pre-Cambrian. These are covered in part by glacial drift, though nowhere to any great thickness or wide areal extent.

Briefly, the exposed pre-Cambrian rocks fall into two series: (1) a sedimentary-volcanic series, much folded and metamorphosed; (2) an intrusive series ranging from diorite to acid granite and pegmatite. These instrusions are of great extent and now occupy about 80 per cent. of the area. No sedimentary rocks of later age were seen. Keweenawan diabase dikes, so common in the pre-Cambrian areas of central and eastern Ontario, were not observed here.

The following geological table is suggested:—

QUATERNARY	
RECENT:	Peat. Lake deposits of clay and sand.
PLEISTOCENE:	Glacial boulder clay. Sand.
PRE-CAMBRIAN	
ALGOMAN (?): (Intrusive series)	Pegmatite and aplite. White binary granite. Red microcline granite. Porphyritic biotite granite. Grey granodiorite and oligoclase granite. Grey quartz monzonite. Brown granodiorite.
KEEWATIN: (Sedimentary-volcanic series)	Sedimentary gneiss, conglomerate beds, quartz-biotite schists, basic schists possibly of igneous origin. Basic volcanic flows. Quartzite and greywacké.

Keewatin

The sedimentary-volcanic series has been included under this name for the following reasons: Firstly, it is made up of the oldest rocks found in place in this or the adjoining areas; secondly, the lavas and some of the sediments are similar lithologically to those of the series first named Keewatin in the Kenora region. Although there is no continuous outcrop of these rocks across the 40 miles between this area and Kenora, inclusions in the granites of the same rock types occur frequently throughout the intervening area.

The similar rocks of this series across the boundary in Manitoba were first described by E. S. Moore,[1] who divided them into the Rice Lake volcanics at the base and the Wanipigow sediments above. Burwash adopted this classification in describing the geology along the Interprovincial boundary. J. F. Wright, however, mapping on a more detailed scale, could find no sharp division into an underlying volcanic and a younger sedimentary series, but held that lavas, tuffs, and sediments were interbedded in one series, with the possible exception of some of the younger sediments, which might have been deposited in a later period.

In Ontario, the present writer could identify with certainty only one band of lava, but as this lies conformably between two sedimentary beds, it seems reasonable to follow Wright in including the whole under one sedimentary-volcanic series, which has been classed as Keewatin for the reasons given above.

The sedimentary-volcanic series occurs in the area in three narrow belts. The northernmost, in which no volcanic rocks were found, runs east from Davidson lake on the Interprovincial boundary across the northwest corner of Werner lake, whence it seems to turn east-northeast, since a similar band was picked up on the Sturgeon river, just south of Sydney lake. A narrow branch runs off farther south along Rex lake and crosses the Sturgeon river six miles south of the main belt. The boundaries of these belts are poorly defined owing to the high percentage of igneous material in the form of granite dikes and lenses and pegmatitic bands forming *lit par lit* gneisses.

Another belt, consisting of volcanics and sediments, extends from Ryerson lake on the boundary eastwards through Twelnor lake, striking the English river at the north end of Oneman lake. From this point it widens, covering most of the area between the lower part of the Sturgeon river and Separation rapids on the English river, sediments lying to the north and

[1]E. S. Moore, op. cit.

lavas to the south. The belt then runs N. 60° E.; the volcanic rocks pinch out northeast of Lennan lake, but the sedimentary gneisses widen as far as they were followed. These sedimentary gneisses were picked up by E. L. Bruce along the upper waters of the English river, where they occur quite extensively.

A third, very narrow band, not more than a mile in width, was observed just north of Deer falls, near the mouth of the English river, and again on the south shore of Oneman lake. It consists of sedimentary gneiss with some *lit par lit* structure and, on the northern edge, what is probably a narrow strip of altered volcanic material. This belt may be connected toward the east with the central band, somewhere southwest of the Kettle falls.

It should be stressed that many parts of all these sedimentary belts are abundantly invaded by igneous, granitic material, which may form more

Pillow structure in andesite lava.

than 50 per cent. of the rock. Nevertheless these belts are mapped as sedimentary, as they are continuous along the strike and show no evidence of being oriented inclusions in the granite.

Volcanic Rocks

The volcanic rocks of the sedimentary-volcanic series are generally of andesitic composition, green to black in appearance. They cover a limited area, occurring as narrow, rather schisted bands interbedded with, or adjoining, the sediments. In the vicinity of Separation rapids on the English river, there is a wider area of volcanic rocks, much less altered. Here, as well as south of Ryerson lake near the boundary line, pillow lavas are well shown. Two main types of andesitic lava were noticed; a fine-grained variety, often showing pillow structure; and a coarser, more massive type, which may be a slower-cooled phase of the same material. There are also a few occurrences of a rock very rich in garnets and biotite, forming irregular bands within the lava. These rocks may represent metamorphosed tuffaceous material, as suggested by Wright in his report on the adjoining area in Manitoba.[1]

A specimen of the fine-grained variety from a point midway between Ryerson and Twelnor lakes shows, in thin section, that hornblende forms 80 per cent. of the rock, the remainder being made up of interstitial quartz,

[1]J. F. Wright, op. cit.

possibly secondary, and fine plagioclase feldspar. Magnetite grains are scattered throughout, and small apatite prisms form inclusions in the quartz and feldspar. Specimens from more schisted areas show marked parallel orientation of hornblende crystals.

The coarse variety shows, under the microscope, large, irregular phenocrysts of hornblende, embedded in a mosaic of coarse plagioclase (between andesine and labradorite), and a little interstitial quartz, in part, at least, secondary. The plagioclase contains numerous inclusions of finer hornblende. Granular titanite is quite common.

Quartzite and Greywacké

The fine-grained sediments, consisting of quartzite and greywacké, cover a very small area. They are seen in two narrow strips, between the volcanics and the intrusive granodiorite and granite, at the southern edge of the Ryerson lake–Twelnor lake belt. On a continuation of the same belt, they may be seen again near the Indian Reserve on the north shore of Oneman lake. The rocks vary from a dark-grey, cherty, fine-banded greywacké to a pure white, finely granular quartzite, which weathers rusty red, owing to the presence of fine, disseminated sulphides. Under the microscope the pure quartzite is seen to consist of a mosaic of quartz, with a small proportion of fine muscovite in roughly parallel stringers and a little fine pyrite. The darker quartzites have a small proportion of biotite in fine flakes. Finer secondary quartz occurs in stringers and pockets in most specimens.

The banded greywacké shows in thin section quartz and hornblende in proportions varying with the different bands. Biotite, calcite, and sericite are also present in small quantities.

Sedimentary Gneisses and Schists

This part of the series is far more extensive in area than the quartzite and greywacké and forms the major part of all Keewatin belts. These beds appear to be more highly metamorphosed than the quartzites and greywacké, but this appearance is probably due to a coarser original texture and the presence of clayey material having given rise to a rather large proportion of biotite.

A common type is a fine well-banded gneiss of grey or brown colour, the bands being light or dark according to the content of biotite. A thin section shows, besides quartz and biotite, albite forming about 15 per cent. of the rock. Some beds contain garnets in addition to the other minerals, and along such beds there is often replacement by sulphides, mainly pyrite and chalcopyrite, in small lenses scattered along the strike. It is in these banded gneisses that the *lit par lit* structure is most typically developed by the injection of pegmatitic stringers from half an inch to several inches in width. The proportion of the injected material may increase until the rock becomes a gneissic granite with narrow sedimentary inclusions.

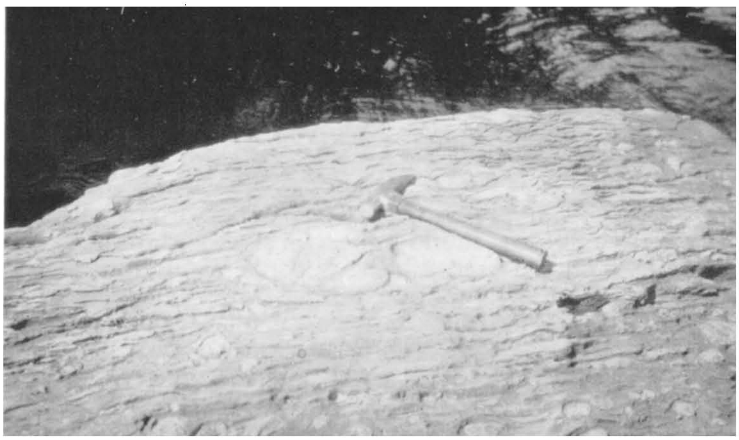
The quartz-mica schists are coarser in texture and owe their schistosity to the greater proportion and larger size of parallel flakes of biotite. Under the microscope they are seen to be of simple composition, consisting of quartz, biotite, and a little feldspar, usually microcline and albite.

A more basic schist occurs less commonly than the above-mentioned types. A representative specimen from a point on the northeast corner of We ner lake shows clear, well-formed crystals of andesine-labradorite forming about 60 per cent. of the rock, a very small quantity of quartz, colourless pyroxene partly replaced by hornblende, and biotite in parallel plates. Apatite occurs as rather large inclusions in all the other minerals. This mineral association suggests that the basic schists may have been produced by the metamorphism of a basic igneous rock.

Another rock, found only on the south side of Sydney lake at the granite sediment contact, is a yellowish to grey hornstone. Under the microscope it is seen to consist of a very fine groundmass of quartz and sericite, in which are embedded larger crystals of quartz and some albite. These larger crystals have irregular, "eaten" boundaries, suggesting that they are the only remains of the original minerals of the rock. The fine silica has probably been added from the neighbouring granite intrusion.

Conglomerate

Several bands of conglomerate have been traced for many miles in the adjoining part of Manitoba; Bruce notes a similar rock north of the eastern end of the English river. In the area under review only one occurrence was seen and that runs across the Interprovincial boundary, on the southern



Conglomerate bed, Ryerson lake.

promontory on the east side of Ryerson lake. The bed is 200 feet across the strike and was followed for about 500 feet east of the boundary. The matrix, being now a fine micaceous gneiss, is the same material that makes up the beds on either side into which the conglomerate grades by a decrease, in size and number, of the pebbles. The included material varies from small pebbles to boulders a foot in diameter. Compression of the bed has resulted in the boulders becoming much elongated in a vertical direction and slightly in a horizontal direction parallel to the strike.

Most of the boulders appear to be of igneous origin. Some 50 representative boulders were selected and listed. There are no sharply defined types, but they may be roughly classified as follows:—

	Per cent.
1. Light-grey biotite granite	38
2. Light-brown granite	12
3. Grey granodiorite	20
4. Fine quartzose rock in tabular boulders	22
5. Quartz in small pebbles	8

The origin of the rocks of group No. 4 is doubtful. They are fine-grained, consisting of quartz with a little decomposed feldspar and a few specks of biotite. There is no banding or stratification but the boulders are plate-shaped, suggesting a cleavage in the rocks from which they were derived. Owing to this feature and their fine texture, it is possible that they are highly altered sedimentary fragments. The granitic boulders are not identical with any of the intrusive rocks of the area found in place, though in the hand specimen a similarity exists in a few cases. No boulders of volcanics were seen, but Burwash reports finding boulders of lava identical with that of the "Rice Lake volcanics" in the corresponding conglomerate beds in Manitoba.

Origin of the Gneisses and Schists

The possibility that some of these gneisses and schists are of igneous origin should be considered, as this has been suggested for similar rocks in other regions. Some of the gneisses show in thin section a crystalline structure similar to a gnessic granite. Certain features, however, have led to the conclusion that most of these rocks are in all probability of sedimentary origin. The conglomerate, which must be of aqueous, or possibly glacial origin, grades both above and below into gneisses identical with its groundmass. Gradational stages, lithologically, exist between these beds and all the more acid schists and gneisses in the area. The constancy in composition and width of the different bands when followed along the strike is also strong evidence of a sedimentary origin. In the case of the darker schists and gneisses, if a volcanic origin is postulated, it would seem unlikely that they would be so susceptible to the production of *lit par lit* structure on being intruded, a feature that was never observed in this area in the definitely volcanic rocks that have undergone exactly the same degree of compression and intrusion.

The only type that does seem to be of igneous origin is the basic schist mentioned above, which was found only over a short lateral extent in a few places. The presence of a rather basic feldspar (andesine-labradorite) and pyroxene and the low quartz content both point to an igneous origin, probably a basic sill or dike. This type, however, forms such a small proportion of the schists and gneisses that it is impossible to map it separately on a small scale; consequently the whole series has been mapped as sedimentary.

Age Relationships of the Sedimentary-Volcanic Series

The Ryerson-Twelnor-Oneman lakes belt was the only occurrence seen where the volcanics were bounded on both sides by sedimentary rocks. Here beds of fine-grained quartzite and greywacké lie in a broken narrow strip on the south border of the volcanics, with the wider band of sedimentary gneisses and schists, including the conglomerate bed, on the north side. It seems, therefore, that the lava is interbedded between two series of sediments. The difference in composition and texture precludes the possibility of the two sedimentary bands being the same beds repeated by folding. It only remains to be decided which band of sediments originally underlay the volcanics. The dip along this belt is, in general, steeply to the south, which would rather suggest that the quartzite series was on top. But in a region so highly folded this is not strong evidence. Both the northern and southern contacts of the lava with the sediments seem to be conformable. The northern contact was examined with some care on the Interprovincial boundary line, where a forest fire had exposed the rock. The volcanics appear to grade easily into the gneiss through a fine-grained pyroclastic rock showing fine banding but also much dark material similar to that in the volcanic rock. This would suggest that the lavas were earlier fine volcanic material, held in suspension at the end of a submarine eruption and deposited simultaneously with clastic material. Further evidence for the conclusion that the northern sedimentary band is the younger is afforded by the discovery by Burwash of boulders of volcanics in the conglomerate in this series on the Manitoba side of the boundary. As Wright, however, has shown in Manitoba that there were a number of interbedded flows of very similar material, even this evidence is not conclusive. Largely on structural grounds, Wright places the sedimentary gneiss and schist, including the conglomerate beds, at the bottom, and the fine-grained sediments (which are more abundant in Manitoba) and interbedded lavas and tuffs at the top.

The floor on which the sedimentary-volcanic series was laid appears to have been entirely destroyed by the later intrusions and subsequent erosion. The only evidence we have of it is in the boulders of granite and granodiorite that occur in the conglomerate. Since the granitic rocks of the area are, wherever seen, intrusive into the sedimentary-volcanic series, these boulders cannot have originated from them. They must represent the old granitic floor, none of which remains.

Intrusive Rocks (Algoman?)

The sedimentary-volcanic series has been invaded and metamorphosed by a series of intrusive rocks ranging from diorite to acid granite and pegmatite. These intrusive rocks are widespread, now covering about 80 per cent. of the total area. The order of intrusion seems to have been regularly from basic to acid, which feature is best seen in the western part of the area where differentiation is most complete. The oldest rocks in Manitoba are ultra-basic: peridotites and amphibolites. On the Ontario side of the boundary these rocks were never found in place, but high metamorphosed remnants were seen as included blocks and lenses in the later acid intrusives.

Of the intrusive rocks in place, the following types are representative of the differentiation that has occurred.

Brown Granodiorite

A rock of this type covers a large area north of the English river on both sides of the Sturgeon river. In the hand specimen it is of medium to coarse texture, rather iron-stained, and in some places very friable. Some occurrences are basic enough to be called diorite, while others more nearly approach granite. A specimen from a point at the east end of Salvesen lake was examined in thin section, and the mineral composition calculated by the Rosiwal method. The constituents are:—

	Per cent.
Quartz	22
Oligoclase-andesine	60
Allanite (?)	15
Biotite and magnetite	3

The mineral thought to be allanite is not always so abundant, and biotite often forms a much higher percentage.

Where this rock lies near the brown sedimentary gneisses, it appears to have incorporated part of the sedimentary material while in a molten condition. In such a place, for example four miles east of Roger lake, it is very hard to draw the line between the intrusives and the sediments.

Grey Quartz Monzonite

This rock, of rather coarse texture, occurs quite frequently, chiefly in the western part of the area. One long narrow mass runs through the southern parts of Umfreville and Oneman lakes, and another through Gib lake and the middle of Oneman lake. The northern band changes to red and green granodiorite as the Interprovincial boundary is approached and to porphyritic granite at its northern edge.

Under the microscope, a specimen from the west shore of Umfreville lake was seen to be made up as follows:—

	Per cent.
Quartz	25
Albite	48
Microcline	12
Hornblende	9
Biotite	4
Apatite, magnetite, titanite	2

The biotite replaces amphibole, but otherwise there is little alteration and the minerals look quite fresh.

In the field, a curious characteristic is the "slabby" structure. This is due to parting planes, either horizontal or dipping as much as 30 degrees, dividing the rock up into slabs from a few inches to a foot in thickness. At a distance this feature gives the appearance of a well-bedded sandstone. Bruce, who found the same structure farther east, attributed it to planes of weakness being developed near the roof of the batholith, due to the com-

Contact of red acid granite with dark greenstone, north shore of Gib lake.

pression of overlying rocks during cooling. The removal of these overlying rocks by erosion, allowed the actual parting planes to develop.[1]

Grey Granodiorite

This type is found in a mass around Lennan and Ball lakes, again west of Separation rapids on the English river, and, in a rather more acid phase, around the Islington Indian Reserve on the Winnipeg river. It is usually grey in colour and often slightly porphyritic. A thin section shows fresh albite to oligoclase forming half the rock and quartz about a quarter, the remainder being hornblende, biotite, and apatite. Where quartz is more abundant the rock has been called oligoclase granite.

Porphyritic Granite

This type occurs most abundantly in the eastern part of the area, along the English river. In the hand specimen it is coarse-grained with large rectangular phenocrysts of pink feldspar, up to an inch in length, embedded in a grey granitic matrix. The feldspar phenocrysts under the microscope are seen to be microline, partly replaced by quartz and albite. The groundmass consists of quartz, orthoclase, albite, and biotite. Biotite and rather fine-grained quartz tend to form flow lines curving round the phenocrysts. The porphyritic granite also shows the "slab" structure, though not so well developed as in the quartz monzonite.

[1]E. L. Bruce, op. cit., p. 8.

Red Biotite Granite

This type is the latest intrusive on a large scale, occurring both in large masses and in dikes and lenses cutting earlier intrusive phases and the sedimentary-volcanic series. In the hand specimens it is red, compact, and usually of fresh appearance. It may vary locally to cream or white in colour and is sometimes gneissic, particularly near its contact with sedi-

Grey quartz monzonite showing slab structure, intruded by red massive granite, Umfreville lake.

ments. Under the microscope it is seen to contain quartz, microcline, orthoclase, albite in varying proportions, biotite, and muscovite. In the region of Sydney lake the granite is light-grey to white and rather fine grained but shows in this section much the same constituents as the red granite. Biotite is less abundant, and there is a good deal of fine recrystallized quartz.

White Binary Granite

This type was seen only as small lenses up to 500 feet in width, nearly always cutting sedimentary gneiss. It is pure white and very hard and typically consists of quartz and albite. In places it carries biotite in minute flakes and sometimes garnet. On account of its superior hardness, it tends to stand out from the surrounding rocks in sharp ridges, usually striking about east-west.

Pegmatite

Red pegmatite occurs over the whole area in dikes, sills, and lenses, usually not over 100 feet in width. The typical composition is red microcline, quartz, muscovite, and biotite. Graphic intergrowth of microcline and quartz is common. In places the pegmatite is pure white, and in such cases albite predominates over microcline. This variation may be due to assimilation of material from soda-rich country rock. Locally the pegmatite contains tourmaline, sometimes very abundant, garnet, magnetite, and in one occurrence east of Ryerson lake, antimonite. In the corresponding pegmatites a short distance over on the Manitoba side of the Interprovincial boundary, cassiterite, beryl, spodumene, amblygonite, and lepidolite have been found. These minerals were not seen in pegmatites on the Ontario side, but it is probable that a careful search would reveal some or all of them.

Red aplite dikes were seen in a few places, consisting mainly of quartz and red potash feldspar. In an outcrop between Cabin and Fletcher lakes, aplite was seen to be cut by pegmatite, both intruding brown granodiorite.

A period of mineralization, closely following the latest intrusives, is described under the section devoted to Economic Geology.

Relationships of Intrusive Rocks

All the above-mentioned types are intrusive into the sedimentary-volcanic series wherever the contacts were seen.

The brown granodiorite, the grey quartz monzonite, and the grey granodiorite were not seen in contact with each other. Relationships with other rocks, however, suggest that these three phases are of about the same age. They often contain inclusions of an earlier basic intrusive and of a basic lava. The red granite intrudes these three phases both as large masses and as numerous dikes and sills. The approach from a mass of one of the grey or brown intermediate types, to a mass of the red acid granite is usually marked by an increase in the number of dikes of the latter, which finally merge to form the whole rock. The brown granodiorite, however, may sometimes merge into the red granite by gradational stages. In such a case the red granite is usually nearest the sedimentary bands. This feature is seen on Winding river, north of Oneman lake, where the brown granodiorite occupies a belt midway between two sedimentary bands, with a border of red granite to the north and south.

The porphyritic granite seems to be the connecting link in the process of differentiation, between the grey granodiorite and monzonite on the one hand and the red granite on the other. For example, in the western part of the area, the difference between the grey quartz monzonite and the later red granite is sharply marked. But as these rocks are followed eastwards the difference becomes less definite, and at Oneman lake both merge into the porphyritic granite. The predominance of the latter in the eastern part of the area is presumed to indicate that this point was nearer the centre of the batholith where less differentiation has taken place. Rock analyses show less difference in composition than the appearance of the rocks would lead one to expect. The analyses quoted below were made by W. K. McNeill, Provincial Assayer.

	No. 1	No. 2
	per cent.	per cent.
Silica	69.68	68.52
Alumina	14.82	16.86
Ferrous oxide	1.60	1.11
Ferric oxide	1.61	1.13
Sulphide of iron (FeS_2)	.13	.22
Lime	3.25	2.86
Magnesia	1.22	.96
Soda	3.30	3.84
Potash	3.20	2.99
Water (—100)	.16	.16
Water (+100)	.45	.68
Carbon dioxide	.19	.12
Oxide of titanium	.39	.36
Oxide of manganese	.04	.03
Phosphorus pentoxide	.09	.20
Total	100.13	100.04

No. 1.—Brown granodiorite, west end of Rex lake.
No. 2.—Porphyritic granite, south shore, Lount lake, English river.

From these analyses it would seem more proper to call No. 2 a granodiorite also. The name granite, however, has been kept on account of the pink, acid appearance in the field and to distinguish it from the grey granodiorite, which may also be porphyritic but is of quite different appearance and mineral composition.

Differentiation on a small scale is well shown in two lenses intrusive into sedimentary gneiss, one west of Lower Kettle falls on the English river and the other on the south shore of Salvesen lake on the Sturgeon river. In both of these lenses the centre is brown to grey monzonite or granodiorite, showing slab structure. This rock changes towards the sides to a porphyritic stage similar to the porphyritic granite described above, which in turn gives way to compact cream or pink granite around the border and at the tapering ends of the lenses.

The hard, white binary granite seems to be closely related to the red granite and was seen to grade into it in a few places.

The red pegmatite, as dikes and sills with sharply defined borders, cuts all other rocks with the exception of the most acid red granite and the white binary granite. It occurs in the red granite, but only as irregular segregations and border phases. It is, therefore, thought to be the last and minor intrusive stage of the red granite magma. The relation of the pegmatite to the white binary granite was not seen, but the latter is so compact that it would not readily be intruded by later dikes.

The igneous injections forming *lit par lit* structure, vary in composition between the red granite, the binary granite, and the pegmatite, hence the structure was probably formed during the later stages of the intrusive period.

Thus we have an intrusive series, from intermediate to acid, in which the different phases are linked up by gradational stages, though the later phases may cut the earlier with sharp boundaries where a high degree of differentiation has been reached.

In the accompanying map an attempt has been made to separate the earlier phases from those later and more acid. Thus the brown granodiorite, grey quartz monzonite, and grey granodiorite have been grouped together and signified by one colour, and the porphyritic granite, red granite, white granite, and pegmatite have been included under another colour. It should be remembered that in some parts the change from one group to another is gradational and in such cases the placing of geological boundaries is largely arbitrary.

Glacial Geology

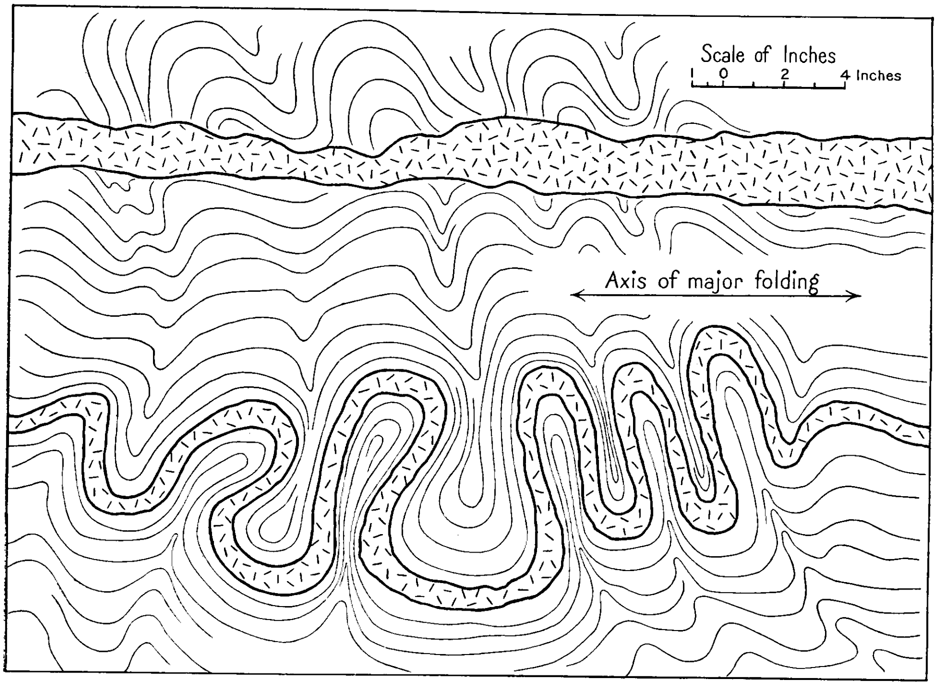
The area in glacial times was covered by an ice-sheet which came from the northeast. This has rounded off and polished the rocks, leaving striae running S. 35° W. to S. 60° W. In valleys and lakes transverse to the direction of movement, the sides nearest the northeast are often precipitous. Glacial drift is nowhere very thick and in some of the higher ground quite absent. Most of the boulders found were apparently of local origin, definite erratics being rare. Banks of sand up to 40 feet in height were found east of Lennan lake, north of Sand lake, and elsewhere.

Post-glacial lakes have deposited fine, bluish stratified clay on low ground on the sides of the English river. This deposit is often covered by a thin layer of Recent sand at the edge of the river or lakes.

Structure

Folding.—The folds produced during, or just previous to, the intrusion of the batholith have axes striking in a general east-west direction, trending towards northeast-southwest in the northern and eastern parts of the area. Not only do the sediments and volcanics follow these strikes, but the lenses and larger masses of the different intrusive phases have their long axes lying in the same directions. The dips of the schistosity and the banding in the sedimentary gneisses is steep, often vertical, rarely less than 60 degrees. The dip usually continues in the same direction when following along any particular band of sediments or volcanics, though both strike and dip may be locally altered around small intrusive lenses. Thus on the English river west of Kettle falls, the plane of schistosity dips away from an intrusive lens to the north, south, and east. The region around Separation rapids on the English river seems to have been a low spot in the roof of the batholith. The volcanics are here much less altered, pillow structure being well preserved. The outcrop is wider than elsewhere, and bands run off in three directions.

Faulting.—Few faults were seen, and these were apparently of small displacement. One fault, however, parallel to the strike, was picked up at two points 8 miles apart, near Deer falls and on the south shore of Oneman lake, both being in the same position with respect to the belt of sediments. The fault is indicated, not by visible displacement but by a well-marked fault breccia. Angular fragments of what appears to be altered andesite lava are cemented by rather drusy quartz. The fault dips at 55° N.



Sketch showing two pegmatite veinlets in contorted sedimentary gneiss.

Rock Flowage.—The study of small stringers and veins of pegmatite in the sedimentary gneiss brings out two interesting features. The first is that rock flowage, compensating the displacement due to lateral compression, was largely upwards, as has been suggested by Spurr.[1] The second feature is that this compression, resulting in contortion and rock flowage, was still going on during the final stages of intrusion, that of the pegmatites. The evidence for these conclusions is as follows: Near Ryerson lake a pegmatite veinlet an inch wide, cutting sedimentary gneiss, is contorted and shortened to occupy a length one-third the length measured along its sinuations.

[1]J. E. Spurr, The Ore Magmas, McGaw-Hill Book Co., New York, 1st ed., 1923, Vol. 1, pp. 165-170.

The strike of the gneissic banding is similarly contorted. This shortening is along the east-west strike or at right angles to the north and south pressure that has produced the original major folds. There has, therefore, been shortening in both horizontal directions, so there must have been flowage in a vertical direction. Increase in density could not account for so much decrease in space. Additional evidence is in the nearby conglomerate where even the compact boulders have been elongated in a vertical direction. Another slightly wider veinlet of pegmatite lies a few inches away from the first with its strike in the same direction. This one is straight and has not been shortened but cuts through the contortions of the gneiss. There has been shortening, therefore, in an east-west direction after the intrusion of the first pegmatite veinlet, but before the second. Both veinlets are of the same composition and there is nothing to suggest that they are not from the same magma. Other pegmatite veinlets in the vicinity show varying degrees of contortion. Movement during the period of minor intrusion seems the only explanation of these phenomena.

ECONOMIC GEOLOGY

A period of mineralization, on a limited scale, seems closely associated with the later phases of intrusion. Quartz veins are rare, and the mineralization generally takes the form of replacement of the country rock.

Several veins of the replacement type occur in the sedimentary gneiss around the contact of a granite lens, northwest of Lower Kettle falls on the English river. Pyrrhotite with a small amount of pyrite and molybdenite were the chief minerals deposited. One such vein, on the south side of the English river, was staked by P. Dusang some years ago; but as only low gold and silver values were obtained, the claims were allowed to lapse. The vein is about 10 feet wide with ill-defined walls and lies close to the northern contact of the granite lens. The ore is pyrrhotite, almost solid in some bands, with a little pyrite and molybdenite. A sample taken of the pyrrhotite ore gave no values in gold. Other veins in the vicinity consist of the same barren sulphides.

Mineralization was found 300 feet west of Lower Kettle falls, consisting of a band of sedimentary gneiss 8 feet wide between two pegmatite dikes, partially replaced by molybdenite. Samples were assayed for gold, silver, and tin, the last because of the close association with the pegmatite, but no values were obtained in any of the metals.

Several zones of sulphide replacement, a mile southeast of Ryerson lake, were discovered and staked by H. C. McNairnay during the summer of 1929. These replacements are in volcanics and quartzitic sediments, and the breaks follow the general strike. The ore is pyrite in a siliceous groundmass, with a varying proportion of chalcopyrite. Disseminated pyrite may be found over zones 100 feet wide and traceable for a quarter of a mile or more. Within these zones are bands of nearly solid pyrite with a small amount of chalcopyrite in stringers and pockets. Samples from the earlier discoveries yielded no gold values, but more recent work has shown low gold values up to $3.25 per ton across a width of 8 feet.

This type of mineralization in the volcanics and fine quartzitic sediments is markedly different from the pyrrhotite replacements in the coarser gneiss and is thought to be more favourable.

Cobalt

At the west end of Werner lake, about 20 miles north of the junction of the English and Winnipeg rivers, a vein of cobaltite was discovered in 1921 and staked. The occurrence was described by J. F. Wright in 1922. The claims were later allowed to lapse, but during the winter of 1928-29, owing to a sudden rise in the price of cobalt, interest was renewed and 48 claims were staked around the original discovery. It is now the property of Kenora Prospectors and Miners, Limited, and surface work was carried on during the summer.

The vein, of the replacement type, lies at the southern contact of a narrow belt of sedimentary gneisses and schists intruded on both sides by red granite. Wright[1] has claimed that some at least of the schists and gneisses are of igneous origin. There has, however, been so much metamorphism with the injection of igneous material that even the presence of typically igneous minerals can hardly be taken as definite evidence of an igneous origin for the schists and gneisses themselves. They closely resemble undoubted sedimentary schists and gneisses in other parts. The granite is of the acid pink type and is rather gneissic in places. The vein follows a garnet-rich band which may be traced for a mile or more along the strike. The walls are ill defined but at the best showing, where a test-shaft has been sunk, the vein may be taken as a zone about 12 feet wide consisting of fractures along which replacement has taken place. The ore from the fractures where the original rock has been totally altered consists of crystalline cobaltite (CoAsS) in a matrix of green chloritic material. Pyrite, later than the cobaltite, is found in a few stringers and pockets; chalcopyrite, pyrrhotite, covellite have also been found. Oxidation, producing erythrite or "cobalt bloom" and a little annabergite has taken place in the upper part of the fractures, and from the amount of bloom on the ore dump, the alteration seems to take place very rapidly. The shaft was flooded at the time of examination, so the vein could not be followed down far from the surface. A channel sample was taken 10 feet below the surface, across a width of 9 feet. This was assayed by W. K. McNeill, Provincial Assayer, and showed 4.20 per cent. cobalt, which is good payable ore if it occurs in any quantity. Earlier assays indicated that there was no trace of silver, which is often associated with cobalt. A sample across 8 feet, taken by J. F. Wright, showed in partial analysis 2.10 per cent. cobalt, a trace of nickel, 0.10 per cent. copper, and no values in gold or silver. The vein dips under a swampy creek just west of the shaft, and to the east it is largely covered by drift. Along the same garnet-rich band a number of small lenses have been found, consisting of replacements by chalcopyrite with a very little cobaltite. The sulphides tend to replace the other minerals, leaving garnets embedded in the ore.

Similar pockets and lenses of pyrite and chalcopyrite replacement were noticed in garnet-rich bands in other parts of the area, for example on the north shore of Rex lake. It would appear that the garnet-rich bands were favourable channels for uprising ore solutions and are therefore worthy of careful search in any prospecting in the area.

Possibilities of Tin

Owing to the recent discovery of tin in the form of cassiterite (SnO_2) in pegmatites in the part of Manitoba adjoining this area, a search was made for this mineral in favourable formations. The properties of the Manitoba Tin Company and Jack Nutt Mines, Limited, in Manitoba were visited on the way in to the area and the rock associations noted. The Ryerson-Twelnor-Oneman lakes belt of sediments and volcanics was found to be a continuation of the series in which the Manitoba tin properties are situated, though it is narrower and more altered in Ontario. The pegmatite dikes in Ontario were also found to be of the same age and general composition as those in the Manitoba tin area, but no cassiterite was seen in the pegmatites or in any other rocks in Ontario.

Although the later acid intrusive rocks in this region are similar to those often associated with tin deposition, it is thought that erosion has cut too

[1] J. E. Wright, Geol. Surv. Can., Sum. Rept., 1922, p. 74C.

deeply into the batholith to be favourable for mineralization on a large scale. Typically, veins of cassiterite and its associated minerals occur in the uppermost part of acid intrusives or in the rocks which they intrude. The extent of granite exposed in the district, particularly on the Ontario side of the boundary, indicates that such "high spots" in the batholith have long since been removed. The cassiterite-bearing pegmatites in Manitoba are thought by the writer to be the deep-zone equivalent of true veins, but having a lower ratio of tin to rock-forming silicates. Local differentiation within the small intrusive masses is thought to account for the pockets and segregations of cassiterite, which generally occur in the hanging-wall side of the pegmatite dikes or sills, particularly where they take the form of an arch. If the companies working in Manitoba can make a commercial success of mining these segregations in pegmatite, the corresponding dikes and sills in Ontario are certainly worthy of prospecting. The pegmatites most like those in Manitoba are those cutting the sedimentary-volcanic band between Ryerson and Twelnor lakes.

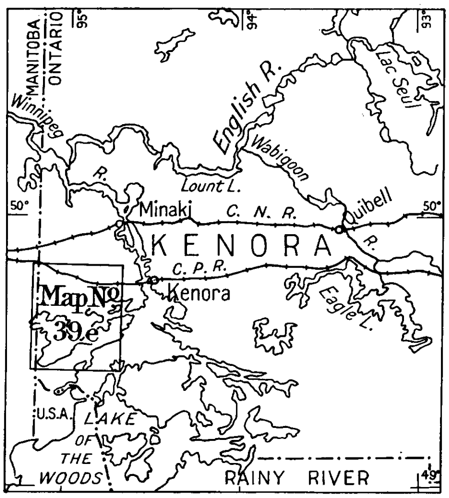
Geology of the Shoal Lake (West) Area, District of Kenora

By Leonard Greer

INTRODUCTION

Shoal lake is an arm of the Lake of the Woods, being connected with it by a narrow strait at Ash rapids. A small part of the lake lies in Manitoba, and the Northwest Angle of Minnesota is but a few miles to the south. This report is based on four months of field work during the summer of 1929. The base map is part of the Kenora sheet and was compiled from aerial photographs by the Topographical Survey of Canada.

The mineral possibilities of the region appear to have attracted attention as early as 1895. Shortly after this date a large number of gold-bearing



Key map showing location of the Shoal Lake area. Scale, 50 miles to the inch.

veins had been discovered and the district was soon booming. Unfortunately most of the development was in the hands of inexperienced men, and there was much waste of money and effort. Not less than 4 mills were erected, but only the Mikado had any considerable production. During the past 20 years there has been little activity. In 1924 operations were resumed for a short time at the Mikado, and some diamond-drilling was carried out on Cameron island during the winter of 1928-29 and the succeeding summer.

Acknowledgments

It is a pleasure to acknowledge the courtesy and hospitality extended by Colonel H. A. C. Machin, M. Malmo, Jas. Smith, the staff of Ventures Limited, and many others. Efficient service in the field was rendered by C. G. Langille, W. E. Newham, and Danvers Bateman.

Location and Means of Access

The lake is about 22 miles from Kenora, a divisional point and holiday resort on the Canadian Pacific railway. The fall at Ash rapids is usually small and depends upon the amount of rainfall and the prevailing wind. Many of the rocks in the channel have been blasted out, and in seasons of normal rainfall tugs and large gas boats can pass from one lake to the other. If the water is low the passage is difficult and sometimes impossible, except for small boats. M. Malmo's *Helen M* makes the trip between Kenora and Shoal lake several times a week, carrying freight and passengers. The Greater Winnipeg Water District railway provides direct access from Winnipeg, the terminus being at Waugh on Indian bay, Shoal lake. Trains are operated three times weekly.

Previous Work

The earliest geological map is that of Lawson,[1] who studied the geology of the area in 1883, 1884, and 1885 and introduced the term Keewatin for the ancient volcanics and sediments here so extensive. His subdivision of the Keewatin series into four groups was based largely on lithological differences. The greater batholithic areas of granite surrounding the Keewatin rocks he interpreted as Laurentian. A number of smaller granitic masses, of which one is the Canoe lake batholith, are indicated on his map as being still younger.

In 1895 and 1896, Coleman[2] visited the area and described the early workings.

Parsons[3] made further investigations and reported on the gold properties in 1910 and 1911. His 1912 report includes a geological map of the northwestern portion of the Shoal Lake area.

In 1924, Bruce[4] examined the old properties and made detailed maps of some of them. The Mikado mine was in operation at the time of his visit, so he was able to inspect the underground workings.

Natural Resources, Game

There have been few fires in the last twenty years, so the natural beauty of the country has not been destroyed. The timber resources are largely exhausted, however, though some pulpwood is cut as well as a little poplar for barrel staves. Fishing is a well-established industry and is a source of revenue for many Indians and three outfits of white men. Whitefish, jackfish, pickerel, and trout constitute most of the catch. The fish are shipped to Kenora by gas boat in the summer and motor truck in the winter.

Moose and deer are fairly plentiful.

Topography

The topography differs in no important respect from most parts of the Canadian shield. The drainage is probably better and the relief slightly greater than in some areas. Though the drift and soil is not heavy, the rock knolls and ridges are usually nearly covered with moss and lichens. For this reason good outcrops are rather scarce except along the lake shore.

GENERAL GEOLOGY

Lawson placed more emphasis on lithology than is the custom at the present time. In modern geological practice rocks are classified according

[1]A. C. Lawson, Geol. Surv. Can., Vol. I, pt. CC, 1885.
[2]A. P. Coleman, Ont. Bur. Mines, Vol. V, 1895; Vol. VI, 1896.
[3]A. L. Parsons, Ont. Bur. Mines, Vol. XX, pt. 1, 1911; Vol. XXI, pt. 1, 1912.
[4]E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925.

to their origin, regardless of their present appearance, and the writer has attempted to follow this usage. For example, on Echo bay, Lake of the Woods, and to the north, Lawson's map indicates belts of "hydromicaceous schists and nacreous schists, with some associated chlorite schists and micaceous schists and including areas of altered quartz porphyry." Such rocks occur, but they have been derived from the regional metamorphism of sediments, lavas, and massive quartz porphyry and felsite. There is no sharp contact between schists and parent rocks, and there are all gradations from unaltered to completely altered types.

The rock succession as worked out by the writer is as follows:—

QUATERNARY
PLEISTOCENE and RECENT: Lake clay.
Boulder clay.

Profound unconformity

PRE-CAMBRIAN
ALGOMAN (?): Granite.
Felsite and quartz porphyry.

Intrusive contact

KEEWATIN:[1] Largely basic lavas, with much interbedded fragmental and clastic sediments: greenstone, agglomerate, tuffs, slate, greywacké, arkose, cherty sediments and conglomerate.
Dominantly basic lavas: andesites (greenstones), with small amounts of interbedded slaty sediments.

A thick and intricate section of Keewatin is exposed in the Shoal Lake area. Lava flows, agglomerates, and obscure sediments are interbedded with no apparent order. There are no marker horizons. The formations are lenticular in outline and are frequently of slight extent both across and along the strike. A good proportion of the lavas and sediments have been rendered schistose and all have been tilted at high angles, the average dip being not less than 70 degrees. The strikes vary considerably but are usually not far off N. 60° E.

Intrusive into the volcanics and sediments are small and large bodies of granite, felsite, and quartz porphyry. Gold-bearing quartz veins occur chiefly in greenstone, though some are found in felsite and granite. The intrusives are tentatively assigned to the Algoman period.

Keewatin

BASIC LAVAS

There are several belts of basic lavas in which little sedimentary rock can be found, the largest running across the middle of the area. Smaller strips outcrop south of Carl bay and also south of Monument bay, Lake of the Woods. The large belt appears to represent the basal portion of the Keewatin series, but it must not be inferred that the small areas are stratigraphically equivalent. It may well be true that other basal sections consist partly of sediments.

Probably nearly every kind of lava from rhyolite to basalt could be identified, but andesite (greenstone) is by far the most common type. It is composed chiefly of feldspar (oligoclase-andesine) and hornblende. Secondary minerals, such as chlorite, epidote, and sericite, have formed owing to alteration.

The greenstones commonly show pillow structure. Sometimes the pillows are of great size, one 14 feet long being noted. Agglomerates are often

[1]Contacts indicated on the map between these members are purely arbitrary.

associated with the pillows. The most common agglomerate is composed of angular blocks of green lava embedded in a tuffaceous matrix, the composition of fragments and matrix being essentially similar. Presumably this type of agglomerate accumulated as a result of occasional explosions, which shattered lava flows previously extruded through long fissures.

Here and there are small amounts of interbedded sedimentary material. On the mainland immediately north of Martineau island there is at least 12 feet of stratified black slaty rock. The contacts are covered, but greenstone is exposed a short distance to the north and south. Undoubtedly such a layer represents a temporary halt in volcanic activity, during which there was erosion and local deposition of a little sedimentary material.

Agglomerate or volcanic breccia, west shore of Martineau island, Shoal lake.

LAVAS WITH INTERBEDDED FRAGMENTAL AND CLASTIC SEDIMENTS

These lavas differ in no way from the lavas of the group already described, but there is a much larger proportion of agglomerates; tuffs, which are in part water-lain; and clastic sediments. At three localities the sediments were of sufficient areal extent to justify separate mapping.

Agglomerates

Agglomerates occur very commonly. The fragments in any one outcrop are usually rather uniform in size, but over the area as a whole they range in diameter from a fraction of an inch to several feet. There is considerable variation in degree of roundness. Usually the well-rounded fragments are composed of grey felsitic material. The matrix is always dark-green and often schistose.

Whether or not the agglomerate was deposited by and in water is frequently hard to decide. In some instances one type of deposit can be traced into the other. To illustrate, at Picture Rock point, Lake of the Woods, the agglomerate is made up of pale-green angular fragments up to 3 feet across, embedded in a dark-green schistose matrix and is obviously a terrestrial deposit. This kind of rock outcrops along the shore to the northeast for nearly a mile and a half, but gradually the fragments become more pebble-like and stratification begins to appear. Such strata must have been laid down in water, and possibly the term volcanic conglomerate should be applied instead of agglomerate. The pebbles are not distributed uniformly. Layers in which the pebbles are abundant pass gradually across the strike into zones containing only fine material. Interbedded with the agglomerate are dense cherty sediments in beds up to 6 inches thick.

One cannot go far without seeing these agglomerates and their associated thin-bedded cherty sediments. Very good exposures occur along the west shore of Shoal lake and south of Shoal Lake narrows. Thick sections with-

Agglomerate or volcanic conglomerate, Silver Fox island, Shoal lake.

out interbedded lavas are not common, but the east shore of the large island southwest of Royal island, Lake of the Woods, is entirely made up of stratified agglomerate and so far as could be determined from a rapid examination no lavas are interbedded. Along the shores of the small islands to the south, however, lava flows, 200 to 300 feet thick, begin to make their appearance and soon predominate.

At an exposure on the south shore of Shoal Lake narrows a few pebbles of granite and vein quartz were discovered among those of felsite. In this instance the term agglomerate is scarcely fitting. Such a rock is certainly a conglomerate. How much of the agglomerate is really of this nature is an open question. Quite frequently all the pebbles are coated with a black film of vegetable matter and their character cannot be determined. The pebbles are usually flush with the surface of the outcrop and are difficult to extract. Most of the agglomerate is quite definitely of pyroclastic origin hence the term is retained. A true Keewatin conglomerate is described in a later section.

Tuffs

Associated with the agglomerates and clastic sediments is a pale-green' fine-grained, sometimes well-stratified rock, to which the term tuff is properly applied. It is composed chiefly of volcanic ash.

Clastic Sediments

Three belts of sediments have been differentiated from the volcanic rocks. The field relations indicate that they were formed locally during pauses in volcanic activity.

Southern Belt.—All of Royal island and many of the smaller islands toward the northeast are composed of a fine-grained, brownish mica schist. The section has a maximum thickness of one mile, striking approximately N. 80° E. and dipping toward the south at an angle of about 70 degrees. Bedding can be recognized at a few places and is parallel to the cleavage. The schist is composed largely of small quartz grains firmly cemented by secondary quartz. Occasional feldspars occur. The good cleavage is due to abundant small flakes of brown mica. Occasionally the schist contains a few small pebbles.

Exposures south and west of Royal island show clearly that the mica schists pass into agglomerates. The agglomerates are more or less stratified and toward the north are certainly water-lain.

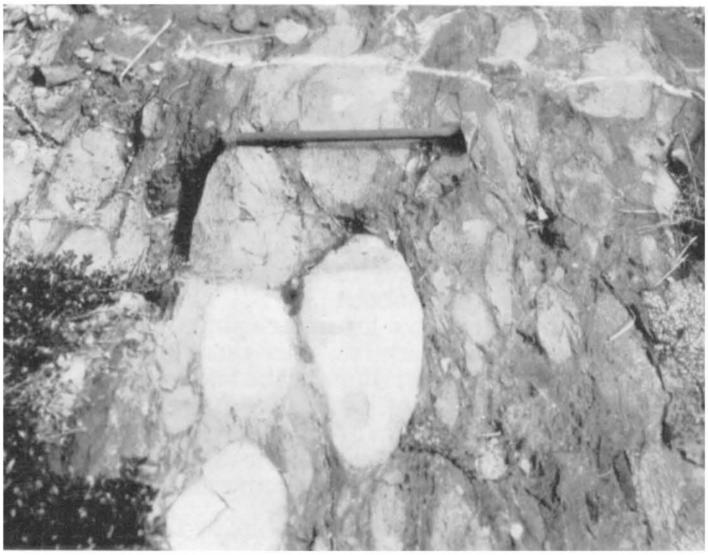
Spike Point Sediments.—Spike point and the country to the east is chiefly underlain by slate and greywacké. The section is approximately half a mile thick, the dip being about 75° S. Arkosic beds are common. Near the south margin thin flows are interbedded. The eastward extent of the sediments is difficult to determine, since there is a good deal of muskeg. At both the east and west ends of James lake there are many exposures of agglomerates and associated sediments. The same rocks are found at the west end of Seager lake and for some distance north and south. Apparently the fine-grained clastics of Spike point pass into coarser fragmental formations, which are interbedded with lavas to some extent.

Crowduck Lake Conglomerate.—The most important section of sediments lies north of Crowduck lake and is composed of conglomerates interbedded with a little finer clastic material. The pebbles are rather well rounded and are made up of several kinds of rock. At an outcrop on the north shore of Crowduck lake where, owing to spalling, there is a fresh surface, a count of the various types was made. The pebbles in an area 4 feet wide and 8 feet long included 103 of granite, 44 of dark-red felsitic material, 23 of chlorite schist, 6 of quartz, and 2 of cherty material. Those of granite that are undistorted attain a maximum width of one foot, but many have been squeezed and are as much as two feet long. The schist pebbles are always smaller and are usually squeezed. A fine-grained quartzose rock containing much chlorite makes up the matrix.

There is considerable variation in the composition of the granite pebbles. Some contain a great deal of quartz, others scarcely any. A microscopic study of one specimen showed it to be composed largely of quartz, feldspar, and calcite. Feldspar, including both orthoclase and albite-oligoclase, is most abundant. The quartz and feldspar phenocrysts are much shattered, the cracks being filled with calcite. Ferromagnesian minerals are not plentiful, but there are small masses of badly altered material in which only quartz and sericite can be identified.

The north shore of Crowduck lake conforms closely to the strike of the conglomerate. Usually the dips are nearly vertical, but at several places an inclination toward the north was observed. The maximum thickness of the section is about half a mile. At the narrows of Crowduck lake it is only 900 feet. On the south shore, near the portage between the lake and Rush bay, Lake of the Woods, is the most easterly exposure of conglomerate. It is safe to say that the conglomerate pinches out not far east of Crowduck lake, since only greenstones and schistose felsites can be found north of Rush bay. To the west of the lake, swamp and heavy drift occupy most of territory in which conglomerate could be expected. The few exposures that can be found consist of greenstone or felsite. Accordingly, the mapping of the conglomerate west of the lake is largely conjectural. Probably, however, the formation does not continue more than a mile or two beyond the lake.

A long sill-like mass of schistose felsite with a maximum width of about 1,000 feet lies between the conglomerate and the greenstone to the south. To the north of the conglomerate, volcanics intricately cut by schistose felsite and quartz porphyry cccur extensively. At one place along the north



Crowduck Lake conglomerate. The large boulders are granite.

shore of Crowduck lake the conglomerate is cut by a 20-foot dike of quartz porphyry.

Granite pebbles predominate in the Crowduck lake conglomerate, whereas in the occurrence on Shoal Lake narrows previously described volcanic material is more abundant. There is no other difference. Evidently there was a period of erosion during Keewatin time, probably in the early part of the epoch. In most places only lavas would be exposed and the products of erosion would be entirely of volcanic origin, but apparently a pre-Keewatin granite was uncovered locally and was the source of the granite pebbles. This granite was not recognized in the field. Near the present site of Crowduck lake it may have formed a mountainous mass, for the outline of the conglomerate and its general make-up rather suggests piedmont deposition.

The Crowduck lake conglomerate appears to be comparable with the Doré conglomerate of the Michipicoten area. Early workers assigned the latter to the Huronian series, but recent studies show that it belongs to the Keewatin. Collins suggests that the Doré conglomerate represents "land accumulations of sedimentary debris in regions of mountainous relief."[1]

[1]W. H. Collins and T. T. Quirke, Michipicoten Iron Ranges, Geol. Surv. Can., Mem. 146 1926, p. 22.

Algoman(?) Intrusives

The volcanics and sediments are cut by several kinds of acid intrusives, the chief types being felsite, quartz porphyry, and granite. Probably all three are genetically related.

Felsite and Quartz Porphyry

In some cases felsite and quartz porphyry are so intimately associated with granite that they cannot be mapped separately. Around Squaw and Cul de Sac lakes there is a good example of this. Along the west shore of the south bay of Squaw lake the rock is a dark brecciated felsite, which is difficult to distinguish from lava. Along the shore of the west bay the rock becomes coarser, resembling quartz porphyry at first, then becoming more and more granitic in appearance. The felsite and quartz porphyry here appear to be the quickly chilled margin of the Canoe lake batholith.

Dikes and small bosses of felsite and quartz porphyry are common features of the area. The felsite is a dense, brittle, greyish or flesh-coloured rock in which small quartz eyes can sometimes be seen. Occasionally there is a greater development of quartz phenocrysts, the rock then being properly called quartz porphyry. Under the microscope the felsite is seen to be composed of a mosaic of quartz and feldspar with a little micaceous material.

In the northern part of the area the felsite is most common and is usually schistose. The schistosity is due to abundant sericite. Felsite dikes, a few inches to many feet in thickness, frequently cut across the strike of the greenstones at such a small angle that it is easy to mistake them for interbedded lavas or sediments.

Intrusion of the felsite may have immediately preceded injection of granite. The granite is massive everywhere, so far as could be observed, but much of the felsite is schistose. Obviously the felsite has been folded, but there is no indication that the granite was subject to the same process. In all probability felsites are slightly earlier phases of granite batholiths.

Lawson's map indicates that a large felsite dike outcrops along the shore north of Martineau island. There are a few exposures of felsite along this shore, but the dikes of which they are parts is too narrow to be shown on a map of this scale.

Granite

The Shoal lake sediments and greenstones are surrounded by granite and are also intruded by small masses of granite. As might be expected the granite varies considerably in appearance and mineral composition, but most commonly it is a massive pink hornblende or biotite granite. Its mode of occurrence dates it as post-Keewatin, but there are no means of determining its age more closely. Since many of the pre-Cambrian granites are pre-Middle Huronian, it is tentatively assigned to the same period of intrusion, i.e. Algoman.

Lawson's map indicates two granites, one cutting the other. The Canoe lake, Carl bay, Portage bay, and several smaller granite bodies are shown as belonging to the younger group, the Laurentian granites north and west of the greenstones being older. Lawson was able to distinguish several small masses of the younger granite within the Laurentian along the west shore of Shoal lake. The present writer examined this shore very carefully, but could recognize only one variety of granite, viz. a massive hornblende granite, pink in colour and of rather fresh appearance. Moreover, the lithology of this rock is identical with that of the Canoe lake batholith. Unless further evidence becomes available, there seems no reason for not assigning all granites within the area to one period of intrusion.

The narrow dike-like body of granite on the south shore of Canoe lake differs in appearance from most of the other intrusives. It is a dark-grey massive granite containing much hornblende and biotite. Dikes of pink pegmatitic granite a few inches in width traverse it in all directions. The dark-green variety is also found on the north shore at the east end of Snowshoe bay and is cut by pink granite dikes in a similar fashion. Toward the west it gradually becomes lighter in colour, the feldspar more pinkish, and quartz more plentiful. Possibly the grey and pink granites represent different stages in the crystallization of one magma, the grey type having solidified first and later being cut by dikes of the residual magma.

Pleistocene

During Pleistocene time the country was completely glaciated. Judging from the scratches on the rocks the course of the ice sheet must have been about S. 49° W. Drift was deposited rather generally though not thickly. At one time, probably as the ice was retreating, the lake must

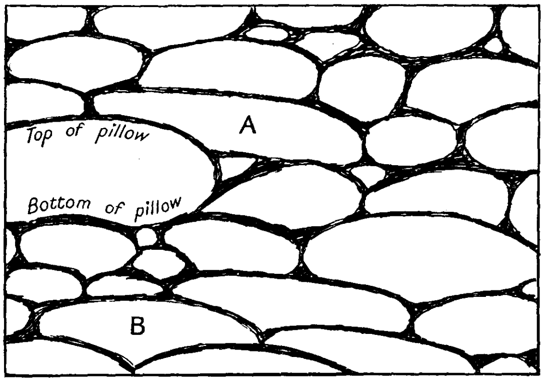


Fig. 1—Diagram illustrating ideal case of pillow lava.

have been considerably higher and more extensive than at present, for along its shore many exposures of varved lake clays up to 10 feet in thickness can be found.

The southwest shore of the lake is low and lined with small boulders. Some of the islands off this shore are probably drumlins, being nothing but great heaps of boulders.

For a good description of glacial phenomena in the region the reader is referred to Lawson.[1]

Structure

The steep dips and the development of flow cleavage in the Keewatin rocks of the area prove that the series is closely folded, and ordinary structural methods of study are of little value. Strikes vary considerably over short distances. The dips are consistent in neither direction nor amount and the possibility of overturning can never be discounted. There are no distinctive beds to be used as horizon markers. In general the flows and sediments have limited extent along and across the strike.

Fortunately there is much undistorted pillow lava. A method suggested by Alcock[2] can often be used to determine the attitude of the flows.

[1]A. C. Lawson, op. cit., pp. 130-140.

[2]F. J. Alcock, Geol. Surv. Can., Sum. Rept., 1922, pt. C., p. 11.

Quoting Alcock, "during cooling, the viscous materials making up the ellipsoids shaped themselves against the underlying layer of pillows, filling the irregularities of the surface." Fig. 1 illustrates an ideal case. In general, the process results in two special and characteristic pillow forms, A and B, Fig. 1, being examples. It is obvious toward which direction is the top of the flow. As a check on the method the textures of two flows were closely studied, one being south of Monument bay, Lake of the Woods, the other on Martineau island, Shoal lake. Near the east end of Monument bay, along the south shore, the grain is very coarse. As it is traced to the south

Pillow lava near Indian village, Shoal lake. The top of the flow is toward the hammer (see Fig. 1).

it becomes progressively finer, and eventually pillows and amygdules appear. It is safe to assume that the top of this flow is toward the south, an assumption which is confirmed by the pillow shapes. Along the south shore of Martineau island a little fragmental material is associated with much vesicular-rimmed pillow lava. When traced to the north the fragmental material and vesicular structure disappear and the pillows are less abundant. Apparently the top of this flow is toward the south, and the form of the pillows supports this conclusion.

Thirty-six exposures of pillow lava were found in the vicinity of the line A-B (see map 39*e*). At all but five the attitude of the flows could be determined by the method just outlined, and no contradictory results were obtained. The structure along the line A-B was inferred from the data so collected. Apparently the Canoe lake batholith determined the anticlinal attitude of the flows on its flanks, the axis of the anticline being nearly a mile north of Galt island. The axis of the syncline to the north passes through Indian bay about a mile north of the Indian village. The axes are about 6¼ miles apart, and along the section the average dip of the flows is approximately 70 degrees. Disregarding faulting and drag-folding, the true thickness of this limb is about 5½ miles. The amount of thickening due to drag-folding and faulting cannot be estimated, but in all probability the series is actually between 4 and 5 miles thick. These figures hold true only for this section; in many places the thickness may be much less and in some cases, no doubt, is considerably greater. Probably the

Ruins of Cameron island mill, Shoal lake.

thickness of the flows is fairly uniform, but that of the sediments and agglomerates must vary widely.

Insufficient data was obtained south of Shoal lake to work out the structure with certainty. Near Picture Rock point, Lake of the Woods, an outcrop of pillow lava indicates that the tops of the flows are toward the south. Not far from here a drag fold in sediments suggests that it is on the south limb of an anticline. It may be that the series was folded anticlinally by the Portage bay granite mass acting in the same way as the Canoe lake batholith.

ECONOMIC GEOLOGY

Gold appears to be the only metal which occurs in important amounts. It is usually associated with rather narrow quartz veins in greenstone. Some sulphide fracture zones also carry gold. The first discovery on Shoal lake seems to have been made by an Indian in 1893. Subsequently this find became the Mikado mine. Between 1893 and 1910 the area flourished, but after this period interest waned. The Cameron island property is the only one on which extensive operations have been carried on since 1924, when Bruce visited the area. Accordingly, the reader is referred to the reports already cited for information about most of the prospects. Brief sketches are given of some of the more important properties.

Description of Properties

Mikado Mine

The Mikado mine is on Bag bay, Shoal lake. It is said to have produced over $500,000, having been operated intermittently between 1895 and 1924. The Canoe lake batholith lies a few hundred feet to the east, the country rock immediately around the mine being mainly greenstone. A large red pegmatitic granite dike cuts the greenstone, striking about east-west. About 400 feet west of the shaft it splits into two tongues. Doubtless it extends eastward to the main granite body.

The main vein cuts across the dike, striking N. 30° W. and dipping at about 85° N.E. Underground workings, nearly 600 feet in depth, show

Olympia mill, Shoal lake.

that the vein cuts across other smaller granitic dikes. The main ore shoot occurred at the intersection of the vein with the large dike, and for this reason an inclined shaft was sunk along the intersection. Bruce[1] states that while the vein improves physically where it passes through granite, it does not follow that the values are higher than where both walls are greenstone. The vein is lenticular in outline, and in places exploration must have been difficult. High values were obtained in the upper levels, but at depth results were less satisfactory. Pyrite, chalcopyrite, tetradymite, galena, malachite, molybdenite, and bismuthinite, as well as gold, were found.

No. 2 vein is about 500 feet east of the main shaft. It is much narrower than the main vein, but the geology appears to be very similar.

Olympia

The Olympia mine is situated on Helldiver bay, Shoal lake, about a mile south of the Mikado. In the greenstone, there are several narrow and moderately sheared zones impregnated with quartz and sulphides. The veins have been developed by 5 prospect shafts and 3 tunnels. Gold valued at a few thousands of dollars was recovered in the course of operations in 1912 and 1915. The ore was treated in a small stamp mill on the property.

Ventures Limited

Ventures Limited recently entered the area, optioning the Cameron island property. The island is in the approximate centre of Shoal lake and has an area of about 6 acres. It is entirely made up of massive greenstone,

[1]E. L. Bruce, op. cit., p. 7.

much of which has been changed to coarse amphibolite. Dark-grey felsite dikes several feet wide are common. The weathered surfaces of the felsite and greenstone are so nearly alike that it is difficult to distinguish the contacts.

According to Parsons,[1] who visited the property in 1910, there are 7 veins on the island with a general strike of N. 45° E. All of them are gold-bearing sulphide zones with some associated quartz. Of the sulphides, pyrrhotite is most abundant; pyrite, arsenopyrite, and chalcopyrite are also common. At the time of the present writer's visit it was difficult to trace the vein system, as clay and soil had slumped into most of the trenches and pits. The vein at the shaft can be traced for about 200 feet toward the southwest, but it seems to pinch out beyond this point. Another vein, apparently a branch of the first, appears here and can be followed for about 200 feet to the southwest, having widths ranging from one to two feet. At the portal of the tunnel on the east side of the island a 2- to 3-foot vein is exposed, the middle 9 inches being mainly quartz. This vein can be traced for only a short distance. Indications of other sulphide zones are revealed by trenches and stripping on various parts of the island, especially along the south shore. According to Parsons, crosscuts from the shaft encountered a parallel vein on each side of the principal vein.

Gold in commercial quantities is fairly common, and a 20-ton mill was operated for some time. Recovery was difficult, and eventually a chlorination plant was installed. No ore has been milled since 1915.

An interesting feature is the abundance along the south and east shores of large angular fragments of highly altered volcanic rock. This rock contains streaks of serpentine and quartz and is mineralized with much arsenopyrite and some pyrite. It is float that was transported during the last period of glaciation, and the angularity and abundance indicates that no great distance was involved. All samples containing arsenopyrite are reported to give a high gold content.

Ventures Limited began a diamond-drilling programme during the winter of 1928-29, and nearly 4,000 feet of drilling has been completed since then. Operations were suspended in August, 1929, but plans were made to drill more holes through the ice north of the island during the coming winter in an attempt to locate the source of the high-grade float.

Some diamond-drilling and trenching were also done on several narrow and very crooked quartz veins and crushed zones on the east side of Stevens island. None can be traced for more than a hundred feet or so.

Kenora Prospectors and Miners, Limited

Kenora Prospectors and Miners, Limited, explored a number of claims in the vicinity of the Mikado mine. On the Gold Coin property (D. 218) a number of trenches were cut at close intervals west of a prospect shaft sunk about 1897. At the shaft the greenstone is slightly schisted, crushed, and impregnated with quartz and pyrite over a zone about 20 feet in width. The crushed zone can be traced about 40 feet to the southwest, but to the northeast there are no exposures. The trenches west of the shaft explore similar though much narrower showings. An interesting feature is the way in which undisturbed-looking greenstone carries native gold along certain zones. A tongue of quartz porphyry outcrops immediately north of the workings.

Work was also done on the old Ontario Limited property, S. 74, D. 204, and D. 203. According to the 1897 report of the Ontario Bureau of Mines, these claims were staked in 1896; and by 1897, 13 veins had been explored by 4 prospect shafts and 420 feet of diamond-drilling. Seven veins were examined by the writer, some being recent discoveries. Most of them are

[1]A. L. Parsons, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, p. 106.

quartz veins, the quartz averaging less than 2 feet across, but in some cases a foot or two of the greenstone has been sheared and silicified and may carry gold. One vein appears to be a shear zone, the greenstone over widths of 2 to 8 feet being crushed and impregnated with tiny quartz stringers. Pyrite is the most abundant, and a little chalcopyrite also occurs. No gold was seen but it is believed to occur.

During the latter part of the season two men were employed on the old Cornucopia property (D. 212) on Cedar island, Bag bay. At the time of the writer's visit a shear zone, 5 feet wide, had been trenched at one place. The vein was mineralized with much pyrite and a little chalcopyrite and pyrrhotite.

Other Properties

A visit was paid to an enormous sulphide zone east of West Hawk lake. The property ties on to the Manitoba-Ontario line near mile post 35 and consists of 15 claims. Years ago a number of pits were sunk, apparently without satisfactory results. The property was restaked in 1929, and some trenching was done by Al. Nunni and his associates. Probably half of the rock is made up of pyrite and pyrrhotite over a zone having a maximum width of at least 350 feet and outcropping in a northwest-southeast direction across more than two claim lengths. A grab sample was taken from the dump beside one of the old pits and assayed for copper, gold, tin, and zinc. None was reported.

An old pit was found on the northernmost bay of High lake. At this place there is, in the granite, a greenstone inclusion, about 75 feet wide, striking almost east-west. The pit is sunk on a break approximately 6 feet wide, about one-third being quartz and the rest schist. Chalcopyrite is the chief sulphide, and there is also considerable pyrite and molybdenite. The vein appears to strike about east-west but cannot be traced more than a few feet. This showing is on S. 505.

Some recent prospecting has been done on High lake, but no staking had taken place prior to September 1. Values in gold and copper were reported.

Recommendations to Prospectors

The area is like most others in the pre-Cambrian shield in that veins are more likely to be found in greenstone or sediments than in granite. Prospectors realize that gold deposits are seldom found in regions in which there are large bodies of granite and relatively small areas of greenstone. Such a set-up indicates that most of the veins that may have existed at one time have been removed by erosion. On the other hand, small bosses or dikes of granite or porphyry in the midst of large greenstone areas indicate that erosion has been relatively less effective. Such an arrangement exists in part of the Shoal Lake area, and it is reasonable to expect gold-bearing veins extending to some depth.

More veins per square mile have been found in the country immediately west of the Canoe lake granite than in any other section of the area. It is an interesting fact that these veins are not more than a mile from the anticlinal axis, which strikes about N. 50° E. from the south shore of Dominique island. If, as was suggested, the injection of the Canoe lake batholith determined the anticlinal attitude of the flows, it is probable that the axis is directly above the highest points of the batholith. The top portion of magmas seems to be the part from which ore-bearing solutions are often derived. The whole question is highly speculative, but as a suggestion that can be taken for what it is worth, the islands and mainland within a mile or a mile and a half of a line passing through the Mikado mine and the south shore of Dominique island may be of particular interest to the prospector.

Most of the veins south and west of the Mikado have a northwest-southeast trend, i.e., are parallel to the trend of the granite contact and dip toward the granite. There is some evidence that the Mikado vein is of the fissure type, and probably the others have a similar origin. Probably, as cooling proceeded after the injection of the Canoe lake granite, tensional stresses were set up, the cracks so produced being filled by vein material. Whether this be true or false, all greenstone within a mile or so of the granite should be carefully searched for veins and special attention paid to those which parallel the granite-greenstone contact.

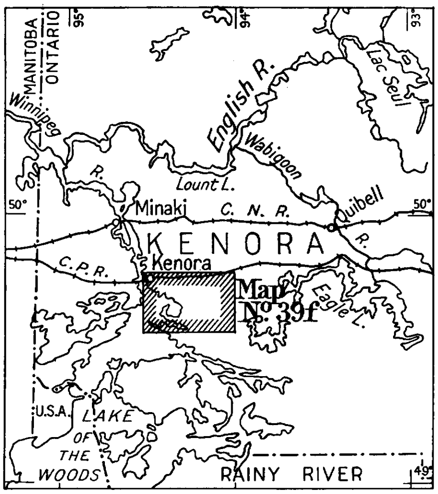
It must be admitted that the entire Lake of the Woods region is not as attractive to the prospector as it might be, because much of the best ground has been staked and can be prospected only by the lessees or patentees. A thorough search is proceeding on a few properties, but far more have lain idle for years.

Geology of the Bigstone Bay Area, Lake of the Woods, District of Kenora

By G. G. Suffel

INTRODUCTION

The primary purpose of this report is to present a geological map of that part of the Lake of the Woods area centring upon Bigstone bay. The only coloured geological map of this region was prepared by Lawson many years ago and is now quite rare and difficult to obtain. While its comparative accuracy has often been attested, detail is, of course, lacking, the base



Key map, scale 50 miles to the inch, showing Bigstone Bay area.

is poor compared to modern ones available, and the geology has not been carried inland to any extent.

The base for the present map was compiled from map No. 17B of the Ontario Department of Surveys, showing the shore of the Lake of the Woods; from maps showing the claim surveys; and from air maps. These have been fitted together and appreciably altered in numerous instances to accord with the writer's observations. Consequently the geology applied to this base is regrettably variable in accuracy and amount of detail. Some changes in classification and nomenclature of the rock types have been made.

Acknowledgments

For numerous courtesies and services the writer wishes to thank J. D. C. Smith, Mining Recorder, Messrs. Neal and Heath, Percy Mitchell, and James Fullford, all of Kenora. Thanks are due also to R. C. Lyons of the Department of Northern Development, particularly for the frequent services rendered by the Department boat *Arcola* and its crew.

The writer's party consisted of Neill D. Runnalls, Fred E. Towsley, and W. G. Beare, all of whom gave wholehearted assistance.

In preparing this report the writer had full use of the office facilities of the Horne mine of Noranda Mines, Limited, Noranda, Que.

Position and Means of Access

The area examined lies a few miles southeast of Kenora, which is situated at the outlet of the Lake of the Woods on the Canadian Pacific railway. It is bounded on the north by the north boundary of Indian reserve 38B; on the west by a line from Devils gap to a point 2 miles south of Allie island; and on the south by an irregular line from the latter point northeast to Gibi lake. The northeastern portion of this quadrangle is occupied by Laurentian granites and gneisses and was not examined.

The numerous islands and the great length of shoreline of the mainland are, of course, readily accessible by boat from Kenora. Short portages give access to Long, Blindfold, and Dogtooth lakes, from which lead canoe routes to the east and northeast. The road now under construction from Kenora to Fort Frances will open up this area from the interior. A portage from Blindfold lake gives access to Hollow and Oblong lakes. Clear lake, Islet lake, and the Black Jack and Gold Hill mines may be reached either by the road which starts in Bigstone bay east of Fish island or by the old "railroad" that ran from the end of Moore bay to the shaft and mill of the Gold Hill. Both are hard to follow. Short portages give access to Lily lake and Lac La Belle. An old but well-preserved road from the end of Andrew bay leads to Stella lake. Gibi and Andy lakes are reached by a portage of 1½ miles from Cole lake, just east of the end of Witch bay; in wet weather it is easier to portage directly from Witch bay.

Topography and Drainage

The Lake of the Woods in this area provides the highly serrate shoreline and labyrinth of islands that is typical of the northern half of the lake. Rock shores and ridges predominate, but the relief is never great. The highest ridges are probably not over 150 feet above the lakes and most of them are under 50 feet, alternating with comparatively narrow strips of muskeg. In spite of the low relief, flat drift areas are small and uncommon.

The shape of the shoreline and the arrangement of the islands show a remarkable relation to the geological structure and do not appear to have been influenced to any appreciable extent by glaciation.

The only drainage of any consequence emptying into this section of the lake is at Blindfold rapids in Route bay, where the water from a large section of the granite area drains in through Dogtooth and Blindfold lakes.

Previous Geological Work

Some geological information of a fragmentary character appeared from 1823 to 1885, much of it due to R. Bell and G. M. Dawson. In 1885, the "Report on the Geology of the Lake of the Woods Region with Special Reference to the Keewatin (Huronian?) belt of the Archæan Rocks," by A. C. Lawson, appeared.[1] In it he first applied the name Keewatin to the schisted volcanic series and showed that the Laurentian gneisses were intrusive and not metamorphosed sediments. The accompanying map was the first and has remained the only geological map of the lake as a whole.

Subsequent work has consisted of additional observations and some changes in mapping by Parsons,[2] various reports on the mines and prospects, especially by Hopkins, Coleman, and Coste, and recently a report on the

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

[2]A. L. Parsons, Ont. Bur. Mines, Vol. XX, pt. 1, 1911, pp. 158-198; Vol. XXI, pt 1, 1912, pp. 169-204; Vol. XXII, pt. 1, 1913, pp. 210-232.

most important properties by Bruce.[1] Outside of some corroboration or qualification of previous statements, little reference is made to the work of other writers in this report.

As little new development has taken place since the properties in this area were fully reported on, a detailed description of properties will not be given.

Summary of General Geology

The area is largely occupied by typical Keewatin volcanic rocks, which may be conveniently divided into three parts: a basic series, a siliceous series, and a basic intrusive later than both.

The basic series consists of ellipsoidal greenstones, dark massive trap-like rocks, hornblende and chlorite schists, amphibolites, and some minor intrusives.

The siliceous series is composed of volcanic fragmental rocks, but flows are also present. It consists of altered quartz-feldspar porphyry commonly occurring as an agglomerate, which may be quite coarse. All phases, however, grade into sericite and sericite-carbonate schists, often very fissile.

The later basic intrusive is highly altered and varies from a diorite or gabbro to a fine-grained dark quartz porphyry, probably a quartz diorite, the latter occurring predominantly as a border phase. The Keewatin is intruded by the Laurentian gneiss and granite, which occupies the north-eastern part of the area and also occurs in masses surrounded by schists, notably on Sultana and Quarry islands and in the central part of the Eastern peninsula. Probably more or less related to the granite are certain felsite and quartz porphyry dikes and the mineral-bearing quartz veins.

The youngest rock of the area is a quartz diabase dike, presumably Keweenawan, which cuts several of the islands in the southwestern part of the area.

The schists are all highly folded. The folds in the southern part strike east and west parallel to Andrew and Witch bays; those to the north strike slightly east of north.

In this area are several mines which produced a certain amount of gold at one time but are now in ruins. These are the Sultana, Ophir, Winnipeg Consolidated, Pine Portage, Keewatin, Golden Gate, and Gold Hill. There are numerous other prospects which have been explored to some extent. The latest, and the only one that has not previously been described, is the Cameron-Earngey copper discovery at the southeast corner of Bigstone bay. Several mineralized shear zones occur here, one of which is of appreciable size and gives good values in copper.

As may be judged from the numerous mines and prospects in the area, mineral-bearing veins are numerous, particularly near the granite contacts; but with the exception of the Sultana, which is said to have produced a million dollars in gold, no important mine has ever been developed. It is necessary, however, to remember that most of the activity took place many years ago and that much of the older work has been done on the most meagre of showings. Although a large number of shafts and pits have been sunk, trenching and stripping appear to have been neglected and the diamond-drill has never been used to any extent. It seems quite possible that modern methods of prospecting and development would accomplish much in this area.

GENERAL GEOLOGY

A basic and a siliceous series of volcanic rocks, largely extrusive, are intruded by a series of dioritic to gabbroic bodies, with a marked linear arrangement parallel to the schistosity. These bodies have not been mapped

[1] E. L. Bruce, Ont. Dept. Mines, Vol. XXXIV, pt. 6, 1925, pp. 1-42.

or specifically described before. All of these rocks have been intruded by granite of Laurentian age and many small granite, felsite, and quartz porphyry dikes and bosses, presumably related in origin. The intrusion was accompanied and followed by marked deformation. Much later the complex was intruded by narrow diabase dikes of great linear extent, probably Keweenawan. Subsequent erosion and moderate Pleistocene glaciation complete the main events in the geological history of the region.

Table of Formations

PLEISTOCENE and RECENT:	Alluvium and boulder drift.	
	Unconformity	
PRE-CAMBRIAN KEWEENAWAN:	Quartz diabase.	
	Intrusive contact	
LAURENTIAN:	Gneissic, porphyritic, and massive granites.	
	Intrusive contact	
KEEWATIN:	Coarse diorite or gabbro. Basic quartz porphyry.	
	Intrusive contact	
	Siliceous series:	Rhyolitic or dacitic quartz and quartz-feldspar porphyry. Agglomerate, sericite schist, tuffaceous (?) banded sediments.
	Gneissoid biotite schists, etc.	
	Basic series:	Ellipsoidal greenstone. Massive "trap." Hornblende and chlorite schist. Altered basic intrusives of various types.

Keewatin

The Keewatin series covers practically the whole area not occupied by the main body of the Laurentian granites. The position of the contact between the two great divisions is best appreciated by a study of the map. From the south end of Hilly lake it follows roughly the contour of the shore of Lake of the Woods, actually touching it in Storm and Route bays, but at Stella lake swings sharply north of east and extends for several miles inland past Gibi and Andy lakes before it turns sharply back again toward the Adams River basin.

The intrusive diorite mapped is in a sense post-Keewatin, but there appears to be no evidence that it did not belong to the same general period of volcanic activity, and as it has been previously mapped with the Keewatin, no change has been made.

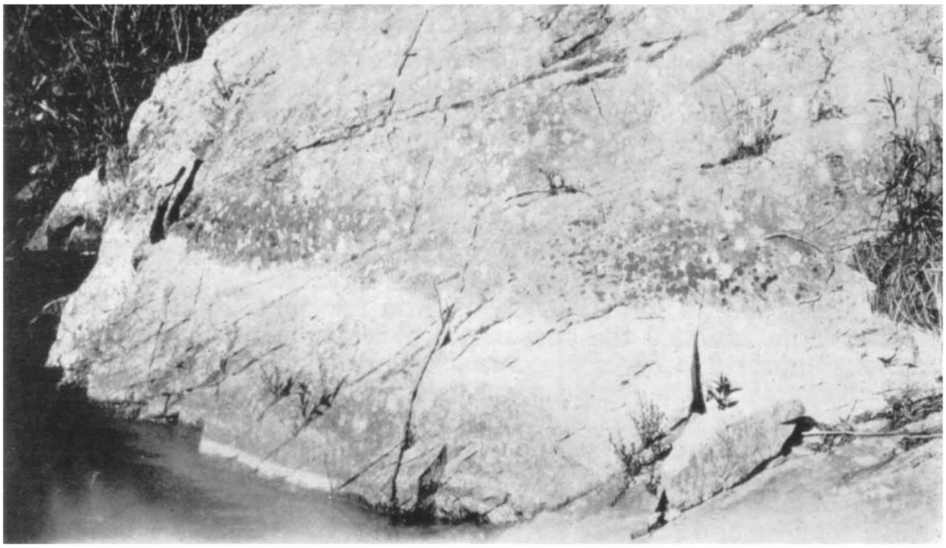
Basic Series

This series is undoubtedly the oldest in the area. Except for the section northeast and south of Andy lake it is the only type found in contact with the main body of the granite. It is exposed in the Indian Reserve and on most of the adjoining islands, on Pine Portage and Bigstone bays, on the north half of Hay island, in a strip from Andrew bay to Gibi lake, and in a strip across Allie island, French narrows, and Bottle bay.

Ellipsoidal Greenstones.—These dioritic rocks, which are exceptionally well developed and cover a large area, constitute the chief evidence of the extrusive character of the basic series. They may be seen almost everywhere around Matheson, Bald Indian, and Bigstone bays, in the northern part of Hay island, in the vicinity of French narrows, and in a few places north of Witch bay. It was observed in many places that the hornblende or chlorite schists still retain traces of the ellipsoidal structure.

On island No. 206 north of Sultana island amygdaloidal greenstone occurs. The cavities have been partly or wholly filled with quartz and epidote. This is the only amygdaloid observed.

In numerous places the greenstone carries highly altered white feldspar crystals as large as 1½ inches in diameter, but mostly under half an inch. Most of these are rounded but some have typical feldspar outlines, and occasionally a crystal that has recognizable faces can be picked out of the soft schist. These crystals were not studied in detail, but they appear to consist of a fine felt of quartz and clinozoisite. Good exposures may be found on the small greenstone point in Witch bay south of the west end of Lac La Belle; at the end of Andrew bay north of the road leading to the



Spotted greenstone, Witch bay. The white spots are highly altered feldspar crystals.

Stella mine (see photograph above); and on the southeast tip of island No. 79, northeast of Middle island.

Massive "Trap."—Areas of massive, hard, fine-grained, dark rock, which shows little structure of any kind except jointing, were observed in the general vicinity of Islet lake as well as in many other localities. There is little doubt that they are flows, however, and some of the ellipsoidal rocks appear to be of much the same type.

Hornblende and Chlorite Schists.—The hornblende schists, which are particularly common, have been described by Lawson[1] and Parsons.[2] They are well exposed on Route bay. A study of this and other localities convinced the writer that they are due to the contact effects of the granite, confirming the observations of Parsons. At the contact occurs a fine-grained black hornblende rock, which grades into ordinary greenstone, the hornblende crystals becoming larger and fewer with an increase of chlorite.

True chlorite schists are not common. Around Bigstone bay they are chiefly noticeable as bands a few feet wide in a much more massive rock.

[1]A. C. Lawson, op. cit., p. 37.
[2]A. L. Parsons, Ont. Bur. Mines, Vol. XXII, pt. 1, 1913, p. 219.

While these are probably simple shear zones, it is possible that they have originated along easily altered lamprophyre dikes.

A marked schist zone extends through Heenan and Needle points. The schist contains considerable carbonate, much chlorite, and in places a large development of minute crystals of magnetite.

Altered Basic Intrusives.—At numerous places basic rocks that are probably intrusive were observed, and in some cases the contacts could be seen.

On island No. 230 and the adjacent southeast tip of Sultana island, a narrow dike occurs. The small basic bodies shown at the east end of Andy lake and on Gelley lake are almost certainly intrusive, and it may be that some or all of the south side of Gibi lake is an intrusive also. Several other coarse-textured bodies might be shown to be intrusive if studied intensively.

Gneissoid Biotite Schists

These schists are the equivalent of Lawson's "clay-slate, mica-schist, quartzite and fine-grained gneiss." The writer does not feel competent to draw any definite conclusions with respect to this series, as it was only hurriedly observed in the vicinity of Andy lake and in a few places south of Gibi lake. As this particular locality is difficult of access, a few observations may not be out of place.

Around Andy lake, the coarser gneissic phases almost invariably show small feldspar phenocrysts. Occasionally a trace of agglomeratic structure was seen. A fine-grained mica schist under the microscope was seen to consist almost entirely of biotite, quartz, and sericite.

No other type was observed except in a few spots south of Gibi lake where the series assumed the appearance of a sediment, banded in places, some types appearing to be fine greywackés or quartzites.

The character of the Andy lake schists, their position on the strike of a body of more or less siliceous agglomeratic porphyry, and the lack of a well-defined contact between them leads one to believe that they are identical in origin and that the gneissoid character has been induced by the intense pressure and movement suffered by being folded in the end of the sycline in which they lie and possibly by proximity to the granite. This confirms the opinion of Parsons.[1] If this is so, the presence of true sedimentary material in the series must mean that there are two divisions capable of separation or that this series grades into the siliceous series described hereafter and contains lenses of more or less true sedimentary material, as does the latter.

Siliceous Series

This series includes all the rhyolitic rocks of the area as well as more basic ones, which are probably dacitic or even andesitic. All of them appear to be extrusive or to have prominent extrusive phases. The division between this series and the basic one as shown on the map is thus rather arbitrary; and in many instances, particularly inland where exposures are poor, the position of the contact is doubtful. As a rule, the presence of feldspar phenocrysts was considered a sufficient criterion to place the rock in the siliceous series.

The siliceous series is found along the entire south shore of Witch bay and on the south side of Andrew bay west of Clam island. It occurs on the south side of Pipestone peninsula, the south side of Hay island, most of Middle island, all of Scotty island, and nearly all of the small islands to the south. An arm of the body extends into Bald Indian bay west of Sultana island. A smaller strip runs through the centre of Gibi lake and is apparently separated from the main body to the west by greenstones, the nature of which is somewhat doubtful.

[1]A. L. Parsons, op. cit., p. 217.

The series consists largely of quartz porphyry and quartz-feldspar porphyry, commonly quite massive but mostly occurring as an agglomerate or finer fragmental. Practically all types are somewhat sericitic and in places can be observed to grade directly into fissile sericite schist and even into slate. In the field an attempt was made to separate the different types, but it was soon found that although they occur roughly in bands more or less parallel to the strike, all types grade into each other and are not capable of separation.

Mapped with this series are a number of small intrusives. Some of these may be contemporaneous, but it is believed that many of them are post-Keewatin, very probably related to the Laurentian. They are commonly feldspar or quartz-feldspar porphyry.

The only masses of appreciable size that could have been separated are those found at Devils gap and within the Indian Reserve. It is probable that they should be distinguished from all other formations, as they do not resemble any of the granitic or gneissic rocks and their age is by no means certain.

Quartz-Feldspar Porphyry.—The porphyries may contain either quartz or feldspar, or both, as phenocrysts. From their appearance in the field, feldspar porphyry is more common.

The types of porphyries found are so numerous that it would be useless to attempt to describe them individually. A particularly fresh quartz porphyry with a dense greenish-grey matrix is found on the southwest tip of island No. 208 north of Sultana island; on islands Nos. 210 and 204, it is found associated with agglomerate. In thin section there are numerous large quartz phenocrysts and some feldspar crystals, the latter almost entirely altered and more deformed than the quartz. The groundmass is fine-grained sheared quartz with a little sericite and chlorite.

On the west side of island No. 192 is a particularly hard brittle type of quartz porphyry, with an almost black matrix, in sharp contact with the greenstone. Agglomerate was found on island No. 145, and flow structure was observed on the north tip of island No. 151. A very chloritic type of feldspar porphyry, which occurs on a number of the islands, may be seen on the east shore of Kipling island.

Typical sheared quartz-feldspar porphyry is found on the northwest shore of Square island. Phenocrysts are not prominent except on the weathered surfaces. The matrix is a light-green schist. In thin section the feldspars are highly altered. The groundmass is composed of quartz, sericite, and chlorite, highly sheared.

Agglomerate.—The fragments in the agglomerates appear to be of the same composition as their matrix. As this rock is practically always highly altered and the matrix alters much more readily than the fragments, it is rather difficult to determine the original character of the matrix. It is probably tuffaceous in most cases, but may be flow material in others. No evidence was anywhere observed to show that it is intrusive. The fragments in places are as large as 2 feet or more across, but ordinarily are only a few inches. All gradations in size doubtless exist, but the outlines of the smaller ones are more easily obliterated by shearing. In the coarser, unsheared agglomerates, the long axes of the fragments appear to show rough alignment. In most agglomerates the fragments are so deformed that the original shape and attitude is destroyed, and in extreme cases they appear as thin hard lenses in schist.

West of Middle island on island No. 553 is an excellent exposure of coarse fresh agglomerate. The fragments are not excessively distorted. Their long axes are roughly parallel and strike about N. 55° E. (see photograph on page 64).

Sericite Schists.—These schists are the direct result of the metamorphism of the porphyries and agglomerates of the siliceous series into which they grade. They are composed of sericite, quartz, carbonate, and other minerals. Some are probably talcose. Typically, they are various shades of greenish-yellow, but the weathered outcrops are commonly rusty, owing to the considerable amount of iron-bearing carbonate that they contain, often as small euhedral rhombs thickly scattered between the *laminae*. Quartz phenocrysts are commonly preserved. The schists derived from the darker types of porphyries appear to contain much more carbonate and some chlorite, resulting in a darker and less fissile type. The basic quartz porphyry described later appears to occur in places as a sericite-carbonate schist.

The fissility of these schists approaches that of slates in a few cases, and large thin slabs may be broken off, which ring when struck.

A narrow strip of fissile schist runs along the north shore of Witch bay, and good exposures are common on numerous points of Andrew bay and

Coarse volcanic agglomerate, comparatively fresh, island No. 553, west of Middle island.

the islands to the west. The outcrops of these schists usually show a flatter dip than the original, due to recent slumping.

Tuffaceous(?) Sediments.—Along Witch and Andrew bays and on some of the islands a few narrow banded lenses occur within the porphyries and agglomerate.

On island No. 339 in Witch bay a laminated cherty rock is interbanded with feldspar porphyry and strikes N. 85° E. On the mainland, south of the island, and in various spots to the west for over half a mile, dark shaly or slaty rocks, some quite black, are interbanded with rocks resembling fine greywackés and quartzites, striking east to southeast. Rocks with a rather coarse tuffaceous appearance occur on the east end of island No. 340. They are composed largely of highly altered crystals of feldspar, with some quartz, in a scanty matrix.

On the south side of Middle island between islands Nos. 26 and 129 is a similar series, which is most interesting. The beds are about vertical and are considerably distorted, showing drag folds and a fault, the south side having moved west relatively The beds strike from N. 45° to 75° W. The top of these beds is toward the southwest.

In the small bay south of island No. 553 and west of Middle island is a banded strip, striking about N. 85° W., which shows a fault plane, striking about N. 25° W., the west side having moved north.

Several other small outcrops of banded rock were observed, but the above are the most interesting.

Intrusive Diorite and Associated Quartz Porphyry

This intrusive extends in a more or less continuous band from a point near the granite contact east of Stella lake westward between Moore and Andrew bays and across Pipestone peninsula and Hay island. It constitutes most of the group of islands between Middle and Hay islands. Here the strike changes abruptly, as does that of the whole of the Keewatin. Similar rocks were noted on the northeast end of island No. 220 and along the west side of Bald Indian bay. Other bodies occur between French narrows and Bottle bay, and a long narrow strip lies inland south of Witch bay.

The coarse phase is an easily recognizable rock; bladed greenish amphibole crystals intersect each other and are set in a whitish matrix of highly altered feldspar, which gives a characteristic texture. It is undoubtedly the rock described by Lawson[1] as a "rather coarse-textured, mottled, green and white rock, from the north side of the east end of Andrew bay." In thin section it is described as follows, agreeing essentially with the writer's observations:—

> Very much altered. Plagioclase originally predominated, but this has almost entirely changed into saussurite. Now and then a very opaque crystal remains that has not been completely altered. The hornblende is in comparatively small quantity. It is very light green and feebly pleochroic. Associated with it are sphene and leucoxene. Considerable calcite occurs in the groundmass.

For some time the relation between this and the quartz porphyry was not suspected. On mapping the two types, however, their association became apparent, gradations toward each other were observed, and finally a few cases were found where the change from one type to the other could be traced without any question. The fine-grained porphyritic type, often recognizable only by its quartz phenocrysts, is most difficult to identify in places as the phenocrysts are not always present. When they are too small to be seen with a lens, the rock closely resembles the altered lavas. This is particularly true of Pipestone peninsula and Hay island.

As the coarse phase of this intrusive has little or no quartz, it must be regarded as a rather highly differentiated body. Some phases are probably more basic than a diorite. Certain coarse-grained, rusty-weathering magnetic bodies south of Magnet and Lodestone lakes may be related to it. On the other hand some of the porphyries are remarkably high in quartz, as, for example, those on the southeast side of island No. 83 in the group between Middle and Hay islands.

Typical, comparatively fresh, coarse-grained diorite may be readily observed on the west side of the northeast arm of island No. 71 and on parts of the islands to the south, along the south side of Moore bay east of Pipestone portage, and at several places on the north shore of Andrew bay and southeast of the portage. The altered and sheared phases are numerous. The body shown on the map east of Pipestone point is practically unrecognizable on the north shore, as a strong shear zone follows the shoreline and carbonate and chlorite schists only are to be seen. On the south shore and on top of the intervening ridge the diorite is fairly typical.

The quartz porphyry phases are of innumerable types, and there are all gradations into the coarse diorite. For the most part they lie along the borders of the intrusive bodies but may occupy its whole width. On the

[1]A. C. Lawson, op. cit., p. 46.

whole they are quite similar to greenstone or altered "trap" but are commonly massive and nearly always show small quartz eyes, which are often seen only with a lens but may be quite conspicuous. As most of the exposures on the shore are parallel to the strike and are commonly sheared, the gradation of these porphyries into the typical coarse intrusive is not easily observed without crossing the ridges inland, and there drift commonly prevents observation. It may be observed quite well at a point directly north of island No. 312 across Pipestone peninsula. An examination of the group of small islands just north of the deep bay in Middle island is quite convincing.

Porphyritic Intrusives

There are a few porphyritic intrusives, mostly small, which are certainly later than the fragmentals. Some of them cut the diorite. They are believed to be related to the Laurentian granites; as there is no proof of this relation and they are similar in appearance to many of the siliceous porphyries just described, they are included here.

Two outcrops on the Indian Reserve south of Devils gap and northeast of island No. 211 may be the same intrusive. The southern one is a sheared light-grey quartz porphyry. The northern one, also a quartz porphyry, is more granitic in appearance.

Just south of the entrance to Devils gap proper, mostly on the west side, a dark greenish-grey, fine-grained porphyritic rock with a somewhat granitic appearance is intrusive into ellipsoidal greenstone. The outcrops of porphyry shown in the north central part of the Indian Reserve are largely a light greenish-grey felsite.

Narrow acid dikes, usually only a few feet wide, are quite numerous. They have been observed cutting the basic quartz porphyry, e.g. on the east side of island No. 323 southeast of Pipestone portage and in the small bay on the north shore directly east of Pipestone point.

A rather remarkable quartz-feldspar porphyry occurs at the south end of the bay in Pipestone peninsula opposite island No. 312. The matrix is dark-grey and fresh. Feldspar phenocrysts up to a quarter of an inch in length are numerous. The intruded rock here is rhyolitic.

Ankerite Deposits

Besides the disseminated carbonate occurring in the schist, there are dikelike masses which have been well described by Lawson[1] and have also been mentioned by Parsons,[2] who cites one of them cutting across Square island. Although occasionally quite massive, they are simply an accumulation of dolomitic stringers between the *laminae* of the schist. The rusty outcrops have a characteristic rough surface with a raised network and ridges parallel to the schistosity.

A considerable mass of this rock occurs on Hay island south of island No. 97, and other outcrops are not uncommon.

Laurentian Gneisses and Granite

These rocks have been so extensively described and discussed in previous literature that only brief comment will be made here. The main body of the Laurentian shows many types of granite. They may be pink or grey, coarse or fine grained, porphyritic or granular, gneissic or massive, and may contain little or much biotite. This is doubtless the result of multiple intrusion. On the whole, the contacts are sharp, and contact breccias are remarkably developed in places (see photograph opposite).

[1]A. C. Lawson, op. cit., p. 59.
[2]A. L. Parsons, op. cit., p. 221.

The writer found no reason to believe that the outlying granite bosses are of a different age to the main body. One of these occurs in the interior of Pipestone peninsula, two about a mile east of Bottle bay, one at the narrows between Allie island and island No. 403 (considered as one island on older maps), and one on the east end of island No. 426. This last is a peculiar rusty altered type but undoubtedly granitic. The outcrop on the west side of Bottle bay was discovered to be quite small.

The porphyritic granite of Quarry and Sultana island appears to be unique in this area and deserves mention here.[1]

Keweenawan Quartz Diabase

One of the dikes described and traced by Parsons[2] cuts a few of the islands southwest of Hay island. It cuts the southwest tip of Scotty island and the east end of Slate island and runs across island No. 430 west of Queer

Breccia at the granite-greenstone contact, Route bay, west of Blindfold rapids.

island. It was not observed elsewhere by the writer's party, but Parsons[3] has mapped it just west of French narrows.

The rock has been well described by Parsons, who says it is a quartz diabase consisting of labradorite, augite, quartz, and ilmenite. On Slate island, where it cuts across the slaty sericite schists, it contains enstatite. On the east side it is in contact with a finely and regularly banded rock, which strikes east and west and dips about 85° N. At the north end the dike has a rather notable gneissic border. Although narrow it shows a remarkable gradation from a medium to coarse grained rock, with an almost granitic appearance and texture, through a dark, brittle, fresh diabase, prominently jointed, to a fine-grained black trap at the contact.

The lamprophyre dikes as described by Bruce[4] may be of nearly the same age as these quartz diabase dikes. Although no new ones were observed in granite, similar dikes are not rare. One in the southeastern part of Bottle bay is quite prominent.

[1]Ont. Bur. Mines, Vol. XXXIV, pt. 6, 1925, p. 16.
[2]A. L. Parsons, op. cit., pp. 222-225.
[3]Ibid, p. 211.
[4]E. L. Bruce, op. cit., p. 15

Glacial Deposits

The glacial deposits of the area are unimportant in extent and consist of boulder drift. The southwestern portion of Hay island is largely drift covered, and an appreciable area of drift with scarcely any outcrops was encountered northeast of Gelley lake.

There is little evidence that glaciation removed much unweathered rock from this region. At the water level on island No. 313, south of Pipestone point, a small patch was observed which entirely escaped the latest glaciation.

Structure

Other than the general strike of the formations and contacts, the only positive evidence as to structure is obtained from the banded lenses found in the siliceous rocks already described. The basic rocks show practically no large-scale structure of any kind. There is every reason to believe, however, that the schistosity is practically parallel to the contacts of the flows and fragmental beds, and the granite appears to have invaded the schist zone along the axes of anticlines farther than along synclines.

Considered as a whole, the schists bordering the granite appear to be the southwest end of a large truncated anticline. According to Lawson, the Eastern peninsula is occupied by an anticline. If this is so, a long, tightly folded syncline follows Andrew and Witch bays, parallels the portage to Gibi lake, and continues through Gibi, Andy, and Gelley lakes toward the granite, swinging from east and west to almost northeast-southwest. Pine Portage bay appears to lie in a syncline, and it seems probable that the granite of Quarry and Sultana islands occurs in an anticline, both having a trend somewhat east of north.

Along the west side of Scotty island at the contact between ellipsoidal lava and a banded rock, good evidence was obtained that the formations strike about N. 10° E. and are on the east arm of an anticline, possibly extending through Bare point, in which case Bald Indian bay occupies a syncline.

The strike of the formations changes abruptly along a line from the centre of Hay island past the south end of Middle island. This is probably due to faulting. In this vicinity the strike of the schists may give little clue as to the general strike of the formations. A more thorough study of the banded lenses of the siliceous series might throw further light on the structure.

ECONOMIC GEOLOGY

This region has periodically attracted the attention of geologists and the mining fraternity since the earliest days of gold mining in Ontario. The literature contains many references to properties around Bigstone bay. Many of these were of little importance, and even their location would be difficult to find now. The more important ones mentioned in the early literature are Sultana, Ophir, Pine Portage, Keewatin, Winnipeg Consolidated, Gold Hill, Golden Gate, Black Jack, Stella, Jenny Leigh. Later the Wendigo mine and the veins on the Gauthier claims of Pipestone peninsula were discovered.

In 1925, Bruce reported on the Sultana, Ophir, and Wendigo mines, and the Gauthier claims. Since that time there appears to have been only one discovery, that known as the Cameron-Earngey copper prospect, and little or no work has been done on any of the other properties. Except for this discovery, little more can be said about these properties, but some comment will be made on a few which were visited by the writer.

During the summer of 1929 interest in the area did not appear to be entirely dormant, but there was practically no activity on any of the properties. The exceptionally dry weather was doubtless responsible in part, all travel in the region being forbidden on account of the fire hazard.

Most of the gold-bearing veins in this region are closely associated with the contact between the granite and basic schists, many showings being in the schist but some in the granite itself. A few veins are some distance from any granite. These veins are of quartz, usually with more or less dolomite, and are commonly narrow and lenticular in form. Gold may be readily seen with the naked eye in many veins, and such minerals as silver, pyrite, arsenopyrite, chalcopyrite, sphalerite, galena, and tellurides have been reported. Mineralization of the walls of these veins appears to be slight as a rule.

It may be noted that the veins on the Cameron-Earngey claims and at the Wendigo mine that show an appreciable amount of chalcopyrite are

Shaft-house at the Gold Hill mine, Islet lake.

some distance from the granite and probably carry little or no gold. The native copper deposit on Allie island[1] appears to be directly related to a basic intrusive.

Cameron-Earngey Copper Claims

The main showing is in the southwest corner of claim X. 45, just north of K. 2,279, on the mainland just east of Eagle passage. The most important mineralization occurs in a shear zone, about 130 feet long as exposed by trenching, which strikes at 45 degrees and dips about 75° S.E. This zone is more or less heavily mineralized for about 75 feet. The richest part is lenticular and not over 5 feet wide. The walls of the shear zone are composed of a dark, hard, fresh variety of greenstone, which is disturbed and brecciated but not appreciably mineralized.

The mineralization consists of networks of pyrite, chalcopyrite, and probably some pyrrhotite, associated with lenses and veinlets of quartz and dolomite. Quartz occurs in a fine granular state as well as in coarse eyelike bodies in sugary carbonate, which, in places, contains numerous elongated crystals of epidote. The carbonate, however, also occurs as crystals as much as an inch across. Malachite and other secondary copper minerals

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

are abundant and form crusts of appreciable thickness. Although the lens had been blasted out to a depth of 10 feet in places, the bottom of the oxidized zone was not reached.

A grab sample of the richest-looking and freshest material from several places on this showing assayed copper, 12.66 per cent.; gold, none. A sample of the oxidized ore showed copper, 5.92 per cent.; gold, none.

Two sheared or brecciated zones have been exposed in trenches to the southeast, but there the mineralized portions are quite small. Other workings to the east have revealed little or no mineralization.

Sultana Mine

The Sultana mine[1] was for some years the foremost gold mine in Ontario and operated continuously from 1891 to 1906. At the time the writer

Main shaft, Wendigo mine, Witch bay.

visited this mine, it was in the hands of a caretaker and in the same condition as it has been for some years. Practically all the hoisting machinery has been removed, but the stamp mill is still intact. Interest in this property is far from dormant and it seems probable that it will be reopened eventually.

Wendigo Mine

The Wendigo mine[2] is located 20 chains south of the east end of Lac La Belle and is reached from the north shore of Witch bay by a road nearly three-quarters of a mile long. During the previous year, the property had been sampled both on the surface and in the shaft, and the vein had been cleaned off fairly well for this purpose.

The vein as exposed between the west and east shafts strikes about N. 80° E. and is about 260 feet long. From the main or east shaft it continues due east for another 100 feet and apparently pinches out. The best showings are in the latter section, the vein being 2½ to 3 feet wide in places. The average width of actual vein material, however, is considerably less. The vein is of quartz with pyrite, pyrrhotite, and chalcopyrite, the

[1] E. L. Bruce, op. cit., p. 15.
[2] Ibid, p. 20

sulphides being almost massive in places. Locally, the country rock contains much quartz, but it appears to be barren.

Pine Portage Mine

This mine is situated about half a mile east of the north end of Pine Portage bay. It was at one time (1884) the most important development in the Bigstone bay region.

In a cut north of the shaft, the writer observed a shear zone, about 7 feet wide, striking due north and dipping vertically or very steeply to the east. About 2½ feet of white quartz was exposed, but it seemed lenticular. The country rock is a dark, fine-grained greenstone. The granite contact is found a few chains to the south. The ruins of the mill may still be seen.

Stella Mine

This property is situated west of Stella lake and is reached by an old road from the extreme east end of Andrew bay. About 30 chains west of the lake is a shaft and a tunnel, which strikes about N. 50° W. Here a vein of quartz about 2 feet wide carrying sulphides is exposed; it has a steep dip to the south.

About the middle of the west side of the lake is a rather heavily pyritized shear zone, from 10 to 15 feet wide, striking N. 55° W. Quartz is not prominent. A small shaft has been sunk.

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