# Thirty-Sixth Annual Report

of the

# Ontario Department of Mines

# 1927

## Part III

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PROVINCE OF ONTARIO

DEPARTMENT OF MINES

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

# THIRTY-SIXTH ANNUAL REPORT

OF THE

# ONTARIO DEPARTMENT OF MINES

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**(In pocket at back of report)**

*Photo by Air Service, Department of National Defence, Canada.*

Red lake, looking southeast from a point above Mackenzie island towards the outlet. Keg lake and Gullrock lake lie in the distance. The Howey Gold Mines and McIntyre claims lie in the burned area beyond the green point.

# Geology of the Basin of Red Lake, District of Kenora
## (Patricia Portion)

By E. L. Bruce and J. E. Hawley

## INTRODUCTION

The discovery, in the vicinity of Red lake, of gold deposits that give promise of commercial value and the great amount of prospecting that has followed those discoveries, have made necessary a re-examination of the geology of the Red Lake basin and an extension of the boundaries of the original map to cover the whole area of basic rocks surrounding Red lake. This work was begun by J. E. Hawley in June, 1926, and was taken over by E. L. Bruce in the latter part of July. The large number of claim surveys made during the summer, the control base line, and the township boundaries make possible a more accurate mapping of the geological units than was possible on the previous map. Some other changes have also been made as the result of further study of the rock formations; but, on the whole, the main outlines of the succession and structure, as determined in 1923, have been found to be correct.

### Acknowledgments

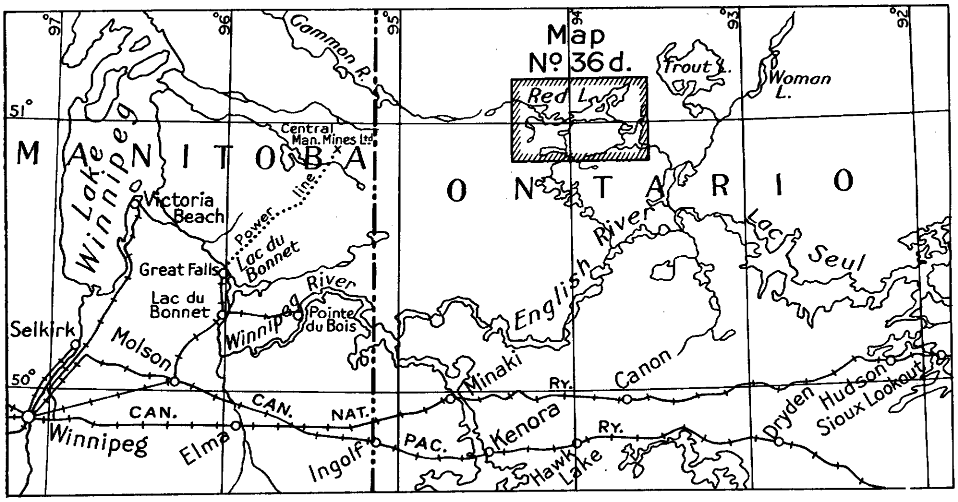
G. G. Suffel, A. C. Lee, and H. C. Laird were field assistants throughout the season and performed their work in a most satisfactory manner. Those engaged in prospecting or developing claims in the area gave much assistance in the prosecution of field work, and the writers wish to express their appreciation of assistance and hospitality to J. E. Hammell; D. G. H. Wright, in charge of development for the Dome Mines; S. Wookey, in charge of the McIntyre claims; Cunningham Dunlop, of the Dunlop Red Lake Syndicate; J. W. Tyrrell, and many others.

### Position, Area, and Means of Access

Red lake lies in the district of Kenora (Patricia portion) about forty miles northwest of the outlet of Lac Seul. It has a total length of thirty-six miles and a width, from the northern extremity of Slate bay to the outlet, of eight miles. The area covered by the accompanying map, No. 36*d*, extends for some distance inland from the lake and has a length of 35 miles, and a width north and south of 22 miles. The 9th base line passes through the map area, and township boundaries have been surveyed on either side of the base. The map covers part of the township of Ranger, the northeast corner of which is at mile 24 on the base line; the townships of Dome, Balmer, and Todd, all of which lie in a tier just south of the base line; the township of Heyson, lying south of Dome township; and the townships of Bateman and McDonough lying north of the base line. In addition, it includes unsurveyed country outside of the blocked-out townships.

Hudson, a station on the Canadian National railway, is the starting point for power-boat lines which take travellers, without change, to Pine Ridge at the west end of Lac Seul; from there, smaller boats are used down the English river and up Chukuni river to Red lake. On English river, there are two short portages or one longer one, across which there is a wagon road. On Chukuni river, there are four short portages in the part between Pakwash lake and Gullrock lake, expansions of the Chukuni river.

Two commercial air lines are operating: the Patricia Airways[1] from Sioux Lookout, a divisional point on the Canadian National railway, and the Western Canada Airways from Hudson. Sea-planes take passengers from the railway to Red lake in about an hour and a half. The journey by water requires two full days.




Key map showing position of the Red Lake area. Scale, 50 miles to the inch.

## Previous Work

A post, known as Red Lake House, was established during the seventeenth century by the Hudson's Bay Company. Red lake is marked on Arrowsmith's map of 1795-1802, and Gullrock lake is shown as Prince of Wales lake. As it is located off the main travel routes of those days, none of the naturalist explorers of the great fur companies visited it; and it was not until 1893, when the late D. B. Dowling passed through the lake on his exploration from the English river to Berens river, that there is any mention of the geology or physical features of the region north of the English river. Prompted by Dowling's description of sedimentary rocks at Red lake, a geological party of the Ontario Department of Mines, working along the English river, visited Red lake in 1922, and the preliminary mapping of the basin was completed in 1923. The report, accompanied by a coloured geological map, formed a part of Part 4, Volume XXXIII, of the Ontario Department of Mines.

## Summary

### General Character of the Country

The country surrounding Red lake has typical pre-Cambrian topography. In the western part, the elevations have a linear arrangement controlled by the folding and by the intrusion of igneous masses parallel to the bedding of the sedimentary formations. The maximum difference of relief from the lake bottom to the tops of the ridges is 265 feet; some of the hills rise 125 feet above lake-level. In the eastern part, the irregularities of the consolidated rock floor

[1]Successors to Patricia Airways and Exploration Company, Limited.

are masked by beds of lake clays. The chief elevations in this part are a few hills of glacial debris which project through the clay. The pronounced ridge several miles east of Red lake is believed to mark the beach of the pre-glacial lake in which the clays were laid down.

The part of the basin in which the clays are found has a deep productive soil, is well drained, and should be a good agricultural area. The forest growth is large. Beyond the thick clay beds are isolated areas of soil in some of the valleys, and these valleys contain good timber. On the uplands the growth is small and scanty. Red pine grows in the Red lake basin, but is not abundant. Fish and game are plentiful. None of the falls or rapids on the river is large enough to supply any great amount of water power.

**Table of Geological Formations**

| | |
|---|---|
| QUATERNARY | |
| RECENT: | Peat, beach deposits, river silts. |
| PLEISTOCENE: | Stratified lake clays, glacial deposits. |
| | *Great unconformity* |
| PRE-CAMBRIAN | |
| POST-TIMISKAMING: (Algoman) | Granite—quartz diorite and micropegmatite.<br>Lamprophyre dikes; quartz diabase and diorite.<br>Porphyritic granite, hybrid granite, amphibolite and associated gneisses.<br>Granite porphyry.<br>Quartz diorite porphyry.<br>Quartz porphyry. |
| TIMISKAMING: | Slate, greywacké, arkose, and conglomerate. |
| POST-VOLCANIC DIORITE | |
| KEEWATIN: | Metamorphic derivatives of volcanic rocks.<br>Iron formation.<br>Volcanic ash rocks.<br>Agglomerate and fragmental rocks.<br>Rhyolites.<br>Lavas of intermediate composition.<br>Amygdaloidal basalt, greenstone, etc. |

**Economic Geology**

The occurrence of greenstone, overlain by sediments of the Timiskaming type, and of porphyry and granite intrusive into these old rocks, provides conditions favourable to the occurrence of ore deposits. This succession first attracted close attention to the area and led to systematic prospecting of the rocks surrounding the smaller granite masses. The search has been rewarded by the location of gold occurrences which give every promise of sufficient size and value to make producing mines. No mineral, other than gold, yet shows any commercial possibilities. Silver-bearing galena veins were staked as far back as 1922, but they are small. In the serpentinized greenstone, stringers of asbestos of good grade have been seen, but in all cases they are too few in number to be worth developing. Massive talc is common in some parts of the greenstone series, but occurs with a large proportion of carbonates, quartz, and other impurities.

## Topography and Drainage

The topography of the area differs from that of any other part of the pre-Cambrian only in local modifications of the typical surface of low relief. The linear character of some of the igneous intrusions is marked in the topography by ridges, but these are not remarkably high or continuous. The most noticeable features of this kind in the vicinity of the lake are the ridges north of Slate bay, which rise to 125 feet, and the ridge at the mouth of Slate bay, which is scarcely 100 feet above lake-level and yet can be seen from long distances up the lake. At the west end of the lake, the mass of quartz porphyry along the west side of Pipestone bay forms a marked elevation. South from Red lake to the latitude of Medicine-stone lake, there is a gradual rise terminating in linear ridges, which rise from 200 to 250 feet above the general plain and which form sharp divides between Medicine-stone lake and the smaller lakes to the north. These higher ridges are held up in places by granitic dikes.

On the whole, however, the etching of the pre-Cambrian rocks has left but small areas noticeably above the general level, nor have the hollows been deeply incised, the greatest depth determined by soundings in Red lake being only 140 feet. This, taken with the greatest elevation, 125 feet for the ridge north of Slate bay, makes a maximum difference of relief of only 265 feet. As in most pre-Cambrian areas, however, this comparatively slight difference gives the impression of ruggedness due to the steep slopes of the ridges and the numerous cliff faces. It is only when actual elevations are plotted that the regularity of the profile is appreciated.

In part of the Red lake basin, even these comparatively small irregularities of the consolidated rock surfaces are to a great extent masked by unconsolidated glacial material: terminal moraine debris; later outwash sands, gravels, and clays; and recent organic accumulations in bogs and swamps. Towards the western part of the lake, the unconsolidated materials occupy only the hollows and valleys between rock ridges, so that consolidated rocks are well exposed and the area of such exposures is fairly large. To the east, the thickness of glacial and glacial lake deposits increases, and the area of pre-Cambrian formations exposed becomes correspondingly reduced, so that in the country inland few outcrops are to be found, these representing the tops of ridges or hills almost completely buried or the flanks of those hills where streams have washed away some of the mantle. Hence, although rocks may be abundantly exposed along the lake, many exposures are completely covered only a short distance back from the shore, and inland little but good clay soil with some muskeg and swamp may be seen.

In Heyson township, south of Red lake, many of the strike depressions owe their origin to shear zones, as exemplified on the Howey, McIntyre, and other claims where fracturing and schisting have made the rocks more susceptible to erosive forces. Some of these shear zones have been mineralized and afford promising places for prospecting, but many of them have been so deeply filled with sand and gravel as to be rendered inaccessible. Depressions with a more northerly strike cut across the eastward-trending ridges in several places, and are suggestive of north-south faults as pointed out by Wright.[1] South of Faulkenham lake, bare, relatively flat topped ridges afford an excellent view of the slightly lower country to the east, most of which has been burned over.

Eastward toward Trout lake, glacial lake deposits become still thicker, and the land surface gradually rises into a conspicuous ridge of gravel and sand, which lies about six miles east of Red lake and can be seen from some parts of the lake.

Red lake drains southward to the English river, and its waters are carried from there westward to Lake Winnipeg. It lies, however, well up to the divide that separates the English river from Berens and Bloodvein rivers, which flow directly westward into Lake Winnipeg. Hence, the drainage basin of Red lake is not large, and most of the streams which flow into the lake are small. No stream large enough for canoe navigation enters from the northwest. There is a

[1]D. G. H. Wright, Eng. & Min. Jour., Vol. 122, July 3, 1926.

canoe route said to lead westward to the Bloodvein river, but this route leaves the western part of Pipestone bay by a portage three-quarters of a mile long. At the west end of Trout bay, the stream that drains Douglas lake is fairly large, but over the high ridge along the south side of Trout bay there is a considerable fall, and a portage of over half a mile is necessary. A lake of some size, Hatchet lake, drains into the south end of Douglas lake from a considerably greater elevation. A navigable stream also enters Douglas lake at its northeast extremity, draining several small lakes for a distance of four miles to the south. The upper part of this stream consists of a series of narrow lakes connected by shallow, sluggish channels. Between West and Wolf narrows, a small stream enters, draining Suffel, Lee, and Laird lakes. Four short portages were cut around rapids in the portion between Suffel and Red lakes, and one between Suffel and Lee lakes. This course was opened to Medicine-stone lake by a short portage over a sharp ridge from the centre of Lee lake.

Just east of the Middle narrows, a third northward-flowing stream, heading in the Medicine-stone lakes, and flowing successively through two others, discharges into Red lake. Portages must be taken around six short rapids on this route, and the drop in elevation between Medicine-stone and Red lakes, 11 feet, is distributed rather evenly among all the rapids.

Two other small streams enter Red lake from the south and, though unimportant in size, afford an easy means of access to the country south of the lake. One of these, draining Russet (Ross) and Flat (Shoal) lakes, is choked with logs and brush for a mile and a half, and a portage is necessary. The other drains Faulkenham lake and passes through Snib (Bobs) and Coin (Gillies) lakes. Five portages, the longest of which is 43 chains, enable one to reach Faulkenham lake. In the past field season, a route from this stream by way of three small lakes to Russet lake was made by cutting four portages.

On the north shore near the Middle narrows are two small creeks; one drains a lake of some size, and the other rises in a swamp. Three creeks flow into Slate bay, but all are small.

The largest river entering Red lake is the Chukuni, which drains Little Vermilion lake and brings in a large volume of water from Pine lake and other lakes to the north. A broad but somewhat sluggish creek flowing into the north end of East bay was followed upward a short distance to the point where the trail eastward to Trout lake leaves it.

## Natural Resources

### Soil

Of the present and prospective resources of Red lake basin other than mineral resources, the soil which covers a large part of it so completely is probably the most important. This clay area is no doubt a continuation of the belt which extends along the river below Lac Seul.[1] The northeast margin of this agricultural area, according to Dowling,[2] is the sand and gravel ridge lying between Red lake and Trout lake. The west and south margins are extremely sinuous, depending upon the irregularity of the floor upon which the clay was deposited; the clay lands finger out along the depressions in the floor, and this edge is bordered by almost isolated areas of clay lying among the rock ridges. No doubt, too, many of the muskeg and swamp areas are underlain by clay of good quality. In the main area of clay, the drainage is good, little swamp or muskeg exists, and

[1] Ont. Dept. Mines, Vol. XXXIII, pt. 4, 1924, p. 2.
[2] D. B. Dowling, Geol. Surv. Can., Vol. VII, pt. F, p. 52.

the preparation of the land for agriculture should be a fairly easy matter. At present, the distance of this area from transportation prohibits settlement, and even the small number of Indians who make this their hunting ground practically desert it during the summer months and do not plant gardens. A splendid garden was formerly kept at the old Hudon's Bay Company's post.

### Timber

The well-drained clay land supports a good growth of trees of all kinds that the climate permits. Poplar, spruce, and birch all grow to large size. Balsam is abundant, but small. Red pine, which grows rather abundantly along the English river, is nearly at the northern limit of its range at Red lake, but a number of good-sized trees of this species grow on the large islands south of Mackenzie island. The muskeg areas have the usual stunted growth of spruce and tamarac. Rock and sand ridges and sand plains support a growth of jackpine. Fire has not destroyed much timber, and the areas of brulé are not very extensive. An old burned area extends for eight miles southwest from the outlet of Red lake to the south of Faulkenham lake. Here many of the ridges have been swept clean, but the lower areas are covered with heavy windfalls. A recently burned area crossed by the trail from Red lake to Trout lake is probably the result of carelessness since the trail was opened; but so far as could be judged from the trail, no timber of any value was destroyed, as the trees were small jackpine that would never have reached any useful size. The very wet seasons of 1923 and 1926 prevented any large fires, but care will need to be exercised to preserve the valuable timber as prospecting continues.

### Fish and Game

Fish are abundant in Red lake. Pickerel and pike can be obtained with a line at almost any time. Whitefish are taken by nets. Lake trout are found, and by deep fishing, fish of 40 pounds in weight have been taken. Suckers are the most abundant of all species, but are not used except for feeding dogs.

The larger game animals, moose and red deer, are numerous. During the early summer, deer may be seen feeding along grassy lake shores, and moose in the marshy bays. Woodland caribou are said to be found now and then, but none were seen during the survey of the lake. Bears are not numerous. The smaller animals are those usually found in such districts: lynx, rabbits, muskrats, mink, etc. Beavers were once fairly numerous judging from the old dams, cuttings, and houses, but they have apparently been nearly exterminated as new beaver cuttings were seen on only one of the creeks, southeast of Douglas lake. Muskrats, too, are likely to disappear completely. They are easily trapped, and the high prices paid during the last few seasons make it possible for the Indians to make sufficient for their needs by trapping muskrats, rather than those animals that require more labour and skill in the taking.

Ruffed grouse and spruce partridge are abundant, and ducks nest in large numbers in this area.

### Water Powers

All of the streams draining into Red lake are so small that the volume of water is insufficient to produce much power, even if the fall is large, as on the stream from Douglas lake.

The rapids on Chukuni river, above Red lake, have no great descent or large volume of water. Below Gullrock lake there are four falls, but none of these is important as a water-power site. In fact, the most convenient one, that just above Pakwash lake, is entirely drowned during high-water periods in the English river. Power sufficient for all purposes can be generated at Manitou falls on English river, 35 miles from Red lake.

## GENERAL GEOLOGY

The consolidated rocks of this region are all pre-Cambrian in age. They are covered in part by a mantle of unconsolidated material, consisting of glacial debris, lake silts, and vegetable remains. The pre-Cambrian complex is made up of volcanic rocks and minor thicknesses of sediments interbedded with the flows, an old intrusive, a thick sedimentary group overlying the igneous rocks, and later intrusive rocks of various types. The dominantly volcanic group will be referred to as Keewatin and the sedimentary group as Timiskaming, although, as pointed out later, the correlation is only tentative.

### Keewatin

The rocks grouped in this class differ considerably in appearance and in genesis but belong to the oldest formations in this area. As will appear from the descriptions, they are by no means all of the same age, and it is only because it is impossible accurately to determine age relations on account of severe metamorphism that these rocks are grouped together. In this ancient complex are included volcanic rocks both basic and acidic, carbonate rocks which are metamorphic in origin, a series of basic schists and semi-gneisses which have undergone such severe thermal metamorphism and granitic injection that all traces of their original textures are obliterated, and true sediments such as slaty rocks and iron formation. The continuity of the outcrops of the highly metamorphosed rocks with recognizable volcanic types justifies their grouping with the Keewatin.

#### VOLCANIC ROCKS

Volcanic rocks outcropping in the Red lake basin include nearly all the types which have been found elsewhere in Keewatin areas in Ontario. These grade in composition from rhyolites to basalts, though areally the latter are by far the most important, the acidic types being confined almost entirely to an area south of the eastern part of Red lake in Heyson township. Of the basic types, pillow and amygdaloidal lavas are typically developed. All, however, are much altered. In the following description the definite volcanic types will be dealt with first, and the less easily identified metamorphic derivatives, later.

##### Basic Lavas

Most of the basic lavas are now dense greenstones with the usual torsion cracks and irregular surface markings characteristic of these ancient flows. In most exposures, the ellipsoidal structure is not developed, nor were slaggy and scoriaceous lava tops commonly observed. Well-developed ellipsoids occur along the mainland south from the point south of island No. 137, in the bays west of the narrow channel between Mackenzie island and the west shore, along the shores of the bays north of the outlet, and on claims K. 1,483 and 1,484, and along the west side of the south end of East bay. South of Red lake, in the east bay of Flat lake, and east of Faulkenham lake, ellipsoidal markings are still evident in much altered greenstones.

A thin section from an exposure of ellipsoidal greenstones on the west side of the bay north of the Hudson's Bay Company's old post shows under the microscope only a mosaic of calcite with stringers of secondary quartz traversing the section. Ellipsoidal greenstone is cut by a porphyry mass in an exposure on the west side of East bay, one and a quarter miles from the south end. The greenstone is so fine grained that it requires a high degree of magnification to show the individual minerals in the thin section. Calcite and quartz seem to be present in large amounts; but as the grains are extremely small, the determination is not certain.

### Amygdaloidal Basalt

Large exposures of amygdaloidal basalt occur on the Coniagas claims, K. 1,529 and 1,526, and on K.R.L. 8, all south of the eastern part of Red lake. The flows strike about N. 75° E. and have a vertical dip, exposing a width or thickness of approximately 800 feet. The thickness of individual flows could not be determined on account of the overburden. The rocks are dark-green in colour and are highly altered to chlorite and carbonates, being now essentially composed of secondary quartz, chlorite, epidote, and carbonates. Rounded and pipelike amygdules are filled for the most part with carbonates, of which calcite predominates. Weathered surfaces all show a typical pitted appearance where the softer carbonates have been removed from the amygdules. Amygdaloidal lavas have also been reported on claim K. 1,522 to the west.

### Lavas of Intermediate Composition

Volcanic flows corresponding probably to andesites and dacites occur, interbedded with the more basic and more acidic types, to the south of Red lake on the Howey, McIntyre, and Dome claims. These are recognizable by their grey and black colours, which contrast with the green metabasalts. Occasional phenocrysts of quartz are visible in the more acidic dacites, and these porphyritic flows are with difficulty distinguished from fine-grained intrusive porphyries. All have been somewhat schisted and recrystallized, so that accurate determination of their original composition is now impossible.

Within the Keewatin area lying south of Red lake are several narrow bands of coarsely porphyritic andesite. Outcrops of these occur about half a mile south of Faulkenham lake. Contacts of this rock with adjacent greenstones were not visible. Their parallelism with the eastward-striking and vertically tilted flows, together with their extensive alteration, suggests a close age relation with the Keewatin.

In a hand specimen, the rock has a most striking appearance. Abundant elongated feldspars, more or less oriented in one direction, parallel to the strike of the formation, are set in a contrasting dark-green hornblendic groundmass. Under the microscope the large feldspar laths appear to be andesine. The groundmass consists almost entirely of mosaic quartz and fine fresh hornblende. In many cases the phenocrysts of andesine are almost completely surrounded by a fine mosaic of quartz and fresh albite, both of which are secondary. The interior of the feldspar is altered moderately to sericite, zoisite, and quartz. Though extensively recrystallized, the rock may still be recognized as an andesite porphyry.

### Rhyolites

Interbedded with metabasalts and infolded with them are numerous grey rhyolitic flows, which are best developed on the claims of the Victoria Syndicate, K.R.L. 1,865, 1,866, 2,362, 2,363, and 2,364. Westward these may be traced for about two miles; but west and south of Snib lake, they become so intermixed with more basic flows that no attempt has been made to map them separately.

The rhyolites present a dark grey to white surface, are extremely fine grained and hard, looking like hard grey quartzites, for which they might easily be mistaken. They occur in bands, usually fifteen to twenty feet thick. In some places they are finely banded, in others they are slightly porphyritic, with eyes of quartz showing as dark specks. On a fresh surface they vary from grey to almost black.

Under the microscope the rhyolites are wholly crystalline. Quartz in a fine mosaic pattern is by far the most prominent mineral and is interspersed with lenses of much finer quartz and probably feldspar. Feldspars in the fine groundmass are seldom recognizable, but a few larger crystals of albite occur as phenocrysts. The texture of the rocks is partly schistose. Biotite is fairly abundant and in all cases has a decided parallelism, curving around the plagioclase phenocrysts, which are themselves only partly oriented. Minor amounts of magnetite are associated with the biotite. Sericite and muscovite or bleached biotite are secondary minerals.

The following analysis shows the acid nature of these flows:—

| | Per cent. |
|---|---|
| $SiO_2$ | 76.71 |
| $Al_2O_3$ | 12.58 |
| $FeO$ | 1.56 |
| $Fe_2O_3$ | 1.14 |
| $TiO_2$ | .18 |
| $CaO$ | .33 |
| $MgO$ | trace |
| $K_2O$ | 4.22 |
| $Na_2O$ | 3.32 |
| $H_2O$ | .31 |
| | 100.33 |

(Analysis by W. K. McNeill.)

The rhyolites provide a key, almost as useful as the sedimentary rocks, for unravelling the structure of the region, and they are about the only key where the latter are absent. On claim K.R.L. 1,866, the contact of a dense grey rhyolite and a fine green metabasalt or chlorite schist is folded, showing an eastward pitch of the rhyolite up to 45 degrees. This eastward plunge of interbedded rhyolites and greenstones explains their disappearance as surface outcrops eastward, where they would also be partly cut off by post-Keewatin diorite intrusions.

In the vicinity of the Porcupine area,[1] it has been shown that the rhyolites occupy a stratigraphic position above the bulk of the greenstones. No such relation has yet been determined for the acidic flows of the Red Lake area, though the few indications of tops of flows to the south of Red lake, and the structural section across the lake in the vicinity of the Howey Gold Mines, suggest that the rhyolites here lie also above the greenstones on the south flank of an anticline pitching east. Southward, however, more basic volcanics occur in which the structure is obscure.

The rhyolitic flows are intruded by a coarsely porphyritic granite or rhyolite with abundant phenocrysts of quartz and red feldspar, by small masses of a fresh blue quartz diorite porphyry, and by the much altered older diorite.

[1]Ont. Dept. Mines, Vol. XXXV, pt. 6, 1926.

### Agglomerate and Fragmental Rocks

South of Red lake in Heyson township, many examples of fragmental rocks occur in both acidic and basic types of lavas. The former is well shown on the south line of claim K.R.L. 1,866. Here light-weathering, rounded to angular fragments of rhyolite and rhyolite porphyry occur in a dark-grey matrix. The whole is slightly schisted, and the fragments being drawn out merge with the darker groundmass. Still farther south, several small bands of fragmental rocks are found, in which both rhyolitic and basaltic or andesitic fragments are embedded in a chloritic and schistose matrix. In bulk these rocks are not important.

### Volcanic Ash Beds

Finely bedded, light-grey and green tuffaceous rocks occur interbedded with andesitic flows immediately south of the Howey ore body. These have been encountered in diamond-drilling there. A small but typical outcrop lies immediately north of the quartz diorite intrusive on claim K. 1,379 of the McIntyre. These volcanic ash beds are recognized now chiefly by their fine bedding of light-grey and green bands and by their light colours indicative of an original acidic composition. They have been extensively altered and are composed almost entirely of secondary minerals such as sericite, chlorite, quartz, and carbonates.

## IRON FORMATION

Typical banded iron formation occurs with the greenstone at several places. The iron formation itself is of very slight importance, but some of the exposures have been shown on the map in order to indicate the structure of the Keewatin complex. A band of interbedded silica and magnetite was found inland, south of Pipestone bay, and another northeast of the east end of Douglas lake. Small exposures occur along the south shore of Trout bay. A fairly large band of iron formation crosses East narrows, but it is intruded and broken up by a huge porphyry dike, so that no extension of it southwest was seen, although there is strong local attraction along the shore in that direction which may be due to inclusions of the iron formation in the porphyry.

On a small point at the east end of Snib lake, a narrow band of white and black, thinly bedded iron formation lies immediately to the south of what appears to be a basic fragmental and partly amygdaloidal basalt, which grades northward into more massive basalt. To the south of the iron formation and truncating some of the iron formation bands is massive medium-grained basalt. This relationship strongly suggests that the iron formation lies on the top of the basalt to the north and that the beds dip steeply south.

Other zones of highly siliceous, pyritiferous rocks with no marked bedding planes have been included as iron formation, although they are not of the typical variety. One lies inland about along the strike of the band just mentioned at East narrows. Another highly siliceous zone occurs on the mainland east of Mackenzie island. Well-banded, magnetite-bearing beds form the east shore of the channel for some distance east of Mackenzie island. These have been classed as iron formation, rather than with the later sediments, because they are associated with the siliceous band mentioned above and contain magnetite, which is not found abundantly in the later sediments.

East of Balmer (Jackfish) lake, large bands of iron formation outcrop on claims K.R.L. 955 and 956 and extend eastward. Southeast of Balmer lake, the exposures shown as sediments of Timiskaming age on map No. 33*e* are now placed with the iron formation.

North of Wolf narrows, a band of conglomerate is, in places, in contact with much contorted iron formation, and the abundant fragments of the latter included in the sediments give them an extremely rusty surface.

### METAMORPHIC DERIVATIVES OF VOLCANIC ROCKS

Practically all of the basic volcanic rocks as mentioned above are now metamorphosed. Most common among these are the massive greenstones, which vary in character from place to place but are similar in being composed of secondary minerals, chiefly chlorite and minor amounts of serpentine, amphibole, or carbonates. These in many places retain original structures, such as ellipsoidal markings, and are easily recognized as basic volcanics. There are, however, other more severely altered rocks, the origin of which is less clear. These occupy relatively large areas and include rocks composed dominantly of


Fig. 1—Serpentine showing some calcite.
(Crossed nicols × 13.)
S = Serpentine. C = Carbonates.
Q = Quartz.

serpentine, carbonates, or mixtures of the two, and they seem to be the result of deep-seated hydrothermal alterations. Another group, consisting chiefly of amphibole rocks, hornblende and biotite schists and gneisses, seems the product rather of thermal and contact metamorphism, accompanied to some extent by granitic *lit par lit* injection. These owe their present textures and in part their composition to the widespread granitic intrusions of the area.

#### Serpentinous Rocks

Serpentine is found in many of the altered greenstones, but in some it forms the main mass of the rock. A description of some of the more important of these dominantly serpentinous rocks will indicate their character. A sample from an exposure on the mainland east of Mackenzie island consists entirely of light-green serpentine, and the original rock was evidently made up of only one mineral, possibly hornblende or pyroxene. Ellipsoids are developed on the weathered surface only a few chains south of this exposure and, with the exception of the ellipsoidal markings, the rocks are similar in appearance. Along the east shore of East bay, the rocks are foliated. The most abundant type is greenish and purplish, or a mixture of green and purple grains. A series of sections from specimens along this shore show under the microscope variations from rock consisting of nothing but sheaves of serpentine to a variety containing about 50 per cent. serpentine and the rest calcite and mosaics of quartz lying between the fibres of serpentine or appearing as irregular areas in which the serpentine sheaves are included. A specimen from the west shore north of the narrows has the same texture, but the dark mineral in it is actinolite, showing pleochroism from green to yellowish-green to blue. Possibly it represents an intermediate stage in the alteration of the volcanic rock, whereas the rocks previously described have undergone further alteration of the actinolite to serpentine. The proximity of igneous intrusions may have had an influence in the production of actinolite. Similar actinolite and serpentine rocks occur at other places.

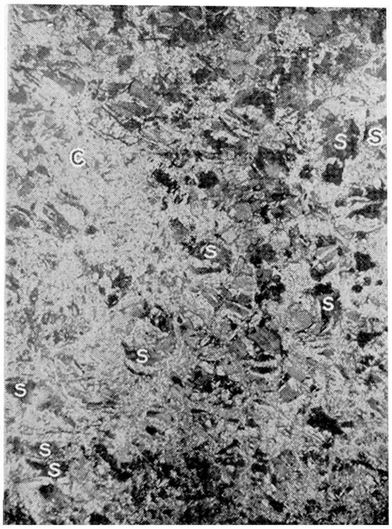



Fig. 2—Serpentine remnants in carbonates.
(Crossed nicols X 13.)
S = Serpentine. C = Carbonates.

Among the smaller islands southwest of Mackenzie island, the rocks are extremely schistose, the schists being grey or green. In the field, the grey schists were thought to be sericitic. A greyish massive rock was taken as an unfoliated representation of the grey schists. Under the microscope, it is found to consist of serpentine fibres and some carbonate. It seems likely, therefore, that the schists are high in carbonates and have resulted from the metamorphism of massive lavas, first altered to aggregates of serpentine and carbonates and later further changed into schists. Rocks consisting chiefly of talc occur at the narrows just south of Pipestone bay.

Massive serpentinous rocks, in some of which stringers of asbestos have formed, lie between Trout bay and Pipestone bay. The serpentine fibres are small and have a closely felted texture. A serpentine of somewhat different character was found along the shore southwest of island No. 228. Under the microscope, it is found to consist of polygonal areas of serpentine with tiny fibres arranged normal to the polygonal boundaries or to cracks (Fig. 1). Surrounding and separating the polygonal forms are narrow zones consisting of quartz, which has a peculiar fibrous structure transverse to the stringers. Some of the serpentine areas have roughly the outlines of blocky hornblende crystals, and it may be that the original rock was a hornblendite now altered to serpentine and that during the alteration silica was set free and migrated outward to the margins of the crystals of hornblende and was deposited in the intercrystal spaces. Carbonate is abundant, and there seems to be a gradation from rocks of this type to those consisting chiefly of carbonates.

### Carbonate Rocks

The carbonate rocks differ from the greenstones in appearance. They are rusty-weathering, greyish to buff rocks, many of which are sufficiently coarse in crystallization to show the cleavage planes of the carbonates. The surface in places retains the peculiar surface markings of the greenstones, and the space relations of high carbonate rocks and of greenstone show that one is derived from the other. Specimens to illustrate a gradation between the two were collected along the shore southwest of island No. 228. The serpentinous facies of the series is that described and illustrated above. The photomicrographs, Figs. 1 and 2, show stages in the alteration. Analyses of three samples have been made in order to trace the quantitative changes that may have taken place:—

| | No. 1 | No. 2 | No. 3 |
|---|---|---|---|
| | per cent. | per cent. | per cent. |
| $SiO_2$ | 56.6 | 44.1 | 52.1 |
| FeO | 5.2 | 5.4 | 4.5 |
| $Fe_2O_3$ | 4.4 | .5 | 3.7 |
| $Al_2O_3$ | 4.6 | 12.1 | 4.2 |
| CaO | 9.6 | 2.6 | 1.0 |
| Mgo | 7.6 | 14.1 | 14.2 |
| $H_2O$ | 5.4 | 6.5 | 3.9 |
| Loss on ignition, $H_2O$ deducted | 6.3 | 12.8 | 16.5 |
| Total | 99.7 | 98.1 | 100.1 |

Analyst—W. Davis.

Specimen No. 1 was a typical greenstone with no apparent alteration to carbonate. In No. 2, carbonate could be recognized in the hand specimen, and in No. 3 the rock seemed to be chiefly carbonate. In the analyses, water was determined directly and was subtracted from the total loss on ignition; the difference is assumed to be chiefly $CO_2$, since other gases that might be present would be in proportions too small to affect the calculations and, in any case, would be compensated to some extent by a slight oxidation of the ferrous oxides.

The following are recast analyses:—

| No. 1 | | No. 2 | | | No. 3 | | |
|---|---|---|---|---|---|---|---|
| | per cent. | | | per cent. | | | per cent. |
| Quartz | 41.10 | Quartz | | 23.16 | Quartz | | 46.44 |
| Serpentine | 12.93 | Serpentine | | 15.61 | Serpentine | | 1.70 |
| Calcite | 14.30 | Calcite | 4.62 | 28.26 | Calcite | 1.80 | 27.12 |
| Magnetite | 5.10 | Siderite | 8.35 | | Siderite | 5.92 | |
| Kaolin | 2.58 | Magnesite | | 15.29 | Magnesite | 19.40 | |
| Epidote | 9.19 | Magnetite | | .70 | Hydromagnesite | | 9.10 |
| Chlorite | 13.68 | Kaolin | | 30.44 | Magnetite | | 2.55 |
| Uncombined water | 1.65 | | | | Kaolin | | 10.55 |
| | | | | | Limonite | | 2.24 |
| Total | 99.53 | Total | | 98.17 | Total | | 99.73 |

Epidote calculated to a formula, $16CaO\ 9Al_2O_3\ 3Fe_2O_3\ 24SiO_2+4H_2O$
Chlorite calculated to a formula, $5MgO\ 5FeO\ 2Al_2O_3\ 6SiO_2+8H_2O$.

The recast compositions correspond fairly closely with the mode of the rocks except that hydromagnesite was not definitely recognized microscopically. The considerable difference in the quantity of quartz in No. 2 compared with No. 1 probably does not mean an actual loss of quartz during metamorphism. In No. 2 there has been a considerable addition of $CO_2$ from some source, so the proportion of quartz will be less. The increase again in No. 3 can be accounted for by the change of a large part of the kaolin to some other form, thus setting free part of its silica. A significant feature of the three compositions is the continuous change in the composition of the carbonate from a high calcium content to a high magnesium content. This may represent a continuous addition of magnesium and iron to the carbonates, due to the breaking down of the serpentine and chlorite rather than to any actual removal of calcium from the rock.

A comparison of analysis No. 3 with that of a rock that has undergone ordinary weathering shows marked differences. Surface alteration results in losses of constituents, such as the compounds of magnesium and calcium, with magnesium showing greater losses than calcium. In this case the losses are reversed. In weathering, alumina remains almost constant. In this alteration, alumina has apparently decreased. It is certain, too, that the carbonate in the greenstones, as shown by analysis No. 1, is not the product of surface carbonatization of the original lavas, since all greenstones have varying quantities of carbonate, a proportion quite independent of their depth below the surface. Furthermore, in the case of thick flows, there is no regular variation in the degree of carbonatization in various parts, which would be the case if the alteration to carbonate immediately followed extrusion and preceded the covering of one flow by the succeeding one.

Carbonate rocks are commonly found as marginal zones where quartz porphyry and granitic intrusions cut greenstone. In this relationship, the rock in contact with porphyry may be completely carbonatized, and only at some distance from the intrusive will typical greenstone be found. Where carbonate rocks occur with no porphyry actually in contact with them, it can be explained by carbonatization in greenstone immediately above unexposed porphyry masses. This relationship can be demonstrated where the tips of porphyry tongues are separated by a carbonate band. An excellent example of this is shown by the porphyry tongues north of Trout bay. Evidently then, if the porphyry causes the alteration of greenstone to carbonates, that process must be a deep-seated and not a surface one.

About Russet lake, highly carbonated and serpentinized rocks are abundant. These are similar to those described above. They retain in a few places ellipsoidal markings. The proximity of a large mass of medium-grained granite to the west of this lake, and the marked decrease in alteration of the Keewatin rocks eastward, away from the granite contact, also points to the deep-seated character of the alteration.

The volume relations of the greenstone and its carbonate derivative are of some economic importance. In most localities where such rocks have been studied, they are found to be traversed by a large number of quartz veins of varying sizes. In discussing the dolomite zones of Larder lake, where similar relationships to igneous intrusives occur and where gold has been found, Cooke[1] concludes that after the primary dolomitization of the schistose country rock by deposition of ankerite in the cleavage planes, fissuring took place, probably in relief of pressure set up by increase in volume consequent on the addition of so much carbonate.

[1]H. C. Cooke, Geol. Surv. Can., Mem. No. 131, p. 53.

It seems hardly possible that increase of volume could have opened up fissures now occupied by the quartz veins. Under the conditions of deep-seated metamorphism that have been assumed, it seems doubtful if any increase of volume would be possible. It is probable that the volume remained fairly constant during metamorphism and that during the cooling of the intrusive rocks there were reactions between the minerals of the greenstone and the vapours being exhaled from the cooling quartz porphyry. To the greenstone would be added carbon dioxide and water from the igneous mass, producing carbonates and kaolin. Meantime, there would be the absorption by the porphyry of alumina and iron. This hypothesis is borne out by the fact that plagioclase phenocrysts are more abundant near contacts. As a further indication of the probability of the constancy of volume, it will be seen that by taking the specific gravity of the calculated minerals in analyses Nos. 1 and 3, a given weight of greenstone will have 1.01 times the volume of the same weight of carbonate rock, a difference so slight as to be negligible, but on the side of diminution, rather than increase, of volume by metamorphism.

Rather, then, than fracturing due to increase of volume, it is likely that the fracturing was considerably later than the metamorphism and due to mechanical deformation, perhaps at the time of the granite invasion. There would be increase of volume at this period, but this would be quite independent of the changes taking place during metamorphism.[1]

### Amphibole Rocks, Hornblende and Biotite Schists and Gneisses

Occurring in two separate elongated bands south of Red lake are schistose and very fine grained gneissic rocks, all of which are characterized by the presence of abundant hornblende and biotite. The smaller of these bands lies south of the Douglas lake granite and lenses out, disappearing into the granite to the west and south. The larger band forms a continuous belt, striking east for 20 miles from a short distance northwest of Medicine-stone lake.

That these dark, partly schistose and partly gneissic rocks are the highly metamorphosed equivalents of Keewatin and possible of some Timiskaming sediments, which have been wholly recrystallized by the thermal and contact effects of the engulfing granitic intrusions, is shown by their continuity with less altered phases of these rocks and by their prevailing basic composition. They present a most varied and interesting study of thermal and contact metamorphism, a detailed discussion of which will not be attempted here.

In the immediate vicinity of the granitic intrusions, particularly where the bands of basic rocks are narrow as at Hatchet lake, coarse-grained amphibole rocks are developed. These are usually black and contain, besides the large amphiboles, hornblende crystals as long as half an inch, and minor quantities of epidote, quartz, and secondary albite. Their texture is more igneous than schistose, but it seems clear from their gradation to finer greenstones away from the contacts, and their gradual transition into hornblendic granite, that they are the contact metamorphic equivalents of basic Keewatin rocks.

To the south of Faulkenham lake, the basic rocks bordering the granite intrusions are more typically hornblende schists and gneisses. Narrow bands of hornblende schist occur as lenses in the granitic rocks on the south shore of the lake. The size and continuity of the schists increase a short distance to the south, but on the whole this type of border is more characteristic of the granitic rocks lying south of the basic schists than of those to the north.

[1]W. Mead, Jour. Geol., Vol. 33, 1925, p. 685.

Sections made across the 20-mile tongue of basic schists and gneisses bring one constantly on rocks of slightly different colour, grain, and composition. All members of the series, however, are composed essentially of quartz, feldspars of varying composition, hornblende, biotite, magnetite, epidote, and titanite. Some are quite massive, others are finely banded. While the terms "schist" and "gneiss" denote the true textures, the abundance in many of non-platy minerals accompanies their lack of well-defined schistosity. Many of the gneisses might more properly be referred to as micro-gneisses on account of the fineness of their banding. All gradations between the latter and the rather massive schists may be found.

A peculiar greenish-grey rock on fresh fracture shows a definite parallel orientation of the minerals. Porphyroblasts of hornblende, also oriented, stand out like basic fragments in a schistose greywacké.

Microscopic examination of these rocks reveals their similarity. Quartz is arranged in a fine mosaic as, often, is albite. Hornblende, which may or may not be segregated in fine bands, varies in quantity from place to place. Epidote is occasionally present with the hornblende. Titanite appears as clusters in some, with magnetite or ilmenite, and many specimens have rather abundant small magnetite crystals distributed throughout. In a few cases, large basaltic hornblende crystals have been developed without any marked orientation. Their freshness suggests a secondary origin.

Interbanded with the dominant amphibole schists are a few biotite and hornblende-biotite schists. In these the biotite occurs as fine fresh flakes with a parallel arrangement. All the other minerals common to the hornblende schists are also present, as well as a few partly sericitized feldspars.

Toward the southern margin of the eastward-trending band of the metamorphic rocks, finely banded gneisses become more abundant. These are predominantly dark in colour and have alternating dark and light bands, a tenth of an inch or less in thickness. The dark bands consist chiefly of fine basaltic hornblende, epidote, chlorite, and minor amounts of fresh mosaic quartz and albite or andesine-oligoclase. In the lighter bands quartz predominates and feldspars are more abundant, consisting of microcline, orthoclase, and albite. Some highly sericitized feldspars are also present. Many of these rocks undoubtedly represent basic Keewatin schists, into the folia of which acidic constituents have been injected. Others may represent only recrystallized basic rocks in which the more acid constituents have been segregated into bands.

A narrow band of greenish rock lying between quartz porphyry intrusions along the west side of Pipestone bay is made up of fibrous actinolite with mosaics of quartz lying between the fibres. Along the northwest side of Slate bay, near the intrusion of granite porphyry, the greenstone consists of radiating fibres of actinolite.

The changes which have taken place in these basic rocks have apparently been accomplished largely by recrystallization, accompanied by certain gains and losses of constituents, determination of which has not been made. The agency bringing them about can only be referred to the heat and pressure attendant on the adjoining granitic intrusions. The almost complete absence of fissile schists suggests that shearing stresses were not sufficient to produce much differential movement, but that these stresses were present is indicated by the orientation of all the platy minerals.

Near the south shore of Medicine-stone lake, where the southern boundary of the metamorphics has been drawn, granitic and porphyritic dikes are abundant; and locally to the east, veritable networks of granitic and pegmatitic stringers have soaked through the schists and gneisses. The gneisses pass southward from the basic types described above to more acidic types, mapped originally by Dowling as Laurentian gneiss and interpreted by him as probably highly altered schists.[1] The prevailing granitic composition of these has led to their classifica-

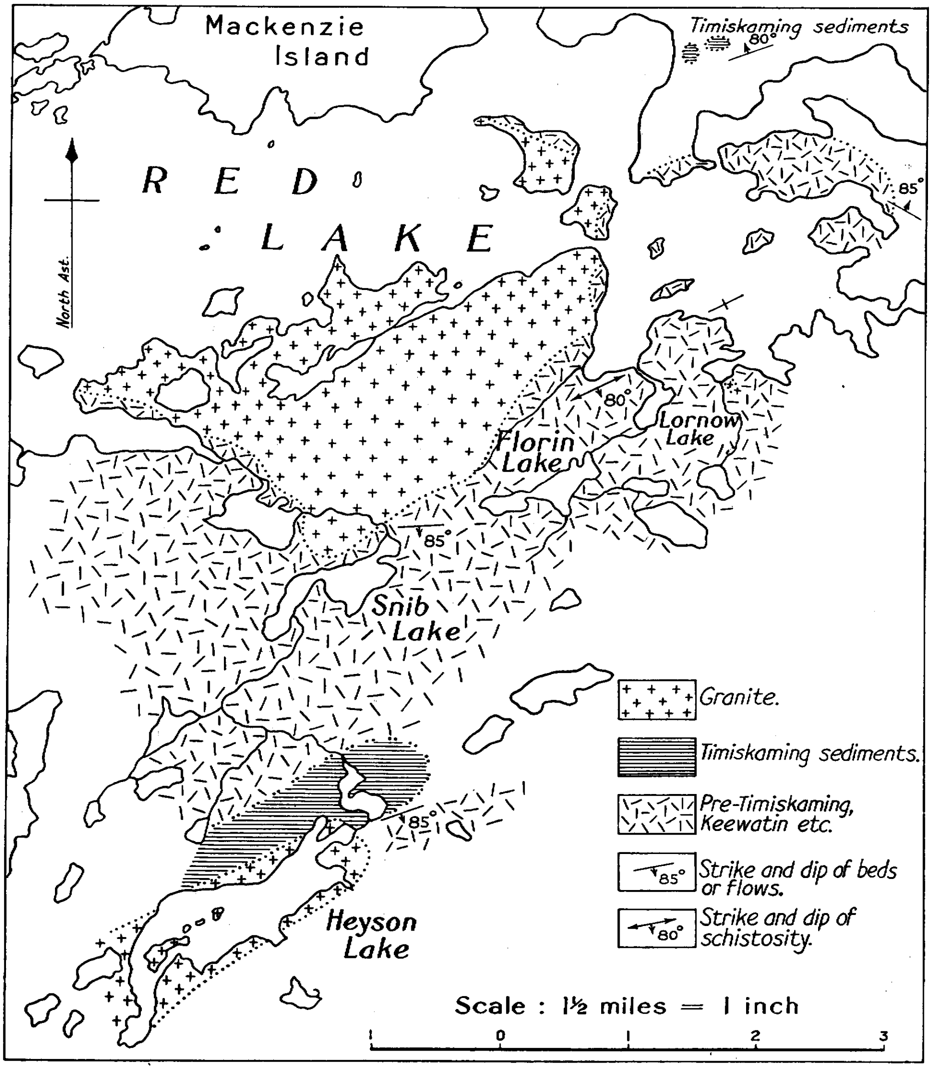



Fig. 3—Sketch showing the structure of the southeast part of Red lake as suggested by flow tops and sediments.

tion with the granites. Most of them are penetrated by numerous pure granite and pegmatite stringers and are obviously in part older than the granite, originating, as Dowling surmised, by the more complete alteration and injection of basic schists followed by dike intrusions as the granitic batholith ascended. An interesting relationship of this same kind exists between the basic schists of Hatchet lake and granitic gneisses lying along the same strike to the west.

[1]D. B. Dowling, Geol. Surv. Can., Vol. VII, pt. F, 1894, p. 40.

### STRUCTURE OF THE KEEWATIN ROCKS

The structure of the Keewatin rocks in the Red Lake area is not readily discernible from these rocks themselves except, as has been mentioned above, where rhyolites and iron formation are present. Flow tops, such as occur in the Keewatin of the Porcupine area, are seldom evident, the metamorphism of the rocks having quite obliterated them in most cases.

A few instances of flow tops have been observed in the eastern part of the area, on the McIntyre claims and at the east end of Snib lake. At the latter point the flows dip steeply south, an anticline lying somewhere to the north. On the Noranda claims, K. 1,479 to 1,486, north of the outlet of the lake, trenches expose massive to schisted pillow lavas, striking N. 115° E. In several places suggestions of fragmental tops may be discerned in these, all of which occur on the north of the beds, indicating a syncline to the north and an anticline to the south. The southerly trend of the strike here may indicate that this horizon is near the nose of an anticline plunging eastward. If this structure is traced back to the west, along the regional strike of N. 65°-70° E., it becomes apparent that an anticline lies between this horizon and the one on Snib lake, the crest of which may fall near the south shore of Red lake.

Indications of the structure as revealed by the rhyolites show a decided easterly plunge to the isoclinal folds. The easterly extension of the folds appears to be cut off entirely by granites and granitic gneisses.[1]

## Post-Volcanic Diorites

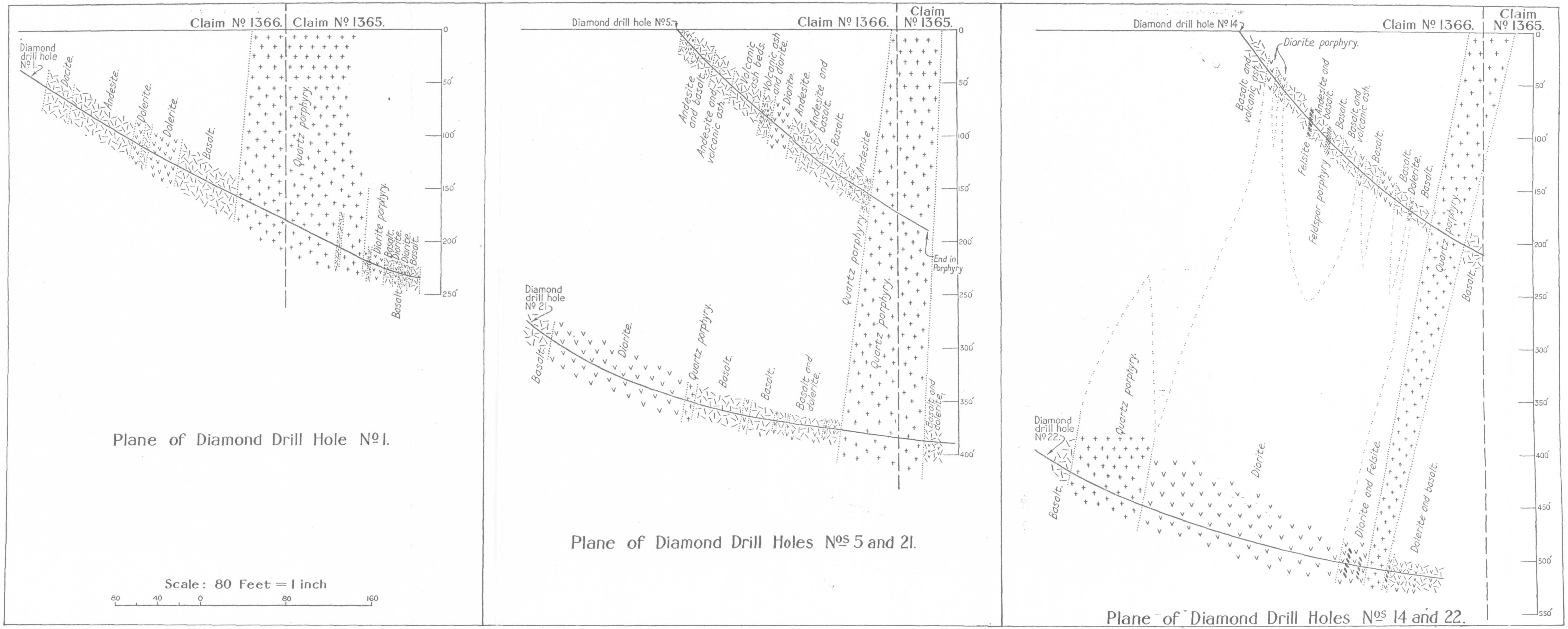
The rocky, burned country along the south shore of Red lake, west and south of the outlet, is in part occupied by a light-green-weathering, medium-grained diorite, which is clearly intrusive into the Keewatin volcanics, interrupting the latter along their strike and differing from them chiefly in being more massive and of coarser texture. In all cases the diorites are rather highly altered, though to a lesser degree than the Keewatin volcanics. In places they are somewhat schisted and have evidently undergone considerable shearing.

On the Howey, Nipissing, Coniagas, and Lang claims, as well as on the south boundary of Balmer township, the diorites are composed chiefly of feldspar with lesser amounts of ferromagnesian minerals, all of which have been altered to secondary minerals. To the west, on the Huronian Belt claims south of Coin lake, hornblende is a very abundant constituent. Thin sections of the diorite from several eastern localities show the presence of primary feldspars, ranging in composition from albite to andesine, and secondary minerals, sericite, zoisite, epidote, quartz, and varying amounts of carbonates, as well as some rutile, possibly residual from biotite, and titanite (Fig. 4). The quartz which is evident in a few hand specimens appears to be largely secondary, though some primary quartz may also be present. To the west the diorites have a darker-green appearance, due to the abundant hornblende with which are associated andesine feldspars and more titanite and ilmenite. Locally, fine feldspar laths are embedded in hornblende, but the rock as a whole lacks any marked ophitic texture. Zoisite, epidote, and chlorite are abundant alteration products of the hornblende and are sometimes mixed with the secondary sericite of the feldspars.

The diorite intrusives appear in some places to be dikes; in others, rounded bosses. Where of dike form they parallel more or less the strike of the volcanics. Their intrusive nature in the greenstones is excellently revealed in diamond-drill cores obtained south of the Howey ore body. Contacts of the two show the diorite

[1]D. B. Dowling, op. cit., map No. 576.

Insert to face page 18.




Vertical sections of quartz porphyry ore bodies, Howey Red Lake Gold Mines.

penetrating in fine tongues between the schist *laminae*. On the Howey claims at about the 500-foot level, a diorite dike, 200 feet wide, cuts the greenstones and is represented at the surface and to a depth of 150 feet by several narrow dikes (see insert facing page 18). This vertical change is characteristic of an ascending intrusive and suggests that the diorite intruded the volcanics after they had been folded to an almost vertical position, rather than as a sill while the flows were still more or less horizontal. The interruption of the greenstones by the rounded bodies of diorite suggests a similar conclusion, though the local schisting of the narrower bodies of diorite points to the fact that some folding took place after their intrusion.

So far none of these altered dioritic rocks have been found in contact with Timiskaming sediments. Their highly altered condition suggests a pre-Timiskaming age. Fresh hornblende diorite, however, has been found cutting sedimen-

Fig. 4—Diorite. (Crossed nicols × 15.)

tary rocks near Faulkenham lake, but this differs so in degree of alteration and is so close to the post-Timiskaming granitic intrusions that it has been interpreted as probably a differentiate from the younger granitic magma.

The age, then, of the older diorite intrusives must be left indefinite. If they are pre-Timiskaming, it would seem that an early period of folding took place in the Keewatin, followed by dioritic intrusions, and that the Timiskaming sediments were later laid down. No such great unconformity between the Timiskaming and Keewatin as this theory would require has yet been found in this area, although as shown below there is reason to suppose some unconformity does exist.

## Timiskaming Sediments

### Distribution and General Character

The sediments that have been grouped as Timiskaming in age lie in three main bands and a few other smaller bands whose structural relationships have not been worked out. One main band extends along the northwest side of Mackenzie island and across the islands west of it and terminates west of Wolf narrows against the granite batholith at island No. 191. A large band lies north of the lake. At the west end it is cut off by the granite a short distance northeast of Pipestone bay. It extends across the south end of Slate bay, but its position northeastward is doubtful, due to the concealment of the consolidated formations beneath the glacial and post-glacial sands and clays. Sediments occur along the shores of a lake northwest of the Hudson's Bay Company's post, and a belt of sediments extends from the bay just north of the post northwestward across the peninsula and appears again on island No. 91, on the hook-shaped point beyond it, and still farther along on the northern mainland, where it disappears entirely beneath the overburden. Neither of these two latter belts is exactly in line with the main belt that crosses Slate bay. The types of rocks in this sedimentary series are conglomerate, greywacké, quartzite, and slate. No individual bed can be traced for any great distance, and in most cases the bedding is so indistinct that it is difficult to determine the dip and strike. The conglomerate beds are the most easily recognizable, but they are not continuous: Sections made inland only short distances apart may show conglomerate beds in one and none in adjacent traverses, in the positions where they might be expected to occur.

A narrow band of sedimentary rocks occurs also to the north of Faulkenham lake, south of Red lake. These disappear a short distance to the east, and west of Faulkenham lake are terminated by the large granite batholith. The sediments are chiefly impure quartzites, greywacké, and narrow slate lenses. No conglomerates seem to be present. The sediments are intruded on the south by granite and granite porphyry and, on the small lake northeast of Faulkenham lake, by narrow dikes of hornblende diabase.

### Slate

Slate is well developed on some of the islands north of Mackenzie island, and the prominent exposures at the entrance to Slate bay give this arm of the lake its name. Ordinarily, the rock is soft and black with eminent fissility. Occasionally it is massive and more properly termed an argillite. Some of the slates are grey, but these are not common. Bedding is not well marked and in most exposures is so obscure that it cannot be recognized at all. The well-marked slaty cleavage and the bedding seem to be nearly parallel in most places, and the cleavage obscures the bedding planes. Under the microscope, the slates show a very fine texture with much material that is nearly opaque and quartz in grains, which are usually angular. In some specimens, the black material has begun to segregate into knots, evidently the beginning of the development of secondary phenocrysts. The determination of the opaque constituents and the cause of the black colour is impossible, but the material is probably clayey in character, with some carbonaceous colouring matter. The thickness of slate must be great; but in the absence of well-marked bedding, no estimate can be given. No doubt the thickness appears much greater than it actually is, on account of minor foldings and crumplings which cannot be definitely recognized.

### Greywacké

Greywacké occurs with slate along the north side of Mackenzie island and on the smaller islands near it. Inland, through its greater resistance to erosion, greywacké is much more abundantly exposed than slate. It shows all gradations from slate to conglomerate, from fine-grained, dark-grey rocks, with tiny bits of quartz showing in the hand specimen, to light-grey, granular rocks with abundant quartz and feldspar recognizable. A specimen from one of the small islands west of Mackenzie island has the characteristic greyish, granular appearance in the hand specimen and under the microscope is found to consist of angular to sub-angular fragments of quartz and feldspar set in a fine-grained matrix of the same minerals (Fig. 5). Some of the quartz porphyries, as mentioned later, have very much the same appearance, especially where sheared, but they have a much smaller proportion of quartz fragments.

The matrix of the greywacké when fine is dark-grey owing to the opacity of the constituents. In specimens with coarser matrix, the colour of the rock is much lighter; and these varieties are properly arkose.

Some of the greywackés are very massive and show no distinct bedding planes, especially inland where the surfaces are to some extent protected. In places, however, bedding is well marked, and these rocks afford the chief means of unravelling the structures of the sedimentary group. Alternating beds of light and dark grey greywacké have been well exposed by the burning of the forest near the west extremity of Mackenzie island. Well-banded and somewhat thicker beds outcrop on the east side of Mackenzie island near the narrow passage between that island and the mainland.

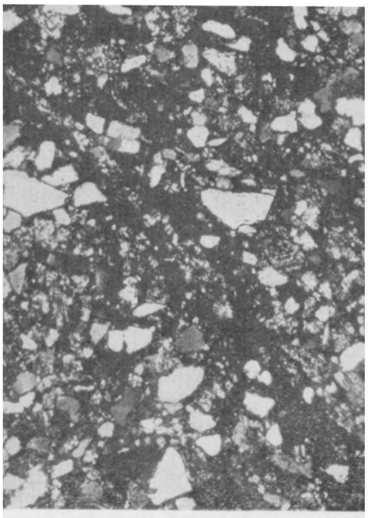


Fig. 5—Greywacké. Light-coloured fragments are mostly quartz. (Crossed nicols X 13.)

Shearing of beds of greywacké or arkose has produced foliated rocks consisting of quartz and sericite. These were fine grained originally, and the shearing action has apparently further fractured some of the grains, so that the resultant schist may be very fine grained with only quartz and sericite recognizable. Quartz porphyry subjected to the same dynamic metamorphism develops a rather similar schistose rock, as the porphyry has essentially the same mineral constitution as many of the sediments have (Fig. 6).

**Impure Quartzite or Arkose**

Impure quartzite or arkose has been found in a number of localities. Some of these rocks are very similar to the greywackés, differing chiefly in the colour of the constituent minerals. Some, however, have been found in localities where sediments belonging to the Timiskaming series do not occur and may be quartz porphyry with an exceptional proportion of quartz. They may, however, be fragments of the sedimentary group caught up by the porphyry.

Remarkable rocks occur on island No. 191 where the sediments are cut off by the granite batholith. They are well banded in places, but the bands are very much contorted and the layers are of unequal hardness. Along the lake shore the action of the waves has etched the surface, so that the softer layers are cut in as much as an inch below the hard ones. The resistant layers are not continuous, but consist of nodules of hard quartzose material standing out above the softer material but still in a stratiform arrangement and evidently once parts of hard beds which the crumpling has broken up. The microscope shows that the soft beds are made up chiefly of carbonates with some introduced quartz

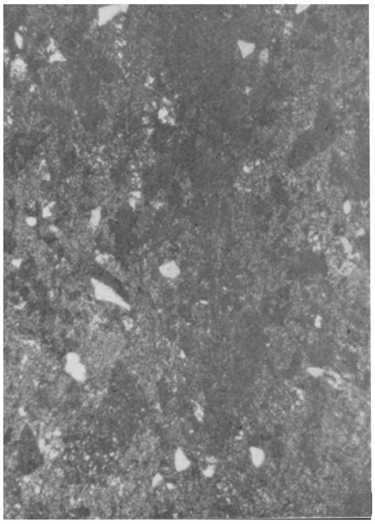


Fig. 6—Fractured quartz porphyry. Light-coloured fragments are quartz. (Crossed nicols X 13.)

and with enough rounded quartz grains to indicate that even the soft beds were impure quartzites originally. Other rocks on the same island have a very marked bedding, beds being as much as four feet in thickness separated by lighter-coloured layers, a quarter of an inch to one inch thick. Still a third variety is a massive purplish rock with biotite visible in the hand specimen. Under the microscope biotite is found to be plentiful, and the only other mineral is quartz in a closely interlocking mosaic. This rock has probably been formed by the contact action of the granite intrusion on the sediments, and the contorted quartz-carbonate rock mentioned above may also be, in part, a product of action of the intrusion.

The sediments lying north of Faulkenham lake contain many bands whose nature suggests an impure quartzite origin. These are brownish and very fine grained. Shearing and some recrystallization have in large part altered the rocks beyond recognition, but their dominant quartzose composition and occasional rounded feldspars serve as a means of identification. Thin sections show, besides the recrystallized mosaic quartz, small amounts of biotite, chlorite, zoisite, and locally secondary fresh albite. In one the quartz grains have a yellow stain around the edges, typical of recrystallized iron-stained sands.

Fine slaty bands separating the quartzose rocks serve as a means of determining the attitude of the sediments.

### Conglomerate

Conglomerate is not abundantly exposed along the lake shores; but inland across the northern band of sediments, many thick beds of conglomerate occur. Beds of conglomerate cross the entrance of Slate bay at the north side of the smaller bay that lies between Slate bay and the main lake. These beds are nearly vertical and strike N. 65° E. The section exposed is as follows, from southeast to northwest:—

| | |
|---|---|
| Conglomerate | 5 feet |
| Sandy arkose | 1 foot |
| Conglomerate | 4 feet |
| Arkose | 4 inches |
| Conglomerate | 2 feet |
| Arkose and quartzite | 4 feet |

The pebbles are of various sizes, the largest being four inches in diameter, and are ellipsoidal with the longer axes parallel to the bedding. The variety of pebbles is considerable, including granite porphyry, quartz, and some dark, greenstone-like varieties. No band that could be considered the continuation of this was found to the southwest; but in some of the inland sections northward from points southwest of the entrance to Slate bay, other conglomerate bands were seen. In all of these, granite or granite porphyry pebbles are abundant. A pebble from the Slate bay bed was examined microscopically and proved to be a typical but somewhat altered granite. Since all of the granitic rocks found in place are later than the sediments, the pebbles must have come from an older formation not yet recognized in this area, one entirely destroyed by later intrusions, or else from some older granite not represented here.

Conglomerate occurs with greywacké along the shore north of island No. 294. The pebbles are comparatively small, all being less than an inch in diameter. The matrix is dark grey. There are other occurrences along the south shore of the long bay north of Wolf narrows in which the pebbles are of well-banded, jaspery iron formation, and the matrix is heavily pyritized. Dowling describes this bed as follows:—

> In a bay just north of Wolf narrows, a band having the appearance of a conglomerate is found with occasional pebbles of red-banded jasper and others of light-yellowish quartzite, but the majority of the pebbles are of a dark purplish-grey to green with a matrix of the same colour. The thickness of the band is about ten feet, and the associated rock is of a greenish to grey colour in rather thin beds.[1]

In some trenches that have been dug across the southern part of the conglomeratic rocks, the conglomerate is seen to be composed of large subangular masses of iron formation with a small amount of iron-stained matrix between the fragments. The conglomerate is in contact with solid contorted iron formation. This explains the very rusty appearance of a large part of the outcrop.

These rocks are believed to be true conglomerates, but rocks very similar in appearance at East narrows have been formed by a quartz porphyry dike intruding a band of iron formation, the dike itself carrying fragments of the intruded rock. A rock of conglomeratic appearance occurs with the sediments on

[1]Op. cit., p. 47.

island No. 191. The fragments are packed closely together, so that there is very little matrix. Many of the pebbles are of greenstone, but the presence of some chert and quartz indicates that the rock is a true conglomerate, rather than a shear breccia as it at first appears to be.

#### Origin of Sedimentary Group

An hypothesis to explain the origin of this group of sediments must consider the following characteristics: All of the beds are lenticular; this is especially well shown by the strong conglomeratic layers. All of the beds are fragmental, although of varying degrees of fineness, from coarse boulder conglomerates to fine-grained slates. The great mass of greywacké is not well sorted, the minerals are not rounded, nor were they much decomposed before being enclosed in the present rock. Hence the removal of rock waste during the formation of the greywacké was largely mechanical, rather than chemical, and the material was not carried far. All of these facts are explained if it be supposed that the material was carried down from a high and recently elevated land mass by rapid rivers and was deposited as an outwash fan or delta.

#### Structure of Sediments

The determination of the structure of the area is complicated by the lenticular character of all of the beds and the lack of distinct bedding in most of them. In addition, igneous intrusions have disturbed, metamorphosed, and engulfed considerable parts of the older rocks. The deep covering of unconsolidated material which almost completely hides the pre-Cambrian rocks in the eastern part of the map-sheet is a still further handicap to a satisfactory interpretation.

All the older rocks are tilted to nearly vertical positions, and thus there is no possibility of using superposition in determining the top and bottom of the formations. There are three possible hypotheses: The two main belts of sediments may be actually two separate sedimentary horizons in a continuous succession; they may be the two limbs of a syncline; or they may have an anticlinal relation to the narrow belt of greenstone between them. Either of the latter two hypotheses would require, in beds which have persistent lateral characters, a symmetrical arrangement of rock types on either side of the axis. In these sediments, however, the lateral variation of the beds makes it impossible to rely on any such criterion. Few actual contacts of sediments and older rocks were observed, and the nearly vertical attitude made these of little value. Drag folds, which in many such cases serve to solve the major structures, fail on account of the indistinct bedding. The simplest hypothesis would be to consider all the sediments as of one age, either underlying the volcanics or overlying them. The latter is believed to be the correct solution and is based on the following evidence: Sedimentary beds can be traced along the north side of Mackenzie island almost continuously, although much disturbed by igneous intrusions; the northernmost band of greywacké cuts across the narrow neck of the island at the north, so that the northern peninsula consists of greenstone; the sedimentary beds continue eastward to island No. 36, where they curve southward with a dip to the west, and this is taken to be the axis of a synclinal trough plunging westward; the whole central part of the trough is occupied by the quartz porphyry and granite of Mackenzie island.

In the northern belt, sediments were found at the north end of Slate bay lying on greenstone in such relations that they are undoubtedly stratigraphically above the greenstone. It seems, therefore, reasonable to assume that these sediments are also synclinal and that the slates on either side of the greenstone ridge at the entrance to Slate bay belong to the same bed that once formed a continuous arch over the ridge. The northern side of the north syncline has also been removed by igneous intrusions, and all of the beds are cut off east of Pipestone bay by the main granite mass.

The northeast end of the northern syncline is not satisfactorily worked out. Patches of sediment outcrop through the overburden in that direction, as will be seen by the map, but these are not exactly in line with the beds of the syncline. Neither are those that occur in the bay north of the old Hudson's Bay Company's post. From the distribution both of the sediments and of certain dikes of granite porphyry, it seems likely that north-south faults with a relative dislocation of the eastern beds to the north may partly explain the first of these difficulties. Faulting is assumed also to have affected the southern syncline. The westerly continuation does not show a sufficient width to account for all the beds which occur on Mackenzie island, even if no allowance whatever is made for the whole southern limb which is believed to have been destroyed by intrusions. Along the western part, a comparatively narrow band of quartz porphyry is all the intrusive rock exposed, and even this is not continuous. This difficulty can be solved if it be supposed that a fault at a small angle to the strike of the axis of the fold has shifted the southern part of the syncline westward. There is some field evidence that this may have happened, as many of the rocks appearing in the islands west of Mackenzie island are very schistose.

The structural relations of the narrow band of sedimentary rocks north of Faulkenham lake have not been worked out satisfactorily. The few indications of bedding and tops of beds, as indicated by gradations in coarseness of grain, show that the portion exposed lies on the northern limb of a syncline, the southern limb of which has been removed by a granite intrusion.

#### Age Relations

The relationship of the sedimentary to the volcanic group of rocks and the age of each are not as yet absolutely determined. The structure outlined in the preceding paragraphs requires that the sediments be younger than the volcanics, but the question arises whether or not there was a period of erosion after the cooling of the lavas and previous to the deposition of the first sediments. No basal conglomerate was found during the field work, nor in fact any conglomerate bed near the base of the sediments. The conglomeratic lenses occurring at various horizons are not continuous and are taken to represent merely accumulations of coarse debris in eddies of the streams from which the sediments were deposited. Nevertheless, some observations favour the theory that there was an erosion period. Pebbles in the conglomerate lenses are very similar in character to the underlying rocks—greenstone and iron formation. This criterion, however, must be accepted with considerable caution, as lithological similarity is not conclusive. This is shown in this series by the occurrence of comparatively fresh granite pebbles in the conglomerate, and yet all the granite which has been found in place in the area has intrusive relations to this sedimentary series.

A relationship that seems to show conclusively an unconformity between the two groups occurs at the north end of Slate bay where a small syncline of greywacké lies on greenstone. If the two were conformable, then the greenstone must necessarily be the top of a lava flow. On the contrary, the greenstone is coarse grained and shows none of the characteristics of a flow surface. Erosion must, therefore, have been acting upon the igneous rocks previous to the deposition of the sediments for a time sufficiently long to destroy the characteristic lava surface or to cut down the surface to intrusive basic rocks of the oldest group.

From these two lines of evidence it has been concluded that the greenstone and associated rocks form a series lying unconformably below the sediments, but no estimate of the magnitude of the erosion interval can be formed from the meagre data available. Both series of rocks are intruded by the igneous rocks to be described later. The succession therefore is similar to successions worked out in other areas of pre-Cambrian rocks of similar character. Hence, it is suggested that the sediments be tentatively correlated with the Timiskaming.

## Post-Timiskaming Intrusives

### QUARTZ PORPHYRY

#### Distribution

An intrusive rock in which quartz phenocrysts predominate occupies large areas west of Pipestone bay, forms elongated belts south of Pipestone bay and in the northern part of Mackenzie island, and is exposed as isolated outcrops in the drift-covered area of the eastern part of the map-sheet. It is in rocks of this type that gold ores have been found on the Howey and McIntyre claims.

#### General Description

The quartz porphyry is a white-weathering, dense rock with great variation in the amount of quartz visible in the hand specimens. In places, practically no phenocrysts can be seen, and only a few feet away the rock may be crowded with quartz individuals. There is also a marked variation in the size of the grains. All are clear, and the smaller ones on fresh fractures appear black.

Under the microscope, the same variation in distribution and size of the porphyritic constituents is apparent.

In the typical quartz porphyry, such as that in the bald rocky point at the sharp bend in the channel between Trout bay and Pipestone bay, the microscope shows the rock to consist of a fine-grained groundmass of quartz, sericite, and probably feldspar, although in too small grains to be determined with certainty. The sericite, which forms about one-third of the whole, is in tiny foils lying between quartz grains. From this it seems likely that some at least of the quartz in the groundmass is secondary from the alteration of orthoclase, perhaps according to an equation such as the following:—

$$3\,(K_2O\ Al_2O_3\ 6SiO_2) + 2H_2O = 2H_2OK_2O\ 3Al_2O_3\ 6SiO_2 + 2K_2O + 12SiO_2$$

A small amount of light-brown biotite is also present. The phenocrysts are well-formed quartzoids, with only a few flecks of sericite marking the alteration of feldspars included in the growing phenocrysts. The large mass of rock that forms the elevated area west of Pipestone bay offers exceptional exposures for study of the character and relations of the quartz porphyry. It weathers light-grey, but freshly broken specimens are dark-grey and dense with conchoidal fracture. Some of the specimens under the microscope show no porphyritic character, but are fine-grained mosaics of quartz, microcline, and biotite, with sericite and some calcite as secondary products. In other places, the porphyritic texture is strikingly developed with large individuals of orthoclase in a fine-grained groundmass of quartz and tiny feldspar laths. Sericite in such rocks occurs both in phenocrysts and groundmass. Other specimens from this area show still more variety in their mineralogy and have large individuals of orthoclase and acidic plagioclase, some of which have complex twinning by both the albite and pericline laws. The minerals of the groundmass are quartz, feldspar, biotite, chlorite, and sericite.

Along the steep rock surfaces facing the lake, the porphyry shows a jointing dipping northward at angles of 50 to 60 degrees. Paralleling this structure are narrow layers of greenstone. Thin sections of rocks at some of these contacts were taken to determine, if possible, the relationships. Greenstone from a band 25 feet in thickness lying between porphyry is made up chiefly of a fibrous amphibole pleochroic from yellowish-green to green.

A specimen of porphyry close to the contact on the north side consists of a very fine grained mosaic of quartz and feldspar with a few stringers of vein

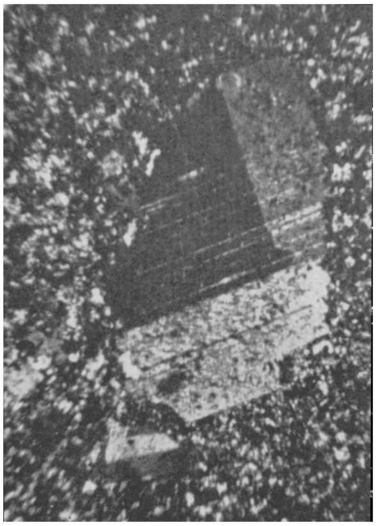


Fig. 7—Coarse quartz porphyry. Plagioclase showing albite. Carlsbad and pericline twins. (Crossed nicols × 13.)

quartz. A short distance away from the contact, the rock is coarser grained and decidedly porphyritic. On the south side, the rock is a very fine grained mosaic of quartz and feldspar with a somewhat foliated character from the development of fine flakes of biotite. In this sample no phenocrysts are present, whereas 300 feet farther south large phenocrysts are abundantly developed (Fig. 7).

The outcrops of quartz porphyry, near the mouth of Trout bay, offer a good opportunity to study the variation and relationships. There are all gradations from fine-grained, white-weathering rocks with no phenocrysts visible to the naked eye, to those in which the blebs of quartz are plainly visible. Under the microscope, the fine-grained varieties are found to be even-textured mosaics of quartz and feldspar; the porphyritic ones in most cases have both quartz and feldspar phenocrysts, commonly somewhat segregated into nests.

Analyses of several specimens of quartz porphyry have been made. Two of them are as follows: others will be given in the detailed descriptions of the Howey and McIntyre porphyries.

| | No. 1 | No. 2 | | No. 1 | No. 2 |
|---|---|---|---|---|---|
| | per cent. | per cent. | | per cent. | per cent. |
| $SiO_2$ | 71.82 | 75.87 | Quartz | 52.42 | 46.87 |
| $Al_2O_3$ | 14.78 | 15.50 | Orthoclase | 9.06 | 11.89 |
| $Fe_2O_3$ | .20 | .81 | Albite | 5.97 | 13.10 |
| FeO | 3.75 | .28 | Anorthite | 3.31 | ........ |
| MgO | 1.65 | .45 | Sericite | 13.20 | 19.90 |
| | | | Biotite | ...... | 3.73 |
| CaO | 1.25 | none | Chlorite | 10.82 | 3.97 |
| $Na_2O$ | .71 | 1.55 | Calcite | 1.04 | ........ |
| $K_2O$ | 3.10 | 4.03 | Magnesite | .95 | ........ |
| $H_2O+$ | 1.81 | 1.01 | Siderite | 1.43 | ........ |
| $H_2O-$ | .04 | ......... | Diaspore | 1.80 | ........ |
| $CO_2$ | 1.49 | trace | | | |
| MnO | .07 | trace | | | |
| Total | 100.70 | 99.50 | Total | 100.12 | 99.46 |

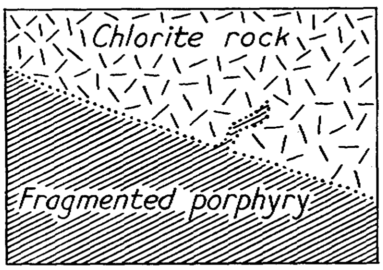
Analysis and calculation by G. G. Suffel.

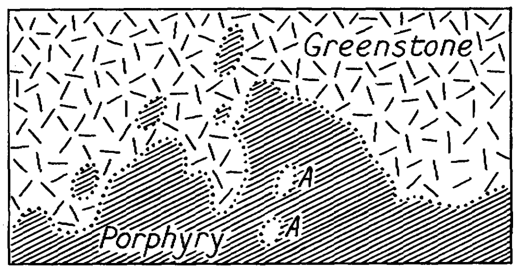
No. 1—Quartz porphyry from the north end of Mackenzie island. This sample, which contains abundant glassy phenocrysts of quartz, was taken from tongues of porphyry which intrude and alter greenstone. In the recast analysis, diaspore is assumed; it was not observed.

No. 2—Sample from a dike of porphyry, 30 feet in width, cutting greenstone on claim K. 300. This rock has apparently sustained a considerable loss of lime. In the recast analysis, sillimanite is assumed; it was not observed.

Specimens from other occurrences of quartz porphyry contain phenocrysts which have been fractured. Many of these fractured parts are surrounded by secondary minerals. In some, the fracturing has not been severe, and the outlines of the fractured phenocrysts can still be recognized. In others, the fragments are widely separated and scattered through the groundmass as angular particles (Fig. 6). Very commonly a brecciated structure shows on the weathered surface of the porphyry with oval, light-grey fragments set in a darker grey matrix. On fresh fractures, however, no differences can be detected between fragment and matrix. In places where the porphyry contains inclusions of greenstone, as well as the autoclastic texture, the rock resembles a sediment. The rather angular or elongated oval form of the inclusion, the identity of the porphyry fragments and the matrix, and the lack of any foreign pebbles are evidence that the rocks are not sediments but brecciated intrusives. Porphyry of this type forms prominent exposures on the northwest shore of the large bay east of the Hudson's Bay Company's new post and is remarkably well developed on island No. 52. On the northwest point of this island, a fragmental series is well exposed with an apparent textural variation in the various bands. In the coarser bands, however, it is noticeable that all of the fragments are porphyry; and on fresh fractures, fragments and matrix both look like quartz porphyry. The igneous character of the whole series is shown by the fact that from one of these fragmental bands a stringer, two inches in width, cuts transversely across the adjacent band of chloritic rock (Fig. 8). In thin sections, the main fragmental band exhibits a flow texture with large angular fragments of quartz, probably fractured phenocrysts, lying in sericite, the foils of which curve around the fragments. The rock from the tongue from this band is decidedly porphyritic with phenocrysts of orthoclase and plagioclase in a fine-grained groundmass, which contains many nests of secondary quartz. At this same locality, other textural peculiarities are well shown at the east end of the island. The porphyry intrudes an ellipsoidal-weathering greenstone, and in places the rock is a typical quartz porphyry but has retained, on its surface, markings exactly like the ellipsoidal markings of the greenstone.

A somewhat different type of pseudo-conglomerate occurs on the north point of island No. 60. On a glaciated rock surface, greenstone and quartz porphyry are in contact. In the greenstone, there are inclusions of quartz porphyry with oval outlines, so that the surface appears conglomeratic. In the quartz porphyry which is sharply in contact with the greenstone, there are oval areas much less clearly outlined than in the greenstone and appearing like shadowy pebbles in the quartz porphyry. The contact and the pebble-like areas are as shown in Fig. 9. The microscopic characters of the masses of porphyry in the greenstone, of massive porphyry without the shadow-like inclusions, and of the porphyry with these inclusions vary only slightly. A sample from massive




Inches 12 8 4 0 1 Foot

Fig. 8—Contact of porphyry and chlorite, island No. 52.

Fig. 9—Contact of porphyry and greenstone, island No. 60. A = "Shadow" inclusions.

porphyry that looks homogeneous appears under the microscope faintly porphyritic with much altered, fairly large, but not well formed crystals of orthoclase and a few small quartz fragments, perhaps from fractured quartz phenocrysts. The fine-grained groundmass consists chiefly of sericite. A sample from one of the oval, pebble-like masses in the greenstone is decidedly porphyritic with phenocrysts of sericitized orthoclase, plagioclase in poorly formed crystals, and rounded quartz individuals. The groundmass is fine grained and contains abundant sericite. A specimen from the area showing faint oval outlines also is porphyritic, but the phenocrysts are plagioclase only. Neither quartz nor orthoclase occur in the first generation of crystallization. The groundmass contains sericite and carbonate, and certain areas of low transparency represent other alteration products. A possible explanation of this occurrence is that the oval areas are really cross-sections of pipelike tongues of porphyry, which came up along the schistosity of the greenstone, and that the oval areas occurring in the porphyry are similar pipes intruded as forerunners of the porphyry and later absorbed in the parent rock as its margin advanced into the greenstone. This hypothesis would explain the character of the porphyry which contains the oval shadows. That part of the rock mass would represent a part of the porphyry which had removed or assimilated a part of the greenstone. It would thus have incorporated some basic material and hence would contain a somewhat more basic assemblage of minerals and plagioclase rather than orthoclase and quartz as the phenocrystic constituent.

On the north point of island No. 100 and on some other islands to the northwest, along the strike of the same band of porphyry, a remarkable banded structure is to be seen. The rock consists of yellowish-green, translucent, waxy layers about an inch in thickness, alternating with denser white layers of about the same thickness. Both types contain rounded phenocrysts sufficiently large to be easily visible to the naked eye, and under the microscope there are no essential differences in constituents or in texture. This dike intrudes a band of iron formation that does not appear at any point farther south. It may be possible that the dike has completely destroyed the band of iron formation and that the banded structure is merely a trace of the bedded character of the iron formation, left as a fossil structure indicating an original *lit par lit* injection by the igneous mass in the first stages of its assimilation of the older rock.

### Alteration

In places where shearing action has been intense, the porphyry has taken on a remarkably regular schistose structure that makes it practically an igneous slate. Where the porphyry was originally somewhat heterogeneous, where certain zones had undergone some alteration previous to the shearing, or where there were inclusions of other rocks, a banded structure has resulted that resembles bedding. Especially where tongues of porphyry are injected as sills in slates, the porphyry may be easily mistaken for a siliceous sediment. The quartz eyes, however, remain clear and can usually be recognized in the sheared rock. Alteration has proceeded in some occurrences to the extreme of producing a sericite schist from the porphyry with the phenocrysts fractured and the fragments scattered through the groundmass. The resultant rock is difficult to recognize excepting by its field relations.

Contact alterations are not noticeable in the porphyry, but are chiefly indicated by the presence of some carbonate and perhaps by a variation in the phenocrysts, as noted above, from the normal orthoclase and quartz to plagioclase near the contact.

### Relations

The gradation in texture and the disappearance of the phenocrysts along the contacts between quartz porphyry and greenstone were the first facts noted that seemed to indicate the intrusive nature of the porphyry. In the rock outcrops on the burned hills of the north shore of the bay that extends westward between Pipestone bay and Trout bay, the greenstone is cut by stringers of quartz porphyry and considerably metamorphosed by them. In other places the carbonate zones on both sides of porphyry tongues are further evidence of the intrusive relationship. Further details of the relation of porphyry to greenstone will be found in the later description of the porphyry on the Howey and McIntyre claims. Mention has been made previously of the manner in which porphyry dikes intrude, disturb, and metamorphose iron formation. Intrusive relations with the Timiskaming sediments are indicated by the relationships of the sediments on Mackenzie island to the porphyry which must have cut off the southern beds of the syncline. Porphyry was observed intruded between the layers of slates north of the Middle narrows; in most places it has the structure of sills in the sedimentary series and does not commonly cut across the bedding.

### Quartz Porphyry of the Howey and McIntyre Claims

Description of the quartz porphyry of the Howey and McIntyre claims, in which auriferous quartz veins occur, calls for separate treatment because of its

View of surface trenches on the Howey ore body looking east from the McIntyre line.

importance in this respect and since it differs somewhat from the larger outcrops of quartz porphyry to the north and west. Its relation to the small granite mass

View of surface trenches on the Howey ore body looking west along the strike of the much fractured and sheared quartz porphyry.

to the northwest has not been established by field evidence, but it is correlated for the present with the other quartz porphyries of the area.

Several dike-shaped bodies of the porphyry occur on the Howey and McIntyre claims; the most important lies along the south line of claims K. 1,365 and 1,373. They differ slightly from place to place, both in coarseness of grain and in content and composition of phenocrysts. In general, they have a characteristic colour which varies from black where fresh to a light greenish-grey where altered and schisted. In the latter case, the porphyry has a decided waxy feel and appearance. It is usually very fine grained, and phenocrysts of quartz are discerned with difficulty. In the fresh rock they appear as tiny black eyes. East of the ore-bearing porphyry, the outcrops are of coarser grain and phenocrysts of quartz are readily distinguished in a hand specimen.

Microscopic examination of the finer fresh porphyry shows phenocrysts of quartz and albite. Locally the feldspar predominates over the quartz. Most of the phenocrysts have been fractured. The groundmass consists essentially of fine quartz, feldspars, and sericite. Clusters of magnetite grains are sometimes found associated with biotite flakes. Chlorite mixed with sericite is a minor constituent.

The freshest specimens obtained all have the feldspars altered to some extent to sericite and carbonates. Satisfactory comparison of the porphyry from different portions of the ore zone is rendered difficult by the differing degrees of alteration. Analyses of moderately fresh (No. 1), moderately fresh to partly altered (Nos. 2 and 3), and highly altered porphyry (No. 4) from the Howey claim are given below:—

| | No. 1 | No. 2 | No. 3 | No. 4 | No. 5a | No. 5b |
|---|---|---|---|---|---|---|
| | per cent. | per cent. | per cent. | per cent. | per cent. | per cent. |
| $SiO_2$ | 72.39 | 71.82 | 74.18 | 70.06 | 53.27 | 53.12 |
| $Al_2O_3$ | 13.87 | 16.00 | 14.45 | 16.61 | 19.48 | 18.06 |
| $Fe_2O_3$ | 1.45 | .10 | 1.40 | 1.80 | 1.14 | .44 |
| $FeO$ | 1.13 | .36 | .96 | .85 | 1.39 | 2.44 |
| $MgO$ | .46 | .21 | .37 | .51 | 1.97 | 2.29 |
| $CaO$ | 1.24 | 1.07 | 1.04 | 1.10 | 4.72 | 8.20 |
| $Na_2O$ | 4.75 | 4.62 | 3.00 | 3.32 | 1.83 | 5.39 |
| $K_2O$ | 2.79 | 2.14 | 2.52 | 3.22 | 5.38 | 1.52 |
| $H_2O$ | .43 | 1.27 | 1.14 | 1.34 | 1.68 | .69 |
| $TiO_2$ | .64 | .66 | .37 | .77 | .76 | .63 |
| $CO_2$ | .52 | .36 | .29 | .67 | 4.65 | 5.87 |
| $FeS_2$ | .48 | 2.06 | .51 | trace | 3.86 | 1.28 |
| Total | 100.15 | 100.31 | 100.23 | 100.26 | 100.13 | 99.93 |

(Analyses by W. K. McNeill.)

The mineral compositions calculated from the analyses are as follows:—

| | No. 1 | No. 2 | No. 3 |
|---|---|---|---|
| | per cent. | per cent. | per cent. |
| Quartz | 31.93 | 35.01 | 45.00 |
| Albite | 40.30 | 39.15 | 25.39 |
| Anorthite | 2.89 | 3.03 | 3.33 |
| Orthoclase | 12.32 | none | .83 |
| Sericite | 6.02 | 18.10 | 20.13 |
| Chlorite | 2.90 | 1.19 | 2.34 |
| Calcite | 1.18 | .66 | .82 |
| Rutile | .64 | .66 | .37 |
| Pyrite | .48 | 2.06 | .51 |
| Magnetite | .98 | .97 | .15 |
| $Fe_2O_3$ | .77[1] | none | .73[1] |
| Total | 100.31 | 100.17 | 100.26 |

[1]$Fe_2O_3$ may be present in biotite.

The porphyry is characterized by its high content of soda feldspar and, in general composition, corresponds with a quartz keratophyre with which the Porcupine quartz porphyries have also been compared.[1] Nos. 2 and 3, with approximately the same degree of alteration, show a difference in quartz content, the latter being higher.

The analyses and calculated mineral composition of the fresher phases of this quartz porphyry differ somewhat from those given on page 28. This difference is most evident in the low content of soda in the latter, which may be due in part to hydrothermal alteration. There seems little doubt, however, that the Howey specimens of quartz porphyry are more alkaline. Both sets of analyses have examples of carbonated porphyry with relatively high ferrous oxide, magnesia, and lime.

The series of analyses bring out well the changes produced by hydrothermal alteration, which will be dealt with later. Analyses Nos. 5a and 5b are from a specimen showing the highly altered phase (No. 5a) and what was taken for a dark fresh phase (No. 5b). A thin section was made of the contact, which is poorly defined and recognizable only by the presence of biotite in the darker rock. Both phases are highly carbonated, and the low silica content may be in part a result of this, or it may reflect an original difference in composition of the porphyry, as will be seen by the following.

At several places in the porphyry exposed by trenches on the Howey and McIntyre claims, narrow, dark, schistose lenses may be found. These seldom exceed a few inches in width. Their length is irregular, and they are seldom traceable from one trench to the next. Most of them are mineralized with fine pyrite. Thin sections show them to be essentially biotite schists with abundant carbonate, minor amounts of fine quartz, and a little sericite. No primary minerals can be recognized. Thin sections of their contact with waxy porphyry suggest that they are intruded by the porphyry, which is closely welded to the schist. Tongues of porphyry project into the schist, and small clusters of biotite appear in the porphyry a short distance from the contact.

The origin of these micaceous bands is obscure. They were interpreted in the field as possibly lamprophyric dikes, but their lenticular character and their apparently pre-porphyry age is against this. They differ considerably from the Keewatin schists along the outer contact of the porphyry and from schistose greenstones which are included in the porphyry or lie between small intrusions of porphyry. These are all dominantly chloritic, and any contact action of the porphyry on the greenstone does not seem to have developed the biotite which is common to the bands under discussion. On the contrary hornblende is formed in some cases where inclusions are present or contact action has been great. Hence the argument that these dark bands are included Keewatin lenses receives little support. The other possibility, that these dark lenses are remnants of an intrusive which has preceded the intrusion of the porphyry is left open. It has been suggested[2] that most porphyries with well-formed phenocrysts may have been preceded by another intrusion to prepare the way. This magma may have been more basic originally or it may have been modified in composition during its intrusion. A dioritic quartz porphyry with abundant biotite occurs to the southeast and may be related to these biotite schists, though it is much more siliceous.

*Hydrothermal Alteration.*—Much of the quartz porphyry has been altered and schisted yielding rocks high in sericite, carbonate, and fine quartz. In

[1]A. G. Burrows, Ont. Dept. Mines, Vol. XXXIII, pt. 2, 1924.
[2]N. L. Bowen, personal communication.

general, the degree of alteration may be gauged by the change to a green waxy colour. Examination of specimens ranging from fresh to highly altered porphyry shows the gradual change in the mineral composition, which consists chiefly of the formation of sericite and carbonates at the expense of the feldspars, which in most specimens are fractured; as the alteration became more intense, these were converted to sericite and quartz or replaced by carbonates.

The changes which have been brought about chemically are best illustrated by means of a straight-line diagram (Fig. 10). Comparison of analyses Nos. 1 and 4 shows the apparent constancy of alumina, oxide of titanium, and potash. Relative to alumina, all other constituents except water and carbon dioxide have decreased; and of these soda shows the greatest loss, and more lime than magnesia is lost. Comparison is also made between Nos. 1 and 5a. This shows the

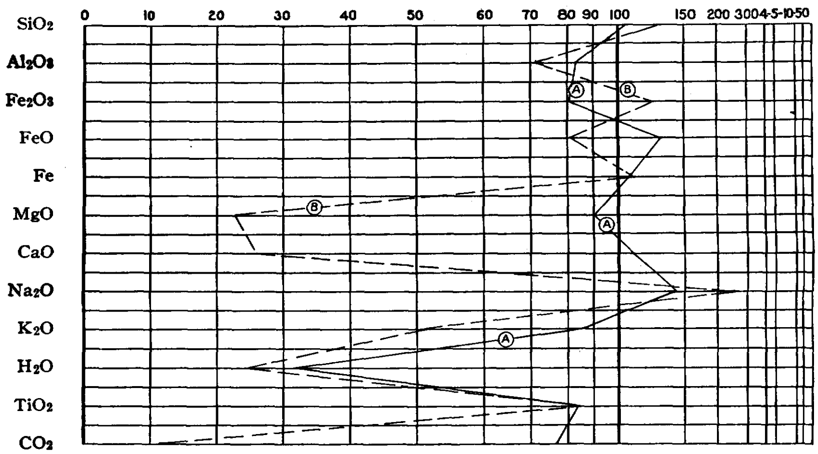



Fig. 10—Straight-line diagram showing relative gains and losses of constituents in hydrothermally altered quartz porphyry of Howey Gold Mines. (A) Comparison of analyses Nos. 1 and 4. (B) Comparison of analyses Nos. 1 and 5a. Points on diagram are obtained by dividing the grammes constituent in fresh rock by the grammes constituent in altered rock and multiplying the result by 100. The points indicate for each constituent the number of grammes of altered rock required to furnish the amount of that constituent originally present in 100 grammes of fresh rock.[1] Assuming any constituent constant, all points for other constituents to the right indicate a loss, and to the left, a gain.

characteristic loss of soda and gain of potash typical of hydrothermal alteration, but the marked gain of lime, magnesia, and carbon dioxide emphasizes the carbonate alteration. The high content of lime and magnesia is taken care of by the carbon dioxide. The time relations between the sericite and carbonate alteration are not discernible. The former is more widespread than the latter and, it is thought, occurred first.

The relation of the hydrothermally altered porphyry to quartz veins is well illustrated in some places where small veinlets of quartz cut fresh porphyry. Adjoining these veins the porphyry is altered to the typical waxy lustre, which fades out a few inches away from the vein. Elsewhere irregular zones of wax-coloured porphyry cannot be so related to the veins on the surface, but the irregular distribution of the quartz in a vertical direction may explain this. Where the veins are most abundant and closely spaced, the porphyry is invariably

[1]Leith and Mead, Metamorphic Geology, H. Holt & Co., 1915, p. 288.

much altered. The hydrothermal alteration then seems related to a period following the fracturing of the porphyry.

*Intrusive Relations*.—The Howey-McIntyre porphyry has been described by Wright[1] as a series of small masses ranging in width from a few feet to 75 feet, arranged *en échelon* to the north. The intrusions have been traced on the surface 1,000 feet east on the Howey and 250 feet west on the McIntyre, where they disappear into low swampy ground.[2] The general strike of the main body is N. 63° E., and the dip, as determined from diamond-drilling is about 82° S. The *en échelon* character is not clearly defined at the surface for lack of outcrops. At the west end, contacts, where exposed, parallel the schistose greenstones, striking more easterly and jogging northward at intervals, as illustrated in the insert facing page 58. In diamond-drill cores showing contacts of porphyry with Keewatin schist, the porphyry injects the schist in fine tongues, paralleling the schistosity.

From the manner in which the intrusions occur, it would seem that a structural control was exerted by the Keewatin schists. It is not clear, however, how greatly the Keewatin was folded prior to its being intruded, and it is evident from the fractured and locally schistose nature of the porphyry that folding and concomitant shearing followed its intrusion.

Cutting the porphyry in a few instances are lamprophyric dikes, some of which have been faulted during or after intrusion. In diamond-drill hole No. 16 of the Howey, a 1½-foot dolerite dike has been reported as clearly intrusive into the porphyry. On claim No. 1,379, a dark brown-weathering dioritic dike cuts across a dike of quartz porphyry. All of these are probably genetically related.

The relation of the quartz porphyry to the granite mass lying near by to the northwest is not determinable from the surface. The granite occupies the area approximately 30 chains west from the last outcrop of porphyry. The only logical correlation is to place the quartz porphyry with the other quartz porphyries of the area, that is as older than the granite.

### QUARTZ DIORITE PORPHYRY

Intruding grey Keewatin rhyolites in the form of small lenticular masses is a striking quartz porphyry, differing considerably from the main quartz porphyry in appearance and composition, but corresponding with the latter in freshness and intrusive relations. The rock contains phenocrysts of bright-blue quartz set in a dark micaceous groundmass. It is best exposed on claims of the Victoria Syndicate, K.R.L. 1,864 and 1,865. The rock weathers reddish-grey and is relatively little altered.

Under the microscope, rounded phenocrysts of quartz are more abundant than lath-shaped feldspars. Graphic intergrowths of quartz and orthoclase are present in minor quantities. Biotite is a prominent constituent of the groundmass and gives the rock its dark aspect. Chlorite and magnetite are in part secondary after biotite. The plagioclase feldspar, according to extinction angles on bisectrix sections, is between andesine-oligoclase and oligoclase-andesine. This is in agreement with calculated plagioclase from the analysis, which shows a considerably lower tenor of soda and potash than the Howey quartz porphyry. The rock properly falls in the class of quartz diorites or tonalites, though its high quartz content, represented by the phenocrysts, makes it on the whole more acidic.

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[1]D. G. H. Wright, Eng. Min. Jour., July, 1926.

[2]The eastward extension on the Howey claims was considerably extended during the summer of 1927. *See* page 57.

| Chemical Composition | per cent. | Calculated Mineral Composition | per cent. |
|---|---|---|---|
| $SiO_2$ | 73.90 | Quartz | 47.00 |
| $Al_2O_3$ | 12.00 | Albite | 20.67 |
| $Fe_2O_3$ | 1.58 | Anorthite | 8.41 |
| FeO | 4.39 | Orthoclase | 3.66 |
| MgO | 1.25 | Biotite | 8.45 |
| CaO | 1.69 | Magnetite | 1.67 |
| $Na_2O$ | 2.44 | Ilmenite | 1.60 |
| $K_2O$ | 1.33 | Chlorite | 4.03 |
| $TiO_2$ | .84 | Pyrite | .15 |
| $H_2O$ | .65 | Kaolin (?) | 5.29 |
| $CO_2$ | trace | | |
| Total | 100.22 | Total | 100.93 |

Analysis by W. K. McNeill.

This porphyry has been found intrusive into Keewatin greenstones and rhyolites only. Its freshness and composition relate it in age to the other quartz porphyries of the area.

## GRANITE PORPHYRY (HEYSON TOWNSHIP)

A rather striking rock with abundant medium-sized phenocrysts of red feldspar and bluish quartz set in a hard, grey, and very fine grained groundmass occurs in several places to the south of Red lake from Faulkenham lake to Keg lake. This granite porphyry lies adjacent to and along the strike of the granite salient occupying Faulkenham lake. To the east it occurs as small masses, lenticular in shape and elongated with the regional strike.

The rock varies slightly in composition from place to place. A specimen from the Victoria Syndicate claims contains many phenocrysts of quartz and plagioclase feldspar (albite to oligoclase). Orthoclase and microcline are also present. Quartz phenocrysts showing resorption are fractured in some cases, and in the fissures fine mosaic quartz has been developed. The groundmass contains chiefly quartz in fine grains and small plagioclase laths with minor amounts of biotite. Its texture is almost that of a rhyolite. At the east end of Faulkenham lake, the porphyry has essentially the same composition, except for the presence of iron oxides, pyrite, more biotite, and some epidote. The quartz in some specimens is highly stained with iron oxide, probably an alteration product from the sulphide.

The intrusive nature of these granite porphyries is shown by the following. On the Victoria Syndicate claims, rounded fragments of Keewatin green schist, as large as one foot in diameter, are present, lying well within it. The contact with adjacent rhyolites, while not sharp, may be traced across their strike. Some narrow lenses of green schist may also be found in the porphyry and have been interpreted as inclusions. Farther west, a short distance east of Faulkenham lake, sedimentary rocks related to the Timiskaming are interrupted along their strike by lenticular masses of the same porphyry. On the small point northwest of the outlet of Faulkenham lake, a contact of granite and porphyry may be distinguished with difficulty. The rocks there are somewhat iron stained, and their age relation cannot be determined, as no offshoots of one were found penetrating the other.

In a few places the granite porphyry is cut by narrow stringers and dikelets of a fairly fresh diorite. The diorite has been correlated with quartz diabase and a few other occurrences of fresh diorite which will be described below.

In view of the occurrence of granitic porphyritic rocks to the north of Red lake and of somewhat similar rocks to the south of Faulkenham lake, into which red granite has been intruded, the age of this granite porphyry is placed as pre-granite, rather than contemporaneous with the large granitic masses. It is clear that the intrusions occurred after the older rocks had been folded to very nearly their present attitude. Later movements are also indicated, following their intrusion, by the fractured character of the phenocrysts.

## PORPHYRITIC GRANITE, HYBRID GRANITE, AMPHIBOLITE, AND GNEISS

Heterogeneous rocks form a large area northwest of Slate bay, lying between the syncline of sediments that crosses the south end of the bay and the granite to the north.

Somewhat similar rocks consisting in part of porphyritic granite, but more generally of hornblendic granites and gneisses, occur to the south of Red lake and immediately north of Medicine-stone lake, where they grade northward into highly altered hornblende and biotite schists and gneisses. These rocks are apparently similar to the porphyritic granite of the north shore of Red lake and are also cut by later red granite. The heterogeneous character of both groups, and particularly their gneissic portions, suggest a hybrid origin.

### North Shore of Red Lake

*General Character.*—The porphyritic granite outcropping along the northwest shore of Slate bay and extending northwestward is extremely heterogeneous in character. In some places it is quite light in colour and granitic in appearance, in others it is a dark-grey, fine-grained rock recognizable only by the glistening cleavage faces of a few small feldspar crystals. Much of it is massive; in places a gneissoid structure is observable, especially in occurrences near the granite. The rock varies from granite to diorite in composition, and no single specimen can be taken as the type. The following description of some of the sections examined microscopically will serve to illustrate only some of the varieties found.

A thin section from a specimen from the northwest shore of Slate bay on claim K.R.L. 2,091 is a porphyry with large crystals of orthoclase, somewhat muddy by alteration to kaolin and sericite, some quartz lying between the feldspars as a mosaic of small grains, and a little green hornblende. This type, however, is not the common one in this locality, and the following specimens taken near the base line and in the northern part of the township of Fairlie just west of Slate bay are more representative of the formation as a whole. A specimen from an exposure along the base line, 40 chains west of Slate bay, is a granular, dark-grey, glistening rock, which in thin section appears porphyritic with phenocrysts of a plagioclase that is near andesine in composition. Many of the crystals show zonal growth, but since crystallization they have suffered some crushing and considerable alteration. Crystals of biotite are common and seem to replace some of the feldspars. The groundmass is fine grained but completely crystalline with quartz and feldspar as the most abundant constituents. Small grains of epidote are fairly common. Fifty chains almost directly south of the place where this specimen was obtained, a rock of somewhat similar appearance was found to have both orthoclase and plagioclase as phenocrysts but in other respects was quite similar to the one just described. Directly eastward, at a point sixteen chains west of Slate bay, the rock also contains both orthoclase and plagioclase as phenocrysts, but a little magnetite and chlorite are present, and pressure has resulted in a faintly gneissic arrangement of the biotite, the foils of which curve around some of the phenocrysts. Two specimens from a traverse west from the west boundary of the township of McDonough, at 39 chains north of the one-mile post, show the variation that occurs in short distances in this rock. The first sample, taken 12 chains west of the boundary, is a light-grey rock that breaks with lustrous faces. It is a mosaic of quartz and plagioclase with a little orthoclase. There are a few areas with indistinct outlines that may be phenocrysts. Biotite is sparingly present. Five chains farther west, the rock is dark grey, finely crystalline, but with phenocrysts visible in the hand specimen. Under the microscope, it appears porphyritic with fresh-looking, but broken phenocrysts of andesine in a groundmass of quartz, feldspar, dark-brown biotite, and some granular epidote. Pyrite is sparsely disseminated, and some chlorite has been formed from the ferromagnesian minerals. The rock of the outcrop, four chains east of the No. 4 post of K.R.L. 2,300, is porphyritic but contains no great quantity of phenocrysts. Well-formed, blocky crystals of orthoclase and a fairly acidic plagioclase are set in a fine-grained crystalline groundmass. Some muscovite is present as an early crystallization product in the porphyry. There has been considerable alteration, and biotite foils are abundant even in the feldspar phenocrysts. Two specimens, one 13 chains, the other 16 chains south of No. 1 post of K.R.L. 2,304, are porphyritic with phenocrysts of quartz, orthoclase, and plagioclase. In the one from the more southerly outcrop, biotite is abundant. It is considerably less so in that from the northern outcrop. In both specimens the groundmass is fragmental-looking; and were it not for the phenocrysts, the rock might easily be thought to be a sediment. Biotite is commonly present in all of these rocks, but whether as a primary or, in part at least, a secondary mineral is not certain.

Rocks believed to belong to this group outcrop along the boundary line between the townships of McDonough and Bateman and were collected, during traverses made in 1923, in the northwest part of what is now the township of Bateman. The first outcrop along the boundary north of Red lake is at four miles, 60 chains. It is a white-weathering, granular rock, grey on fresh fractures, with bluish quartz and some feldspar recognizable in the hand specimen. In the thin section it appears equigranular and completely crystalline, with quartz and orthoclase as the chief constituents. There is some plagioclase. Muscovite is present and appears to be original. Biotite is abundant; epidote less so. This may be a non-porphyritic facies, perhaps a later dike or marginal part of the porphyry mass. Ten chains north of this exposure, the rock looks like a sediment and has a distinctly stratiform appearance. The thin section shows a gneissic structure with a mosaic of quartz and feldspar surrounded by biotite. The very distinct stratification may be the result of the inclusion of a block of sedimentary material which has been partially replaced by igneous matter. Seven chains farther north, the rock is porphyritic with small phenocrysts of orthoclase and plagioclase in a crystalline groundmass. Biotite is abundant and probably secondary.

A large exposure of a dark-grey, medium-grained igneous rock occurs on the south boundary of Balmer between 25 chains and 42 chains from the southeast corner of the township. This rock was classed in the field with that northwest of Slate bay. Microscopic examination shows the rock to be porphyritic with phenocrysts of plagioclase only. The groundmass contains abundant hornblende, pleochroic from green to yellow-green. The mineralogy of the rock is thus somewhat different from the typical porphyritic granite described previously, but it is thought not sufficiently so to make it impossible that both may belong to the same group. It resembles the rocks south of the lake.

*Relations.*—Porphyritic granite intrudes the sediments and greenstones in the vicinity of Slate bay. Certain definite dikes have been found in the sediments; and on K.R.L. 2,086 near No. 4 post, inclusions of greenstone were observed in the porphyry. Upon these few occurrences the relationship of the whole area depends, and even with these definite relations it is perhaps uncertain that all of the rocks included under this class are of the same age. The rock of the dikes is not exactly like that of the main mass, as the description, given later in discussing the relation to the quartz porphyry, will show.

The massive pink granite, to be described later, is clearly intrusive into the porphyritic granite and associated gneisses. The contact is not a gradational one, but sharp tongues of granite cut into the porphyry, which is commonly somewhat gneissic near the contact. That, however, is the only evidence of contact effects produced by the granite. It is possible that intense metamorphism took place at an early stage in the granite invasion and that much of the contact zone was later engulfed and removed by the intrusive.

The relationship between the porphyritic granite and the quartz porphyry has not been definitely determined. The two rocks are decidedly unlike in their typical development, but there are some dikes of such a constitution that it is impossible confidently to assign them to one or the other of the two rock types. For example, a dike intruding slate on the north shore of the channel between Mackenzie island and the northern mainland is a porphyry in which the phenocrysts are both quartz and feldspar. The feldspar has undergone considerable sericitization, but the twinning *lamellae* are still recognizable in some of the crystals, and from these the variety was determined as oligoclase-andesine. In other crystals no twinning can be recognized, possibly because of intense alteration, but probably because some were orthoclase. Most of the feldspars are blocky; a few are lath-shaped. The quartz phenocrysts are rounded and many of them are fractured, but the fragments are not scattered as is the case in many of the quartz porphyries. Dark-brown biotite occurs in aggregates and is probably secondary. A little original muscovite is present. The groundmass is fine grained but completely crystalline and consists apparently of quartz and feldspar. The chief secondary product is sericite, which occurs throughout both matrix and feldspar phenocrysts. This rock resembles the porphyritic granite in the presence of large numbers of plagioclase phenocrysts, but the quartz porphyry exhibits the same characteristic in many of its dikes. The presence of biotite is a second point of similarity, but it is much less common than in the typical porphyritic granite. Biotite occurs as well in typical quartz porphyry, especially at the west end of the lake, but the individuals are smaller and it is lighter coloured than the biotite in this dike and in the porphyritic granite. No epidote was observed in the dike. Mineralogically then, this particular rock seems to lie between typical quartz porphyry and typical porphyritic granite.

*Origin.*—Since this formation lies between the sediments of the Slate bay syncline and the great mass of granite to the northwest and resembles some of the highly crystalline varieties of greywacké in the sedimentary series, there seemed a possibility that it represents the highly altered margin of the sediments. Certain parts of it, in which the rock is a fine-grained mosaic of quartz and feldspar with no phenocrysts, may be absorbed portions of included sediments; but on the whole, it seems clear that there is a great mass of igneous rock of porphyritic habit, with feldspar as the phenocrystic mineral; biotite, perhaps in part, if not altogether secondary, and some epidote are the chief other constituents. This formation has undergone extremely severe alteration, which is expressed by the fracturing of the phenocrysts and by the rough to fairly perfect parallelism of the biotite. In places it is shown by the thorough recrystallization of the groundmass into a mosaic of quartz and feldspar; some of the large clear crystals of feldspar may also be secondary. However, those showing zonal growth are evidently of the first period of crystallization and formed directly from a magma, the composition of which was changing rapidly. The presence of epidote in many specimens suggests the possibility of contact metamorphism, but that this has not been an important factor in the alteration of the rock is shown by the fact that, aside from a more marked gneissic structure, there is no great increase in the degree of metamorphism as the granite margin is approached. On the whole, then, the evidence shows that this formation is largely an intrusive mass which, under the close folding that has taken place in the area, has been altered into a quartz-feldspar-biotite gneiss. The heterogeneity of the formation is due to the digestion of intruded rocks without thorough mixing of the hybrid magma; the stratiform character of some outcrops may in part be due to inclusion and quiet but only partial assimilation of masses of sediments.

### South of Red Lake

Within the long tongue of highly altered Keewatin shown on the map-sheet to the north of Medicine-stone lake, and adjoining this band on the south, are dikes and larger intrusions of a dark reddish-grey, fine-grained rock which varies greatly from place to place, but on the whole has a granitic and, in many places, porphyritic character.

Detailed description of these rocks would be essentially a repetition of that given for the north shore group. The same mineral constituents are present, as are similar variations in composition. The rocks are, if anything, more granitic in character. The outstanding difference is the greater abundance of hornblende and hornblende granite gneiss. Porphyritic phases, while present, are less prominent.

The gneissic types apparently grade into dark hornblende and biotite schists and gneisses, which have been described above as probably a part of the Keewatin. No sharp boundary can be drawn between these two groups. Where dominantly composed of basic minerals, they are classed as Keewatin, and where granitic as a part of the granite gneisses.

Where the rocks are less gneissic and more equigranular, they look much like impure quartzite. Thin sections of these show original orthoclase, microcline and acid plagioclase, quartz and hornblende or biotite, the hornblende being much more abundant than in the later granites. Fine, fresh, and apparently secondary albite may be present with recrystallized mosaic quartz.

On the north shore of Faulkenham lake, red granite has intruded Timiskaming sediments and removed a large portion of them, according to all structural indications. Towards the west end of this lake, dark granitic rocks, similar to the group under discussion, lie between the sediments and the granite. These are characterized by an abundance of green biotite, which in places makes up nearly 20 per cent. of the rock, reflecting perhaps the nature of the intruded sediments.

Many dark granitic porphyries, with a superabundance of hornblende or biotite or both, occur as dikes in the Keewatin or as small masses with the gneisses. On the divide between Medicine-stone and Lee lakes, one of these is essentially a quartz porphyry with a fine, greenish groundmass. Its relation to the adjoining granitic rocks was not determinable.

*Intrusive Relations.*—These granitoid rocks, like those of the north shore of Red lake, are all cut by pure red granite. In the vicinity of intrusions of the granite, narrow stringers of red granite and pegmatite cut across them. To the south of Flat lake, a contact between red granite and an impure granitic rock is exposed on the shore of a small lake. Here one rock is closely welded to the other; and were it not for a few stringers of red granite in the darker rock, it would be impossible to say which was the younger.

The relation of this group to the Keewatin is clearly shown by their occurrence as dikes in the highly altered green schists south of Flat lake. The occurrence of much hornblende gneiss in these rocks, particularly where they lie between highly altered Keewatin rocks and granite, suggests that they are simply a hybrid type developed during the granitic intrusive period by the partial assimilation of Keewatin schists engulfed by a granitic magma. These rocks, then, can be regarded as an early representative of the granitic intrusives. Later, pure red granite masses and dikes were intruded into them, in part replacing them. The welded character of the contacts suggests that the two were not greatly separated in time. They seem always to occur together.

*Amphibolites or Hornblendites.*—The fine-grained granitic gneisses are widespread in the vicinity of granite intrusions, but rocks of still another type occur, particularly in the southwestern portion of the map-sheet. These consist essentially of hornblende and very minute amounts of plagioclase-feldspar and quartz. The hornblende crystals attain diameters of as much as half an inch. The texture of the rocks is more igneous than schistose or gneissic, and they might for this reason be regarded as hornblendite differentiates from the granites. Against this, however, is the fact that they lie along the strike of Keewatin schists, with which they seem continuous. On Lee lake they are developed on the islands and near the north shore. A short distance to the north, they pass into chloritic and hornblendic schists, which are in places foliated and on the north of which lies the large granite batholith. Southward they pass into more granitic rocks with about 50 per cent. hornblende; the hornblende decreases farther south. All of these are cut in places by small granitic stringers, and it seems clear that they belong with the other granitic gneisses and impure porphyries described above. From their field relations, they are regarded as highly recrystallized basic rocks (Keewatin) resulting from the contact action of and partial digestion by the granitic intrusives.

*Origin.*—In summary, hybrid granitic rocks, in places characteristically porphyritic, seem to have been developed by the injection of granitic magma into older rocks and by the partial assimilation of these. Where the intruded rocks are sediments, greywackés, quartzites, and slates, the common basic mineral is biotite. Where the intruded rocks are Keewatin basic volcanics, hornblende is developed both in the intruded and intruding rock. No attempt has been made to prove conclusively this origin for the heterogeneous group of rocks herein described, since the time devoted in the field to this problem was not great and a more detailed study was not justified.

## BASIC INTRUSIVES

### Lamprophyre Dikes

Narrow, dark-coloured dikes occur in places. The greatest width of any of these is only a few feet, and they are, therefore, not large enough to appear on the map. An east-west dike of this character, a foot in width, cuts through the quartz porphyry at the east end of island No. 52. Under the microscope the rock appears equigranular. Plagioclase and biotite are the chief constituents with pyroxene as a subordinate primary mineral. There are areas of calcite, and sericite foils are scattered through the section. This rock may be classed as a kersantite. A similar dike of about the same width cuts at a small angle across a quartz porphyry dike on claim K.R.L. 300. No thin section of this rock was examined.

These dikes for the most part cut quartz porphyry. They occur also in the greenstone areas, but the similarity in colouring of the two rocks makes them inconspicuous. A few have been found cutting rhyolites. In quartz porphyry and diorite, some of them have been faulted.

#### Quartz Diabase and Diorite

On the small point projecting westward in the lake immediately northeast of Faulkenham lake, narrow dikes and stringers of a dark-green, medium-grained diabase intrude banded Timiskaming sediments, chiefly quartzites. Along the margins of the diabase, contact breccias have been developed, fragments of quartzite lying in a dioritic matrix. Similar diabase occurs on the west shore of the same lake. The shape of the intrusives is lenticular, more or less paralleling the strike of the sediments, but in places cutting them.

Under the microscope the rock is found to consist largely of common hornblende in medium-sized crystals. Many of these show deformation by curving and broken cleavages. Portions of the hornblende are completely altered to chlorite, but for the most part the rock as a whole has undergone little alteration of this type. Brown biotite in small flakes and associated with a small quantity of magnetite or ilmenite make up the other basic constituents. Enclosed or partly enclosed by the larger hornblende crystals are smaller laths of plagioclase, probably andesine. Interstitial quartz and a small quantity of fine mosaic quartz, possible secondary, are also present. The rock may be called a quartz-hornblende diabase.

The age of the diabase can be placed only as post-Timiskaming. It seems probable that it is a basic differentiate of the nearby granites.

A very fresh diorite, which may be closely related to this diabase, occurs along the north side of island No. 120 in Red lake. It is a dark grey rock, which under the microscope is made up of plagioclase (andesine), green hornblende, a little biotite, and some magnetite.

### GRANITE

#### Distribution

The volcanic and sedimentary rocks in the Red Lake area are completely surrounded by massive granite. In addition, two bosses of granite occur within the area of these rocks.

The largest mass of granite in the immediate vicinity of the lake extends from the south shore between Middle and West narrows southward to a long tongue of basic schists and gneisses near Medicine-stone lake and joins the main granite mass to the southwest. What appears to be a sharp salient of granite projects eastwards from the main mass from Flat to Faulkenham lakes. Outcrops could not be traced completely across the area between the two lakes, and the granite at Faulkenham lake may be still another small boss. The larger of the bosses mentioned above occupies the southern part of Mackenzie island and extends south to the north shore of Snib lake. In ground plan it is roughly oval with the longer axis nearly east and west. The smaller occupies the curved point extending into East bay from the east shore almost opposite the narrow entrance to the bay. This boss may be actually continuous with the main granite mass to the east, but the scattered exposures that appear through the heavy drift cover are here interpreted to mean that it is a separate mass.

### Lithological Character of Typical Granite

The rocks both from the great area of granites surrounding the older rocks and from the smaller granite masses within the area of older formations vary only within such limits as are to be expected in a great intrusive mass. The character of the granite exposed to the south of Red lake in an immense east-west belt across the middle of Pakwash lake and extending as bands across the English river, may be taken as typical of that southern area where granite is interbanded with the remnants of synclines of sedimentary gneisses. The granites are described as follows:—

> The granite of the upper parts of the batholith is strikingly porphyritic, with orthoclase phenocrysts a half inch or more in length. . . . A specimen of porphyritic granite from Oak lake consists of microcline, orthoclase, and biotite, all of which are but slightly altered. . . . In many of the smaller intrusive bodies, the granite is hybrid in character, with a mineral composition somewhat different from normal granite and commonly with a gneissoid structure inherited from the foliated rocks, which it has intruded. . . . A specimen from an exposure north of post 24 [Pakwash lake] shows under the microscope a granitic texture with orthoclase, plagioclase, quartz, and hornblende. At post 23, the specimen is gneissoid, and the minerals are orthoclase, acidic plagioclase, quartz, and biotite.[1]

Granite from the west boundary of the township of Bateman at 25 chains north of the 4-mile post is a fresh, bright, pink rock, which the microscope shows to be a holocrystalline granite containing microcline, quartz, orthoclase, and biotite as the chief mineral constituents. A peculiarity of this variety is the presence of some augite in well-formed crystals, which were the first to form as the rock consolidated. Biotite crystallized next. The secondary products, calcite and sericite, are not abundant.

Granite from the area northwest of Red lake is essentially similar to that south of the lake. In places, as along the portage northwest from Pipestone bay, a certain degree of foliation appears in some of the outcrops, but this seems to be local and perhaps is due to digested inclusions. Ordinarily the granite is massive. A microscopic examination of a specimen from the area northeast of Pipestone bay shows a typical hypidiomorphic texture, with orthoclase, quartz, microcline, biotite, and muscovite as the primary minerals. The quartz grains show strain shadows. The orthoclase is muddy and has developed some sericite. Chlorite has formed from some of the biotite.

Granite from the north shore of Tack (Contact) lake, the first north of the outlet of Medicine-stone lake, is medium grained and quite fresh. The mineral constituents are quartz, orthoclase, microcline, oligoclase-albite, biotite, and minor quantities of hornblende altering to chlorite and epidote. Apatite and magnetite are accessory minerals. Small amounts of vermiform intergrowths of quartz and orthoclase occur around the plagioclase feldspars.

A specimen from the same mass of granite, south of West narrows of Red lake, contains all of the above constituents save hornblende. Microcline is a more prominent feldspar here.

If differentiation has affected the granite, the small boss at East bay should show marked effects, since it is smaller than the Mackenzie island mass.

[1]E. L. Bruce, Geology of the Upper Part of the English River Valley, Ont. Dept. Mines, Vol. XXXIII, pt. 4, p. 8.

It is light-grey, with biotite as a visible dark constituent. Under the microscope it appears holocrystalline, with quartz containing tiny apatite crystals, orthoclase, microcline, plagioclase, and dark-brown biotite. The only evidence of differentiation is a marked zoning of the feldspars indicating a rapid change in composition of the magma during crystallization. The secondary products are the usual ones, kaolin and sericite. A chemical analysis of this rock gave the following result:—

| Analysis | per cent. | Calculation | per cent. |
|---|---|---|---|
| $SiO_2$ | 68.47 | Quartz | 27.18 |
| $Al_2O_3$ | 16.24 | Orthoclase | 4.90 |
| $Fe_2O_3$ | .28 | Albite | 39.98 |
| FeO | 2.49 | Anorthite | 8.34 |
| MgO | .61 | Biotite | 11.63 |
| CaO | 2.48 | Sericite | 3.27 |
| $Na_2O$ | 4.73 | Calcite | 1.43 |
| $K_2O$ | 2.39 | Kaolin | 2.34 |
| $H_2O$ | .71 | Chlorite | trace |
| $CO_2$ | .63 | | |
| Total | 99.03 | Total | 99.07 |

Analysis and calculation by G. G. Suffel.

From this the variety of the plagioclase is seen to be oligoclase. The replacement of some of the plagioclase by calcite is quite noticeable in the thin section, and some of the feldspar is turbid on account of the development of sericite and kaolin. The biotite is quite fresh. The low percentage of orthoclase places this rock in the class of granodiorites or quartz diorites, but the small amount of dark-coloured constituents is peculiar for a rock of that class. This is probably a further evidence of differentiation, the feldspars being chiefly soda lime varieties and the iron-magnesia minerals lacking. This rock is rather similar in composition to the quartz diorite that is described later.

The granite boss or cupola of Mackenzie island and the south shore of Red lake varies in colour from light-grey at the margins to red in the central parts, where it is essentially the same as the other granite masses. Near the south contact many lenses of altered greenstone have apparently been caught up in the intrusive and partly digested. The granite here is partly schisted. The change in colour towards the margin is probably related to these basic inclusions, though normal differentiation is not excluded. The feldspars of the marginal phase are more of the soda lime than of the alkaline type; but as sufficient specimens have not been obtained, a more complete study is impossible.

### Quartz Diorite

On claim K. 1,379 of the McIntyre group, a short distance from the south contact of the Mackenzie island granite, there is a small lenticular mass of grey granitic rock intruding Keewatin greenstones and tuffs. This has undergone considerable shearing, but differs little from the neighbouring granite in this respect or in general colour and appearance. The rock is medium grained and slightly porphyritic, the phenocrysts of quartz and feldspar being the more prominent on account of shearing and recrystallization of some of the quartz and the presence of fine sericite. The feldspars consist chiefly of finely twinned andesine and minor quantities of microcline. Ferromagnesian minerals are not abundant and are now represented only by chlorite. Finely disseminated cubes of pyrite and some magnetite are scattered throughout, and secondary calcite and other carbonates are present. The high plagioclase and low potash-feldspar content identify this rock as a quartz diorite.

At the eastern extremity of the quartz diorite appear two small lenses of grey sericite schist, which lens out upward as if intrusive. Their downward extent could not be determined. It was suggested in the field that these schistose lenses might be equivalent in age to the Howey quartz porphyry; if so their relations to the diorite would throw some light on their age.

Careful examination of these schistose lenses has failed to reveal any definite evidence for their origin. They may be simply highly altered tongues of the quartz diorite porphyry or inclusions of an acid igneous rock. The contact is serrated, minute tongues of schist extending upward an eighth to a half an inch into the diorite, a condition which may obtain whether the schist is intrusive or an inclusion. No chilled margin could be found, but this might not be expected as the schist lenses are very narrow. The schist itself is waxy and grey in colour and contains small, white, angular to lenticular particles about the size of a pea. It is much altered and rusty in places. Under the microscope it is composed essentially of fine sericite and quartz and has a pronounced augen structure, the eyes consisting of quartz and rusty carbonates. Magnetite and pyrite are finely disseminated throughout. Feldspars are few and can be barely recognized. They are chiefly plagioclase. Chlorite is also present in small quantities. The pea-sized particles, in thin section, stand out as rounded rusty aggregates of ferruginous carbonates, very fine quartz, a few feldspars, and abundant magnetite with minor quantities of chlorite. These appear to be inclusions in the schist, as fine tongues of sericite schist and pyrite penetrate the aggregates as if filling fractures. Their origin is not clear, as all the minerals are secondary. The high content of fine magnetite and carbonate suggests their derivation from carbonated greenstones. The schist as a whole may only be related to an acid igneous rock. Its degree of alteration is more severe than that of the quartz diorite or the Howey quartz porphyry. Arguments for placing its age before or after the quartz diorite are about balanced, since some intrusives are more highly altered and schistose than the intruded rocks. Further data on this perhaps critical occurrence will probably be obtained in the diamond-drilling of the McIntyre claims.

### Granite Dikes

Narrow dikes of medium-grained granite, usually grey in colour, intrude Keewatin schists in the vicinity of the batholith lying south of Red lake. Many of these appear on the north shore near Wolf narrows. Several of fine grain intrude the highly altered schists and gneisses to the south of Shoal lake. On a small lake, 50 chains southeast of the east end of Douglas lake, a narrow granite dike intrudes greenstones and contains very abundant angular inclusions.

The point at the east end of Snib lake is held up by a grey granite dike of medium grain. This is probably closely connected with the granite boss near by.

At the southeast corner of claim K. 1,424 of the Red Lake Prospectors Syndicate, narrow dikes of grey granitic rocks cut Keewatin schists parallel to their strike. Some of these are of medium grain and contain phenocrysts of quartz and feldspar in a slightly finer groundmass. They differ in general appearance from the quartz porphyries and are probably more closely related to the granites. A specimen from one of these dikes is dark-grey on fresh fracture and contains abundant phenocrysts of both quartz and feldspar in a very fine groundmass. The rock has undergone considerable shearing, and under the microscope the fractured phenocrysts lie in a fairly schistose, micaceous matrix of sericite, brown biotite, quartz, and some epidote. The feldspars have undergone little alteration. They consist chiefly of orthoclase and albite. Judging from the mineral composition, this rock may be related to quartz porphyry.

To the south of the same trench on claim K. 1,425, narrow, pink felsitic stringers with rather abundant pyrite penetrate green schists in a most intricate manner. Thin sections of these show them to be slightly porphyritic and of granitic composition, though quartz is not prominent. The feldspars are chiefly orthoclase and albite. Sericite, calcite, and chlorite are secondary minerals, the carbonates being most prominent. Their exact relation to the granite is not known.

An outcrop on claim K.R.L. 1962, northwest of Slate bay, consists of rock in which quartz is abundantly present. Under the microscope the quartz is seen to occur not as phenocrysts but with the irregular interstitial arrangement in which quartz is found in granites. In this rock, however, none of the other constituents of a granite occur. Sericite is the only other mineral present. This rock is interpreted as a binary granite in which the feldspar has been changed entirely into sericite. On K.R.L. 1,710, south of Pipestone bay, a similar dike occurs. The mineralogy is almost exactly similar, except that some chlorite is present. In both these dikes later fracturing has permitted the introduction of some pyrite, and in the latter the dike rock is penetrated by narrow quartz veins.

### Micropegmatite

On the north boundary of claim K. 1,430 of the Red Lake Prospectors Syndicate, a small elongated body of medium-grained, greyish micropegmatite intrudes green Keewatin schists on the north and grey rhyolite and rhyolite porphyry on the south.

In thin section this rock consists almost entirely of micrographic intergrowths of quartz and orthoclase and smaller quantities of quartz intergrown with albite. Minor constituents are brown biotite, granular magnetite, and clusters of partly altered titanite, with which are associated many small grains of ilmenite. Secondary minerals consist of sericite and calcite, alteration products in part from feldspars. The intergrowths of quartz and feldspar commonly have a beautiful centric structure.

The relative freshness of this rock and its intrusive relations to the Keewatin volcanics associate it in age with the granitic intrusions of post-Timiskaming time. Reference to texts on igneous rocks brings out the fact that many of the described micropegmatites are related to the differentiation of basic intrusives, e.g., the Sudbury norite. In this case no large basic intrusives of this general age have yet been exposed, though some hornblendic diabase has been found. Another possibility is that the micropegmatite represents a further differentiation from the granitic magma, caused by the making over of basic inclusions, according to Bowen's reaction series.[1] Emmons[2] cites examples of basic inclusions causing the further differentiation of granite to pegmatite, but no definite evidence of such being the case here was found.

[1]N. L. Bowen, Behaviour of Inclusions in Igneous Magmas, Jour. Geol., Vol. XXX, 1922, p. 513.

[2]R. C. Emmons, Concerning Inclusions in Igneous Magmas, Jour. Geol., Vol. XXXIV, p. 422-28.

### Intrusive Relations of Granite

The manner in which the granitic magmas invaded the area of Keewatin rocks in the Red lake basin is well illustrated in parts of the area. In the section on granitic gneisses and porphyries, it has been shown that an early granitic magma invaded the basic volcanics and the later sediments, engulfing portions of them and being modified considerably in composition and texture. That the rise of this magma was essentially by stoping action is suggested by the occurrence within these granitic rocks of elongated bands of highly altered Keewatin rocks, many miles in length, which retain the regional strike and probably are virtually in place. One of these bands, which parallels Hatchet lake (south of Douglas lake), disappears westward into the hybrid granites and gneisses, its influence being marked by a gradual decrease of hornblende and hornblende gneiss to the west. This early magma, then, may be regarded as the "work" magma, in so far as it provided room for the later red granite.

Later, but probably soon afterwards, the purer granitic magma invaded the areas of previous granitic intrusion, displacing or removing in some way the earlier rocks. The time interval between the two may have been very short. These red granites in general have sharp contacts with the Keewatin and with the remnants of the hybrid granitic group. Where the red granite occurs in smaller masses, some stoping action is suggested by inclusions of Keewatin schists and the lowering of the acidity of the border phases of the intrusive. In such areas, the older hybrid types do not appear, and this may account for the necessity of fresh stoping action by the later granite.

Some discussion has arisen as to the nature of the Mackenzie island granite boss in view of its proximity to the Howey ore body. The dip of the contacts between granite and greenstone appears at the surface to be vertical, a fact which led Wright[1] to suggest that this granite was not a portion of a batholith but a small cupola or conduit for a laccolith above, which has long since been removed by erosion. There can be little doubt that this granite is connected with the larger batholiths of granite in the area. In this regard we may note what Daly[2] says:—

> Batholithic roofs often deviate systematically from the pure domical shape because of the presence of re-entrants composed of batholithic material. These projections of the igneous mass have been called "cupolas," from the analogous relation of an artificial cupola to the building of which it is a part. Many stocks are cupolas on batholiths.

From sections in the same text illustrating cupolas, it is clear that the term "cupola" may be applied here, but this does not imply that the contacts of the cupola, to the depth of the main batholith, will be much steeper than the average dip of batholithic walls. Daly[3] estimates the average angle of dip of the batholiths (below the edge of the roof) at well over 60 degrees. Using the lowest average, 60 degrees, the possible intersection of the granite cupola and quartz porphyry on the Howey-McIntyre claims would be at a depth of 4,000 feet; for a dip of 70 degrees for the granite, the intersection would be at 7,400 feet; and for a dip of 75 degrees, 13,200 feet. From the vertical dip of the granite at the surface, the steep dip of the adjoining rocks, and the dip of the porphyry (82° S.), it is quite evident that any intersection of granite and porphyry will be far below mining depths.

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[1]D. G. H. Wright, Eng. Min. Jour., July, 1926.
[2]R. A. Daly, Igneous Rocks and Their Origin, McGraw-Hill Co., 1914, pp. 101-2.
[3]Ibid, p. 103 *et seq.*

## Pleistocene

### Glacial Deposits

Deposits of purely glacial origin partially cover the surface in the western part of the map-sheet. Small ridges of till and sand are found quite commonly, especially on the southwest side of rock ridges. The glacial striae show a movement of the ice averaging about S. 30° W to S. 40° W., and the rock-protected accumulations of till tail out from the ridges in that direction. Irregular ridges and hills of sand with many boulders occur north of the long arm that connects with the main lake just west of Wolf narrows. These ridges are surrounded by sand plains, possibly formed by the outwash from the morainal material of the hills.

### Glacial Lake Deposits

The most interesting and important of the unconsolidated deposits are stratified clays and sands that mantle the other deposits almost completely in the area east of Red lake. Similar deposits extend southward and have been described in a previous report.[1] They consist of regularly stratified clay, sandy clay, or sand. For the first three miles along the trail from Red lake to Trout lake, knolls of glacial material project here and there above flat, clay-covered country. Beyond that, spruce swamp extends for a mile and no doubt conceals clay land. From the east edge of the swamp, the country is open and the soil sandy. The surface is a plane sloping slightly upward to the east and terminated by a ridge of bouldery material that rises sharply to an elevation ten feet above the sandy slope. From the top of this ridge, a second tilted plane of sandy country extends for a quarter of a mile with a gentle rise to the east, and this in turn terminates at the foot of a second steep, 10-foot slope of boulders and sand. This forms the crest of the ridge that divides Trout lake and Red lake basins. The top is level for ten chains. The eastern slope drops sharply to swampy country, in which there is a small muskeg lake. Dowling gives the following description of these deposits:—

> The till is found rather sparingly spread over nearly the whole area, immediately on the surface of the harder rocks, and has been in turn covered, in some localities, by stratified sands and silts. A high ridge of sand, boulders, and well-rounded gravel is approximately the northern and eastern boundary of these silts. . . .
>
> The top of the ridge, south of Trout lake, is a series of closely placed narrow hills or parallel ridges, steep on the northern face and more gradually sloping to the south, averaging about 270 feet above Trout lake, or 1,575 feet above the sea. The material on the northern slope is sand and gravel with rounded boulders. Several steps or terraces are also noted, but they continue but short distances, and from the lake no such continuous line can be traced. On the surface of the ridge, large boulders are found, the crest being well covered with them, but they occupy a narrow belt only, as the slope to the south, though less abrupt than to the north, commences immediately. The general appearance of the ridge is not that of an ordinary land moraine, but suggests a moraine or accumulation along the front of an ice-sheet terminating in water of considerable depth, in which the debris has been somewhat evenly distributed.[2]

The features observed in the traverse eastward from Red lake to the crest of the ridge agree with the hypothesis, outlined above, of a lake, the northeast

[1]Geology of the Upper Part of the English River Valley, Ont. Dept. Mines, Vol. XXXIII, pt. 4, p. 9.

[2]D. B. Dowling, Geol. Surv. Can., Vol. VII, pt. F., pp. 51-52.

shore of which was formed by an ice-sheet from which morainal material was carried out and laid down as stratified sand near shore and stratified clay farther out. The ice front finally retreated, leaving the beach material standing as a ridge sloping steeply northward or northeastward where the ice had been and gently southwestward down the slightly inclined lake deposits lying in front of the old shore.

### Relations

The relations between glacial deposits and glacial lake deposits are clearly shown in some of the trenching done on mining claims during 1926. On the Dunlop Red lake Syndicate claims, just north of Chukuni river, typical unsorted boulder clay covers the smoothed and striated rock surface to the depth of about two feet. Above the boulder clay are varying thicknesses of evenly banded clays, no doubt deposited as seasonal layers in the lake lying along the front of the stagnant ice mass. Similar occurrences are found in trenchès of the Howey and McIntyre claims, where clays and sands lie above the till.

## GEOLOGICAL HISTORY

The geological record of the Red Lake area begins with a period of great volcanic activity during which large quantities of basic lavas were poured out over a surface, no remnant of which has been recognized. It may be that the basal beds upon which these extrusions rest are sedimentary gneisses similar to those which occur along the English river, but there is no definite evidence as to the age of those gneisses, nor of their relation to the volcanic rocks. Hence it is impossible to form any conclusions as to the character of the old surface over which the lava floods advanced. Where the rocks now show ellipsoidal structures, it may be that the effusions were beneath water.

The rocks of this early period were not exclusively igneous. Here and there conditions were such that sedimentary beds consisting of thin *laminae* of fine-grained silica or jasper and magnetite were deposited. Volcanic ash and the fragmental material produced from the lavas by local erosion were laid down as clayey beds that now form thin layers of black slate in the old complex.

The next event in the geological succession in this area cannot be determined with absolute assurance. South of the lake the altered dioritic rocks, described on page 18, seem to have been intruded into the Keewatin rocks after the latter had undergone at least some deformation. The difficulty in fixing the age of this intrusion, however, makes it impossible to state with certainty that the intrusion of diorite preceded the deposition of the Timiskaming sediments. If degree of metamorphism may be taken as a criterion, the diorite is pre-Algoman in age. For the present it will be assumed that the diorite is older than the Timiskaming sediments, but it must be clearly understood that the evidence is not conclusive. Following a period of folding of the Keewatin lavas and associated sediments (iron formation chiefly), there was a deep-seated intrusion of diorite. There is absolutely no evidence as to whether any period of erosion separated the deposition and folding of the Keewatin and the intrusion of the diorite. It was, however, followed by erosion, chiefly by mechanical processes; that is, the rocks were broken up without very much chemical alteration of their mineral constituents, and the disintegrated material was removed from neighbouring areas apparently by rather rapid streams and deposited in the Red Lake area as the great series of conglomerate, slate, and greywacké beds of the Timiskaming period.

After the induration of the sediments there were crustal disturbances and the intrusion of several simple or one or more complex igneous masses. The first of these were the quartz porphyry and other intrusives of the same period. The quartz porphyry entered as sills between the beds of the sediments and as cross-cutting masses. It perhaps engulfed some of the earlier rocks; in some cases, at least, the beds were already tilted and foliated previous to the porphyry invasions. Intrusions of massive granite followed or may have in part accompanied the folding of the sediments, and the granite engulfed some portions, at least, of all the previous rocks.

The massive granite is the latest pre-Cambrian rock, with the possible exception of the small lamprophyric dikes. Following its intrusion, the sculpturing of the elevated and closely folded rock areas began. Valleys cut by the streams that flowed down its flanks became deeper and wider until the igneous cores of these old mountains were exposed beneath the sediments. Given sufficient time the final product of such a process is a land surface with gentle slopes which bevel both hard and soft layers of rock. This is the character of the consolidated rock surface of this area, and to produce it must have required an immensely long period of time. Furthermore, it is believed that this surface was in practically its present condition before the beginning of the Paleozoic, as in many other areas where Paleozoic rocks rest upon a similar old complex, the surface which was buried beneath the Paleozoic rocks is similar to the surface where no Paleozoic has been found.

There is no definite evidence that other sediments were laid down over this bevelled surface, but it seems likely that the limestones of the James Bay region, those south of Lake Superior, and those west of Lake Winnipeg were once continuous across the pre-Cambrian shield. Any such rocks that may have been deposited have been completely removed by subsequent erosion, so that no consolidated rocks later than the pre-Cambrian granite have been found in this area. It is probable, even, that erosion not only removed the Paleozoic rocks but also attacked the pre-Cambrian basement to some extent.

The next great event that left a definite imprint of its influence on the geological record was the advance of the continental glacier. No great eroding effect can be attributed to the moving ice, but it did remove the decomposed material and polished the solid rock over which it passed. The net result was the transfer of a great deal of weathered and some ground-up rock and the accentuation of the relief by the scouring out of hollows where weathering had affected the rock deeply. When the ice retreated, there was left behind it great masses of unsorted morainal material heaped up as irregular hills and ridges.

During the slow retreat and occasional stagnation of the ice front, the large volume of water from the melting ice formed a lake or lakes ponded against the ice as a north and east boundary. In this lake were deposited stratified sand near the shores and stratified clays farther from the ice margin. These lake deposits in places completely cover the unstratified till of the glacial period. The clays show in their regular bedding the seasonal variation in flow of water from the melting ice, and from these *laminae* it is evident that the glacial lakes persisted for some time.

The final retreat of the ice-sheet left the beach deposits of the glacial lakes as ridges of gravel and boulders. Since that time, some rearrangement of the glacial sands, clays, and gravels has been accomplished by modern lakes and streams, but on the whole these modifications have been slight.

## ECONOMIC GEOLOGY

Search for minerals of economic importance in the Red lake basin goes back to the staking of claims, along the high ridge west of Slate bay, by an English syndicate in September, 1897. At that time the station of Dinorwic on the Canadian Pacific railway was the starting point from which this area was reached.[1]

In spite of the long distance from the railway, comfortable camps were established, the claims were surveyed, and a shaft was sunk on the property. The vein is rather irregular at the shaft, and apparently those in charge became discouraged and work was discontinued.

In the summer of 1922, a prospecting party from Manitoba located claims on the west short of East bay and did a little work on a galena-bearing quartz vein outcropping at the shore. Reports of this find and of the silver values contained in some of the samples led to further prospecting and the staking of the McManus claims near the outlet of Red lake. Gold was found in narrow veins on these properties in 1922 and 1923, but no vein of sufficient size to justify much expenditure in an area so far from transportation. Subsequent to the publication of the report of the Ontario Department of Mines for 1923, interest was revived and prospecting in the area south of the lake revealed the gold-bearing veins, reports of which led to a rush of prospectors to the lake in the winter of 1925-26 and to the staking of most of the surrounding country.

### Gold Deposits

Gold has been found in some of the veins of the Red Lake area in sufficient concentration to warrant extensive development work, and the outlook for some properties developing into mines is very promising. Thorough prospecting has been done on comparatively few of the claims staked. If those properties that are being actively worked should develop into paying mines, there is no doubt that many other claims will be intensively examined with good chances for the discovery of other deposits, similar to those now known.

Gold has been found under somewhat varying conditions, although all types of deposits probably belong to the one period of mineralization. For purposes of description, these may be classed as follows:—

1. Quartz veins occurring in greenstone.
2. Carbonate zones.
3. Fractured zones containing quartz veins in quartz porphyry dikes.

#### Veins in Greenstone

Quartz veins are fairly common in the greenstone, but not all of these carry gold and many have only a small quantity. Some well-defined veins of fair widths have been opened up, but the large definite veins so far tested have been found to be nearly barren. Those in which gold has been found in quantity are narrow and usually taper out in comparatively short distances. Such veins commonly form a network in a fractured zone in the greenstone.

[1]The authors are indebted to J. W. Tyrrell for information concerning this early period of activity.

As yet, no locality has been found where the spacing of the veins is close enough to form ore, the large amount of barren rock so diluting the high gold values of the quartz that the average value of a width that could be mined would be below ore grade.

Veins of this structural type occur plentifully in all the greenstone areas of the map-sheet, but most of these containing more than traces of gold are in the neighbourhood of the quartz porphyry masses surrounding the granite boss of the central part of the lake. The actual outcropping of the granite is, of course, not necessarily important; for, if there be a genetic relationship between the granite and the gold occurrences, the quartz veins lying above as yet unexposed granite bosses would be quite as likely to carry gold as those at the same distance from the granite laterally. In fact they might be of better grade. Hence no quartz vein in the greenstone can be eliminated from consideration, although naturally those whose proximity to granite bosses is evident will be those to receive first consideration.

Although the auriferous veins in greenstone are commonly near intrusions of quartz porphyry, this association alone does not provide conditions for gold occurrences. Many veins in greenstone near porphyry carry only traces of gold, and from this fact it seems clear that the granite is a necessary factor for the deposition of the metal. It is probable that the porphyry merely prepared suitable fracture zones for the penetration of the gold-bearing solution at a later period. Although probably related genetically to the granite, there is no likelihood that these veins will be found to be cut off by the granite within any workable depth below the present surface. Gold deposition in the veins could not take place in the zone immediately surrounding the granite stock. In that region the temperatures at the time of intrusion must have been far above those at which gold could be deposited. Hence, those parts of the veins which are now exposed and which carry gold must be at some distance from the igneous mass from which the metal came. Decrease in values will not occur suddenly as the intrusive is approached; and any change in tenor of the vein will be so gradual that it may with certainty be stated that, if the surface values are sufficiently high to be mined with profit, values approximately the same will be found at any depths to which mining operations can be carried. This statement assumes the same conditions as to wall rock; for, should the fracture zone pass from greenstone to porphyry, the character of the fractures and of the mineralization in the two rocks might and probably would be different.

#### Carbonate Zones

Gold has been found in certain carbonate zones. These are similar in composition to those described in the section on General Geology. They consist of iron, magnesium, and calcium carbonate, which make up varying proportions of the whole rock. The rest is chiefly silica and various minor constituents. A partial analysis of a specimen from such a zone is as follows:—

| | Per cent. |
|---|---|
| Insoluble (chiefly silica) | 56.58 |
| Iron carbonate | 9.41 |
| Calcium carbonate | 16.90 |
| Magnesium carbonate (by difference) | 17.11 |
| Total | 100.00 |

The sample analysed appeared to be homogeneous. In practically all occurrences of carbonate rocks there is a considerable volume of the mass occupied by quartz veins which cut through the carbonate. These vary in size from mere stringers to veins with widths of three to four inches. In the central part of a zone, with greenstone on both sides, the quartz veins have a reticulated arrangement. On the margins most of them are transverse to the walls. Gold occurs chiefly in the quartz veins, but specimens have been observed in which gold particles lie in apparently solid and homogeneous carbonate. Probably it entered from a quartz veinlet along some tiny crack in the carbonate. As is usually the case, the rough cellular surface, consisting chiefly of quartz and limonite, pans gold freely wherever the underlying rock is at all auriferous. The immense amount of concentration effected during this weathering is shown by the following assays from a typical weathered surface and from fairly fresh rock:—

| | |
|---|---|
| Weathered | 4.55 ounces of gold per ton |
| Fresh | 0.1 " " " |

The carbonate zones are believed to be metamorphic aureoles around quartz porphyry intrusions. Carbonate is found as an intermediate rock between quartz porphyry and greenstone. Carbonate which occurs in greenstone where no porphyry outcrops, is interpreted as the alteration product of the greenstone lying above as yet unexposed masses of quartz porphyry (see page 14).

As shown previously, the alteration from greenstone to carbonate probably takes place with some decrease in volume, and the shrinkage of this border zone produces fractures and so opens spaces for the introduction of the quartz veins. There may be some mechanical deformation as well, tending to the production of fractures; but carbonate rocks do not easily retain openings, and it is likely that most of the veins are closely connected with the alteration. The quartz veins, even if not originally gold-bearing, would be much more brittle than the carbonate and so, under any subsequent deformation, would be the part of the zone that would fracture and the part in which ore solutions would find space to deposit their burden. This sequence of events seems to be necessary for the production of any considerable gold content; for, as in the previous case, those zones which have been found to carry gold are in the area surrounding the granite bosses.

The underground extension of the carbonate bands is of prime importance, if any of them are to be considered as possible ore bodies. If those bands which occur between walls of greenstone are the alteration zones produced by the contact action of quartz porphyry on greenstone, the depth to the porphyry will not be great. A carbonate band will probably be found lying on each side of the porphyry which has produced the alteration. These bordering bands will, however, be each less than one-half the thickness of the carbonate zone above the porphyry, since the action of the igneous mass was less intense along its sides than at the top, owing to the concentration of vapours and gases in the upper part of the chamber. As the fracturing, however, is a function of the decrease in volume of the altered greenstone, it will persist to whatever depth the alteration may extend. Owing to the ascension of the contained gases of the porphyry towards its upper part, it is likely that the greater the depth the less intense will be the alteration; hence there will be some decrease in width of the zone downward. On the other hand, any fracturing that may be the result of deformation after the solidification of the quartz porphyry will be more marked in the porphyry than in the carbonate and hence more favourable for deposition from any ore solutions that may come at any later time. In that case, the deposit would thus become one of the third type.

### Fractured Zones in Quartz Porphyry

Up to the present this is the type of gold deposit of greatest promise in the Red Lake area. Certain porphyry dikes have undergone considerable fracturing. The fractures are irregular in disposition and may be at various angles to the walls of the dikes. They are filled with quartz in which are included gold, perhaps some gold tellurides, chalcopyrite, pyrite, galena, and sphalerite. The total amount of metallic minerals is never more than a very small proportion of the whole, and many quartz veins that have a high gold content contain no visible metallic constituents. In those dikes which are auriferous, the gold occurs almost exclusively in the quartz, the quartz porphyry itself being practically barren. It is evident that the fracturing was later than the consolidation of the porphyry, and the irregularity of distribution of the fractures is evidence that they were not produced by contraction of the dike as it cooled. The alternative, then, is to consider them as later effects due to outside disturbances and related, in most cases, to tensional forces produced by shearing. Since the unaltered porphyry is barren, the gold evidently also came from some outside source. The most competent factor to have produced both the fracturing and the mineralization is the granite, which is later in age than the porphyry, which is near the gold occurrences, and which, moreover, is the type of rock with which gold is commonly associated.

Fracture zones in the porphyry may not continue as fracture zones in the greenstone, since stresses that produce fracturing in the porphyry may develop a schistose structure in the greenstone. In some places the stresses were sufficiently intense to have produced from the porphyry a highly foliated sericite schist, and in such places the quartz veins are less abundant. The conditions that seem most likely to have obtained where there are gold-bearing zones are those of relatively gentle movements, perhaps produced by the doming of the older rocks by the upthrust of the granite bosses. This doming may be assumed to have caused a shearing movement, which in the brittle quartz porphyry dikes resulted in the formation of numerous fractures. In other localities, especially those near the main granite masses and probably also where the porphyry has been intensely altered hydrothermally, the lateral thrust of the intrusive granite has produced intense foliation in the dikes with less opportunity for the formation of fractures. If this hypothesis of gentle doming with resultant fracturing be correct, then it is likely that the main fracture zones may be confined to the brittle porphyry. Where the fracturing continues into the greenstone, the veins will be smaller; but there may be the compensating advantage of some deposition of gold in the wall rock. The possibility of the deposits being cut off in depth by the granite is one of the important points to be considered, and the inferences are practically the same as those drawn previously. No granite is known which is later than the ore deposits; and if the period of gold deposition was the closing period of the consolidation of the granite, then any part of a vein sufficiently far from the cooling granite to have high gold values deposited in it, will be sufficiently far that any possible depth of mining operations will not find appreciably lower values in the vein.

## Silver-bearing Galena Veins

In a vein occurring on the west shore of East bay, north of the mouth of the bay, a quartz vein was discovered in 1922, carrying a considerable proportion of galena to quartz. The description in the first report on the Red Lake area was as follows:—

*Silver-Lead Vein.*—The vein containing silver-bearing galena discovered in July, 1922, is close to the western shore of East bay, half a mile north of the narrows. The vein is lenticular, strike N. 35° E. vertical. At the widest point seen it has a width of eighteen inches, from which maximum width it tapers to a stringer each way in a distance of fifteen to twenty feet. Somewhat north of the widest part, approximately one-half of the vein material is galena. The length of the part carrying this proportion is only a couple of feet and the width is one foot. Throughout most of the vein less than one-quarter of the total mineral content is galena. Samples were chipped across the vein at three places and assayed at the Provincial Assay Office with the following results:—

| | Silver, oz. per ton | Lead, per cent. |
|---|---|---|
| 1. | 3.0 | 2.51 |
| 2. | 14.1 | 8.75 |
| 3. | 1.4 | 1.22 |

Assayer, W. K. McNeill.

Sample No. 1 was taken towards the north end of the lens, width sampled 1 foot.

Sample No. 2, 2 feet south of No. 1 at part of vein carrying greatest proportion of galena, width sampled 1 foot.

Sample No. 3 widest part of the vein exposed, width sampled 18 inches.

It is evident, from the assays, that the silver bears a fairly constant ratio to the percentage of lead present and hence is no doubt directly associated with the galena, and not in the form of native silver.

The vein occurs in greenstone and, aside from the larger proportion of galena that it carries, does not differ in character or association from the other quartz veins in the area.

It is probable that this occurrence belongs to the same period of mineralization as the gold-bearing quartz veins and that the granite boss immediately east of it may be the parent rock. The greater proportion of galena in the vein can be explained by the smaller size of the exposed granite mass; that is, the boss has been truncated nearer its apex, hence the galena-bearing vein probably is at a higher level and farther from the mineral-introducing granite than are those quartz veins of lower galena contact.

## Talc

Talcose rocks occur fairly commonly, apparently as an advanced stage in the alteration of some of the highly magnesian greenstones. In most places the rocks are fine-grained aggregates of talc and other minerals, such as sericite, in varying proportions. These might be called soapstone. In a few localities veinlets of translucent green talc, as much as a quarter of an inch in thickness, were observed. These occur in carbonate rocks and possibly represent a still further alteration of the carbonates to talc. If so, there has been along certain fractures a silication of the carbonates; thus there must have been another stage of alteration begun, reversing the direction of the change to carbonate from serpentine, which was essentially a desilication. These reactions may be expressed by the following equation:—

$$3MgCO_3 + H_2O + 4SiO_2 = H_2O\ 3MgO\ 4SiO_2 + 3CO_2$$

The massive talcose rock probably formed as a direct secondary product from the basic Keewatin lavas. The reaction can be represented as follows:—

$$2\,(2H_2O\ 3MgO\ 2SiO_2) + 3CO_2 = H_2O\ 3MgO\ 4SiO_2 + 3MgCO_3 + 3H_2O$$

In this way talc would form at the same time as the carbonate rocks. The occurrences of the translucent veinlets of foliated talc are rare and perhaps indicate only a local excess of silica, which has reacted with the previously formed carbonate rocks. Wilson, in his report on the talc deposits of Canada,[1] mentions the occurrence of dolomite at Red lake. This might lead to the inference that foliated talc of high grade, such as that found in the sedimentary magnesian rocks of the Grenville area, could occur. As was shown in the report of 1924, the carbonate rocks are not sedimentary dolomites, but are themselves merely the product of the alteration of greenstone. The talc, therefore, will be chiefly of the massive soapstone type.

In places small masses of pyrite occur in the massive talc rock without any quartz veins, and in samples consisting partly of pyrite, partly of talc, gold assays $1.80 per ton. It is rather surprising to find such an occurrence in a rock so impervious and so difficult to fracture as this one is.

## Asbestos

A few veinlets of asbestos of good quality have been found in the greenstone areas. Rarely these have a width of a quarter of an inch, with fine, silky, greenish fibres transverse to the walls. The occurrence is a natural one when basic rocks are altering to serpentine, but no concentration of these veinlets sufficient to give any promise of commercial possibilities has been found.

## Howey Gold Mines and McIntyre-Porcupine Mines

### Historical Summary

In the summer of 1925, the Howey brothers discovered what has since proved to be the most promising prospective mine or mines in the Red Lake area. The ore body is largely confined to a series of quartz porphyry intrusives, the known major portion of which lies on the claims of the Howey Gold Mines; the western part, of unknown length, is held by the McIntyre-Porcupine Mines, Limited. The original discovery lies along the south boundary of claims K. 1,365 and 1,373.

The Howey claims, nineteen in all, were optioned to the Dome Mines. An early account of this company's work on the property is contained in the statement of the general manager, H. P. De Pencier.[2]

> As a consideration for getting the option, the Dome paid $25,000, which money was spent on the property. . . . The work done consisted of some 28 trenches of various lengths from upwards of 200 feet down in length. . . . A large amount of sampling was done and the results show values in many places. The incomplete nature of trenching, though, does not permit of us joining up ore sections in various trenches and much more work will have to be done to prove up the deposit. The fact, however, that gold is found over a length on this property of at least 930 feet and at places 60 feet wide makes it necessary for us to further test the property.

It is also recorded that:—

> In addition to the $25,000 mentioned above, the Dome made a payment of $50,000, and was to pay $500,000, within two years for a 75 per cent. interest in a newly organized company called the Howey Gold Mines, Limited.

The Dome option, however, was eventually dropped after 18 holes had been drilled beneath the outcrop. Most of these holes penetrated to a depth of about 200 feet, a few reaching between 400 and 500 feet. In the reorganized company, Howey Gold Mines, Limited, J. E. Hammell is president; Horace G. Young, general manager; and R. T. Birks, secretary-treasurer.

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[1]M. E. Wilson, Talc Deposits of Canada, Geol. Surv. Can., Econ. Geology, Series No. 2.
[2]Ont. Dept. Mines, Bull. No. 56, pp. 5, 6.

The Howey Gold Mines, Limited, is capitalized at 5,000,000 shares (3,500,000 issued) with a par value of $1, the original Howey Red Lake Syndicate owning one-half. In the early part of 1927, arrangements were made to install a plant capable of mining to a depth of 1,000 feet, and plans at present are to sink a 3-compartment shaft to a depth of 500 feet and to open up extensive lateral works on four levels. A steam plant was installed in May, 1927.[1]

On the claims of the McIntyre-Porcupine Mines, much of the porphyry has been uncovered by trenching, though probably a larger part of it is deeply buried in low swampy ground. Diamond-drill holes have also

Assay plant erected by the Dome Mines on the Howey claims.

been bored beneath the porphyry along the strike of the surface exposures. The results of this drilling are not available at present.

### Description of the Ore Body

The ore body comprises portions of the quartz porphyry masses which intrude the Keewatin greenstones and old diorite of this area, *en échelon* fashion, since much of the porphyry is dissected in an intricate manner by abundant auriferous quartz veins, contains lenses of mineralized Keewatin schist, and where highly altered and mineralized, itself contains some gold. There are, however, portions of the porphyry which contain few veins and which cannot be classed as ore.

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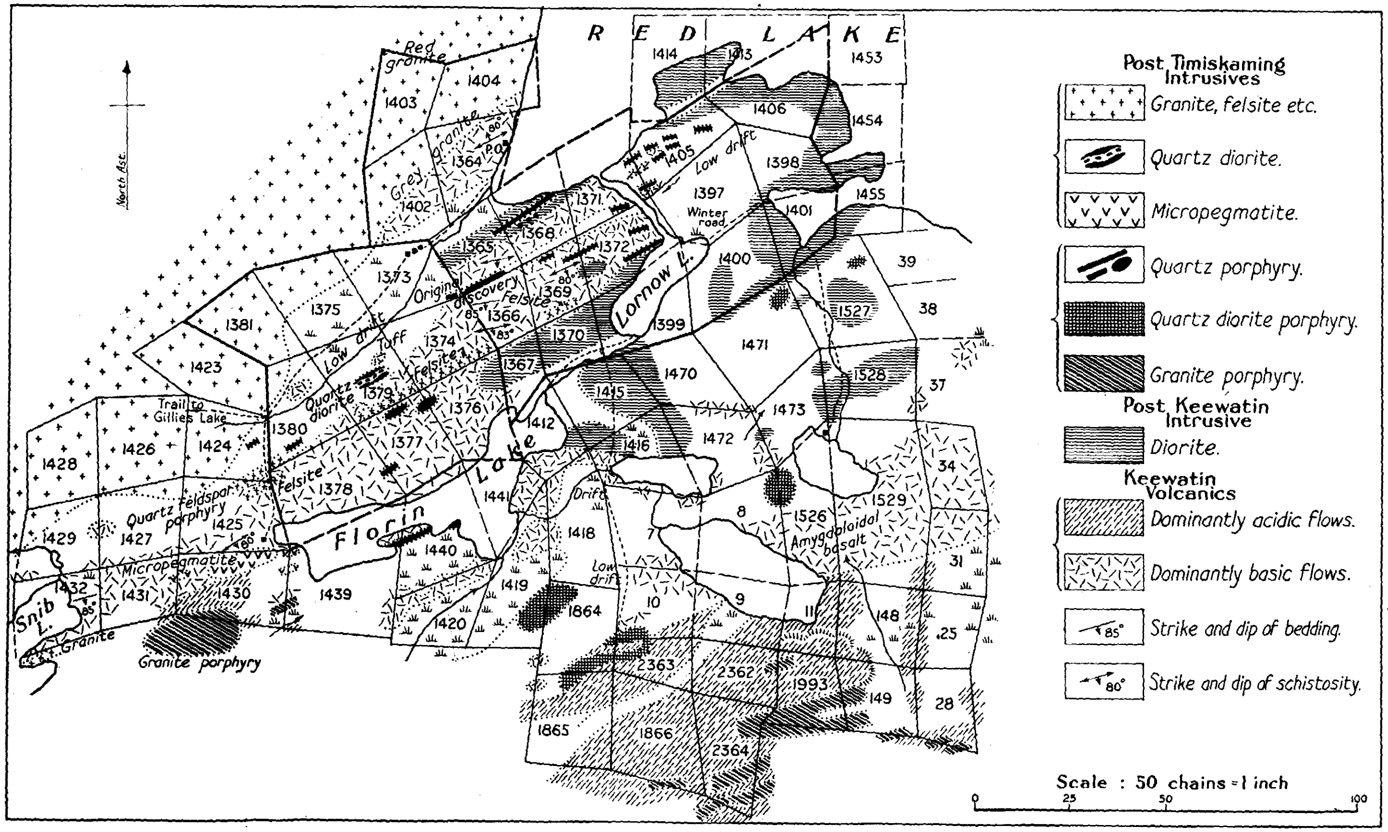
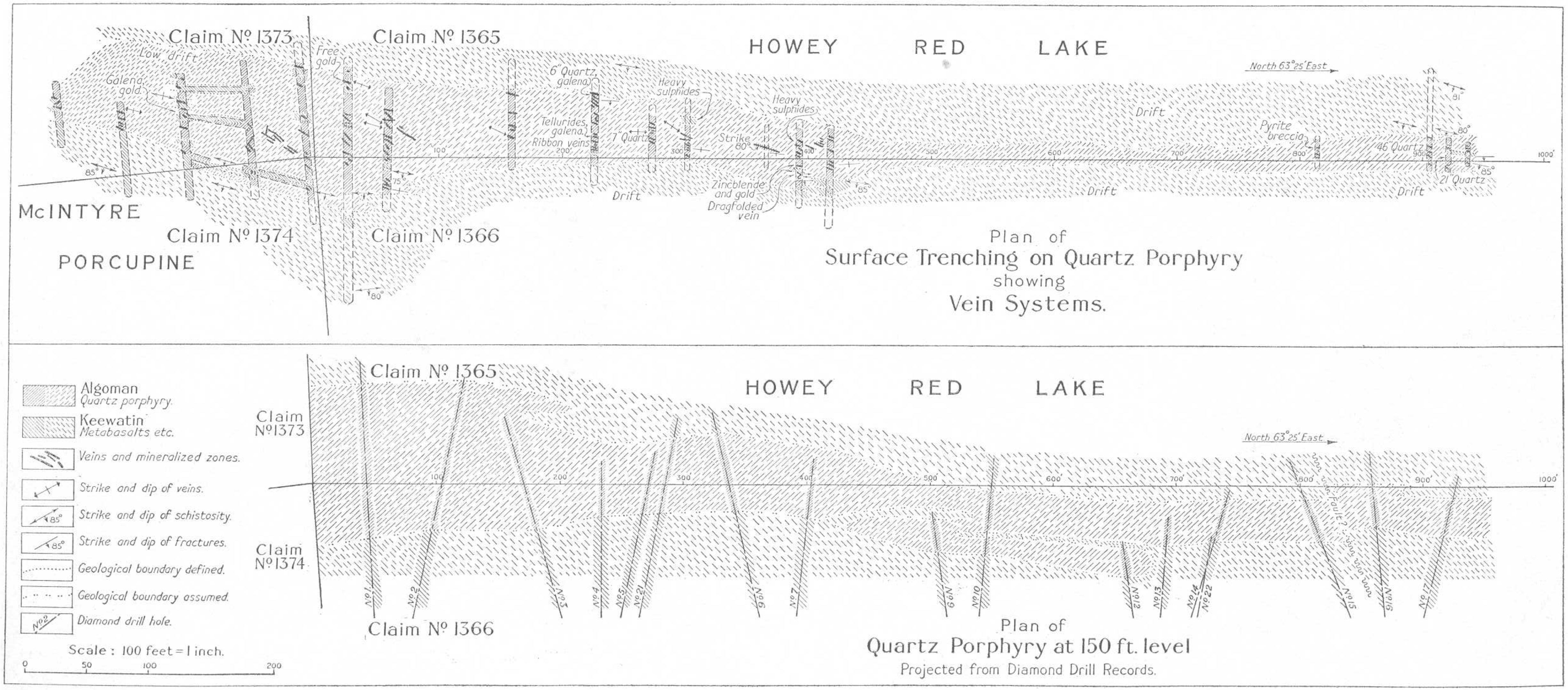
[1]The following report of recent work has been supplied by the secretary of the company:—

The shaft in October, 1927, had reached its objective of 500 feet with a sump of 35 feet. Crosscutting from all four levels (125, 250, 375, and 500 feet) was in progress. The vein is about 25 feet north of the shaft at the surface, and it is expected that only about 40 feet of crosscutting will be required at the 500-foot level to reach this ore body. A 3-compartment shaft is in operation with regular hoisting equipment. It is the purpose to drift both ways along the vein on all four levels. During the season of 1927 considerable trenching has been done, extending the vein eastward another 800 feet and making a total length of 1,800 feet.

Surface samples in the mineralized zone are being taken across the vein every three feet. Some 5,000 samples have been taken for assay. Stripping, of course, has not been completed for the entire length of the vein, but sections at intervals have been uncovered where the overburden is not too heavy.




Geological sketch map of Howey, McIntyre, and adjoining claims. The Howey claims to the northeast and the McIntyre on the southwest are enclosed with heavy lines.


Claim Nº 1373
Claim Nº 1365
HOWEY RED LAKE
Low drift
Galena gold
Free gold
6" Quartz, galena
Heavy sulphides
Heavy sulphides
North 63°25' East
Drift
Tellurides, galena, Ribbon veins
7" Quartz
Strike 80°
Pyrite breccia
46" Quartz
21" Quartz
Zincblende and gold
Dragfolded vein
Drift
Drift
Drift
McINTYRE
Claim Nº 1374
Claim Nº 1366
PORCUPINE
Plan of
Surface Trenching on Quartz Porphyry
showing
Vein Systems.
Claim Nº 1365
HOWEY RED LAKE
Claim Nº1373
Claim Nº1374
Claim Nº 1366
North 63°25' East
Fault ?
Algoman
Quartz porphyry.
Keewatin
Metabasalts etc.
Veins and mineralized zones.
Strike and dip of veins.
Strike and dip of schistosity.
Strike and dip of fractures.
Geological boundary defined.
Geological boundary assumed.
Diamond drill hole.
Scale: 100 feet = 1 inch.
Plan of
Quartz Porphyry at 150 ft. level
Projected from Diamond Drill Records.

The porphyry masses have been described in the section on quartz porphyry. The plan of the main body (see insert facing page 58), is lenticular, with a width at the west end of approximately 100 feet, and at the east, of 30 feet. Vertical sections of the porphyry, compiled from drill-core data kindly supplied by the management of the Howey Gold Mines, Limited (see insert facing page 18), show

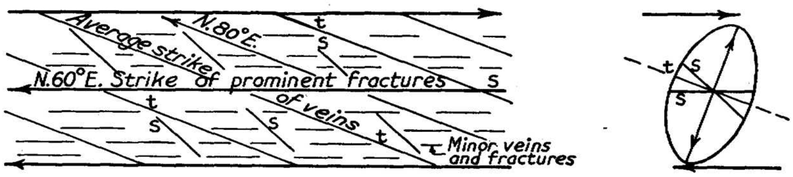



Fig. 11—Diagram showing relation of the veins and fracture systems of the Howey gold deposit to the strain ellipsoid. s = Planes of maximum shear. t = Tension fractures.

a widening at depth at the west end and a narrowing at depth to the east. They also show the intrusion of other quartz porphyry masses not exposed at the surface, some of which may yet be found to contain gold-bearing veins. The surface plan of the porphyry is somewhat similar in outline to a plan of the Homestake ore bodies, South Dakota, on the 300-foot level. These occur in schists with a lenticular and *en échelon* arrangement,[1] though the Homestake and the Howey bodies are comparable in this respect only.

Quartz vein on the Howey showing a "flat" and dragfolded character. The country rock is quartz porphyry.

The quartz veins, to which the gold is largely confined, seldom attain widths exceeding one foot. They vary greatly in length, lensing in and out, and in many places one vein is succeeded by another along the strike.

The vein systems appear at first sight to be decidedly complex, as are joint systems in any highly fractured rock. Careful study of their attitudes and their relation to unfilled fractures in the porphyry simplifies their apparent complexity and explains their origin. Details of the structure of the veins and fracture systems are shown on Fig. 11. The strike of most of the veins is at an

[1]W. H. Emmons, Principles of Economic Geology, 1918, p. 428.

angle of approximately 20°S. of that of the main porphyry mass, which trends at N. 63°E. Some veins strike with the porphyry, others lie at about N. 17°W., and minor ones have various other alignments. The most prominent fractures lie nearly parallel with the direction of the porphyry.

In general, the veins are lenticular sheets filling fractures, nearly vertical or dipping with the porphyry steeply south. Exceptions to this are found in "Z" trench, where a vein occupies a "flat" and is in part folded (see photograph on page 59). Veins with a ribbon structure are also present. These strike with the porphyry, have an approximate vertical dip, and are separated by fine ribbons of highly altered and schistose porphyry (see photograph above). An example of a vein with a dragfold shape is found in trench "I." This shows that the differential movement in the porphyry has caused the north side to move eastward, relative to the south side, regardless of whether the vein itself or a still unfilled fracture was folded.

Ribbon type of quartz veins on the Howey ore body.

With this clue as to the differential movement, the various sets of fractures and veins may be fitted to the strain ellipsoid,[1] as in Fig. 11. From the figure, it is clear that an east-west shearing movement would fracture the porphyry into the various sets recognized. It may be shown experimentally[2] that, in the shearing of a brittle mass, fractures related to tensional stresses and to shearing stresses develop rather systematically and that the time relations between either type may be reversed in different localities within a small radius. From Figs. 11 and 12, it may be seen that the dominant veins lie in fractures related to tensional stresses resulting from the movement. Minor veins occur along planes of maximum shearing, about parallel to the direction of differential movement and at slightly less than 90 degrees to this direction. The main fractures, unfilled with quartz and in many cases cutting both quartz and porphyry, are parallel to maximum shear planes, the set parallel to the direction of differential movement being best developed.

[1]C. K. Leith, Structural Geology, 1913.
[2]Op. cit.

The shearing, then, of the relatively brittle porphyry mass caused fractures of both tensional and shear origin. Into these, principally the former type, came quartz and various sulphides and, probably at the same time or preceding these, hot waters, which attacked the porphyry and altered it considerably. That the shearing movements were not short-lived, but rather long drawn out, is revealed by several facts.

Highly altered porphyry has been rendered schistose; and since hydrothermal alteration in many cases is related to the veins (see page 34), the hot waters accompanied or preceded the ore minerals into fractured porphyry and

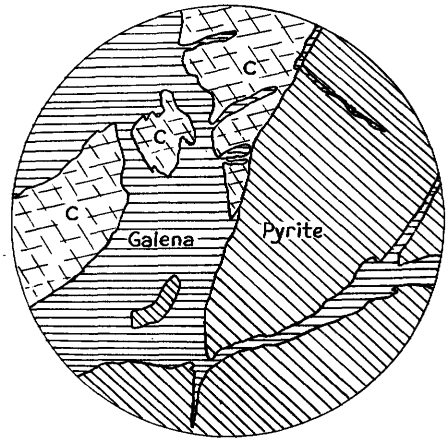



Fig. 12—Camera lucida drawing of Howey ore showing relation of galena to fractured pyrite and rusty-weathering carbonate (C), probably ankerite.

rendered it more susceptible to flowage under later shearing stresses. Many of the quartz veins have themselves been fractured and recrystallized. Some of them appear to have been drag-folded. Coarse pyrite in the quartz has been likewise greatly fractured and recemented by fine quartz and later sulphides and gold. The abundance of unfilled fractures in the porphyry, paralleling a plane of maximum shearing, also points to the continuation of shearing movements after the close of vein deposition.

Towards the west end of the porphyry mass, several quartz veins occur in narrow greenstone lenses, which are highly schistose and well mineralized. Some of these lenses may represent inclusions or unreplaced portions of the greenstone lying between smaller intrusive wedges of porphyry. The veins in these tend to follow the strike of the schists, which they in part replace. Where such veins cut both porphyry and green schist, gold is reported high in the schist, and galena and sphalerite are clearly more concentrated in the porphyry portions of the vein.

The vein minerals are dominantly quartz, with minor quantities of calcite, ankerite, scheelite, tourmaline, and feldspars, the last three being indicative of high temperatures and magmatic sources. The metallic minerals consist chiefly of pyrite and small amounts of galena, chalcopyrite, sphalerite, tetradymite (telluride of bismuth), and native gold. Gold and lead tellurides have also been reported.[1] Wright has estimated that the mineralization in the quartz is about 2.5 per cent. In the adjoining porphyry, particularly where it is highly altered, pyrite occurs as finely disseminated cubes. The mineralization there may reach as high as one per cent.

Thin sections of the vein quartz show how most of it has been sheared and fractured. Between the larger wedges of quartz, fine mosaic quartz and, locally, sericite have developed. In several sections of such sheared quartz, fine gold occurs with the cementing minerals in the fractures (Fig. 14).

Pyrite in the veins occurs as fairly coarse grains and massive clusters. Almost always the coarser pyrite has been fractured. Deformed cubes of pyrite with slickensiding occur in schistose lenses of greenstone.

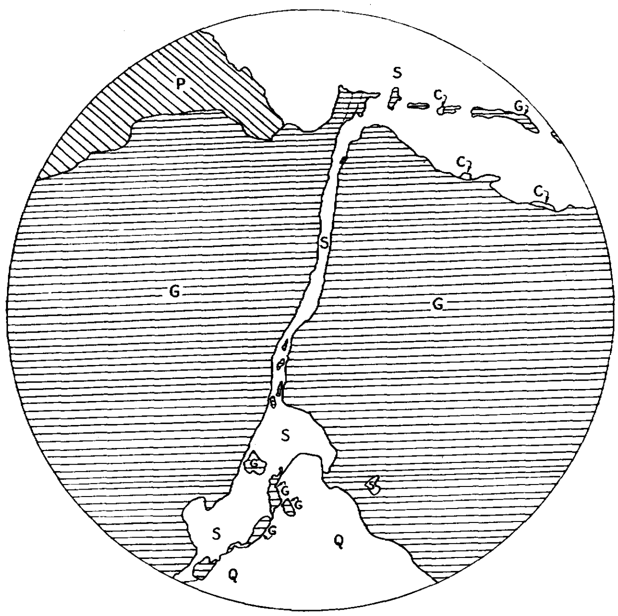



Fig. 13—Camera lucida drawing of Howey ore showing relation of sphalerite (S) and chalcopyrite (C) to galena (G) and pyrite (P). (X 30.)

Tourmaline occurs in quartz and in some schisted porphyry, where it is probably later than the porphyry. It is particularly well developed in highly fractured and recrystallized quartz and is closely associated with the pyrite. It may also be found following very definite fractures in the quartz and as a marginal replacement to the veins. Wright[1] has reported finding gold with the tourmaline.

Carbonates appear in small rhombs within the quartz and are associated with galena. Some pyrite occurs in the centre of calcite crystals, and gold has been found with these.

The galena is always in a very fine state of division. It occurs in quartz, in calcite, filling cleavage planes in the latter, and very definitely fills fractures in pyrite (Fig. 12). Associated with the galena are very fine particles of

[1]D. G. H. Wright, Eng. Min. Jour., July, 1926.

chalcopyrite. These are often related to the contacts of galena and sphalerite (Fig. 13). Chalcopyrite also occurs in fractures in quartz. Sphalerite of the resinous type is also found in fine crystals in the quartz veins and replaces

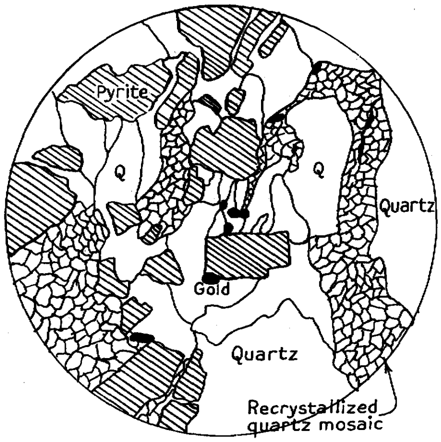



Fig. 14—Camera lucida drawing of Howey ore showing relation of gold (black) to pyrite and brecciated quartz.

sericitized porphyry along the fracture planes. It is closely associated with galena, and in most polished sections of ore is not distinguishable in age from this mineral. One section (Fig. 13) shows a stringer of sphalerite filling a fracture across galena. Associated with the sphalerite is some

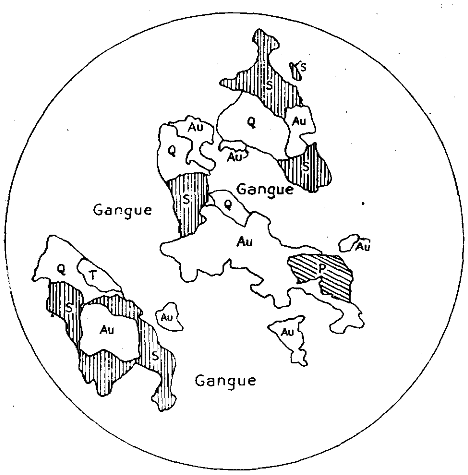



Fig. 15—Camera lucida drawing of Howey ore showing association of gold (Au) with sphalerite (S). (T) is a telluride, probably tetradymite. (× 30.)

pyrite in small cubes, possibly of a second generation, some chalcopyrite, and many fine specks of gold. A steel-grey mineral, corresponding closely with tetradymite in properties, is found in association with the sphalerite and quartz.

A telluride is also found in crushed quartz or in fractures in quartz. It is in very fine prisms, and native gold is generally associated with it.

Gold, as has been noted above, seems to be associated with almost all the other metallic and gangue minerals in the veins. It is never coarse. In polished surfaces of ore and thin sections, gold has been observed chiefly where the quartz is fractured and recrystallized (Fig. 14) and occasionally in unfractured quartz, which may be of a second generation. In some cases it occurs around fine cubes of pyrite, adjacent to it rather than in it (Fig. 14). It has been found with tellurides, of unknown composition, in fractures in quartz. A large quantity of gold is generally present with sphalerite and is in places related to the cleavage of this mineral (Fig. 15).

### Paragenesis

The genesis of the gold ores of the Howey and McIntyre porphyries seems to have been as follows:—

Following the intrusions of quartz porphyry into Keewatin greenstones, extensive shearing stresses caused the development of fractures of both tensional and shearing type. The porphyry behaved as a brittle mass compared with the adjoining, already highly altered Keewatin rocks, which yielded by flowage. During this fracturing, solutions invaded the porphyry, altering it considerably and possibly mineralizing it to a great extent with fine sulphides. Closely related to these solutions in time came the vein-forming minerals, chiefly quartz and sulphides, which filled the open spaces and in part replaced highly altered porphyry. The shearing continued, and the quartz and pyrite were much fractured and recemented with fine quartz and later sulphides, galena, and then sphalerite. The gold in many cases seems to have been one of the last minerals deposited, though it is possible some gold was also brought in with the early sulphides. Wright has suggested that it may have been liberated from the sulphides on fracturing, but its close association with sphalerite does not favour this theory.

The fact that the porphyry behaved as a brittle mass, while the adjacent schists yielded by flowage, accounts for the relative scarcity of veins in the Keewatin wall rocks. Open spaces in the porphyry were apparently sufficient to take care of most of the vein material, and no large replacement bodies were formed at the level now exposed at the surface.

The presence of feldspars, tourmaline, and scheelite in the veins indicates the magmatic origin and high temperature formation of the original fracture filling. The localization of the veins in the porphyry might be explained by their derivation from the porphyry magma at depth, but this may be merely a coincidence, as their localization can be shown as directly related to the manner in which the porphyry yielded to stress. Looking for a source for the veins and ores, we find a probable later intrusion of granite near by. This granite has been considerably sheared and altered and contains in one place at least. near its southern margin, quartz stringers in which some gold has been found, This association, and the occurrence of other smaller gold deposits in the vicinity of the smaller granitic intrusions, suggests a genetic relation between the granite and the ores of the Howey-McIntyre deposit. The intrusions of these granites caused the only marked disturbances known to follow the intrusions of porphyry, so they may be considered not only as supplying the vein minerals, but also as preparing a place for their deposition.[1]

[1]During 1927 a gold-bearing vein was found in granite. This definitely disposes of the porphyry as the source of the gold unless two or more periods of gold deposition are assumed. *See also* page 66.

The relation of the ores to the granites rather than to the quartz porphyries is of great economic importance as it widens the possibilities of discovering other ore bodies and makes favourable the chances of following this particular deposit to good depths. The depth to which the fracturing in the porphyry may be expected to extend will depend partly on how competent it was at depth to withstand the shearing stresses, and partly on its degree of alteration there. Even should the fractures in which veins have been deposited give way at depth, it is most probable that their place would be taken by deposits of a replacement type of equal value.

#### Gold Values on the Deposit of Howey Gold Mines

Through the courtesy of the Howey Gold Mines, Limited, the results of the surface sampling compiled by A. G. Gillies, foreman in charge of preliminary operations for the Howey Red Lake Syndicate, and of the diamond-drilling compiled by the Dome Mines, Limited, have been available to the authors for study.

On the surface, excellent assays of gold are reported over widths ranging up to 66 feet and averaging nearly 20 feet for a length of 1,000 feet.[1]

Diamond-drilling has shown that the porphyry body at the west end widens slightly at depth and at the east narrows, as it does at the surface. Good assays have been obtained from the cores, particularly in the western half, indicating some continuity of gold at depth. These core assays, however, cannot be considered sufficiently representative to warrant any definite estimate of the total ore reserves being made at present. The irregular distribution of the auriferous quartz at the surface is probably duplicated at depth, and only mining operations will adequately test the property. Such work seems entirely justified from the data so far secured.

### Other Working Properties

During the summer of 1926, some development work and intensive prospecting was done in the Red Lake area, but the discoveries reported from the Woman, Birch, and Narrow lakes areas, to some extent diverted the attention of prospectors from Red lake. There was a tendency on the part of many claim-holders to wait for the results on the Howey and McIntyre properties before undertaking expenditures on their own claims. In many cases, too, individuals had staked claims in the hope of a quick sale and found themselves burdened with a large area, which they were quite unable to prospect properly. Some prospectors, and especially many of the mining and prospecting companies, had their claims surveyed in the latter part of the summer, satisfying in that way the requirements for the first year's assessment work. As a result, the amount of actual work put on the ground during the summer was not great. There have been few recent discoveries, but whether this was due to the lack of thorough work on many of the claims or to actual absence of promising veins, only future work will tell. The following is a brief review of some of the properties and a statement of the work done to the latter part of September, 1926. On those not mentioned and appearing on the map as surveyed claims, the assessment work may be assumed to have been fulfilled by survey.

#### Red Lake Prospectors Syndicate

The claims of this syndicate (K. 1,423-32 and 1,439-41) lie immediately to the south and west of the McIntyre and Howey claims. The northwestern

[1]See footnote on page 57.

half is occupied by the southern extension of the Mackenzie island granite boss, which cuts diagonally across the claims to the southwest.

Along the contact of the granite on claim K. 1,424, the rock is much schisted and altered. A few quartz stringers occur in the granite here and are reported to carry gold.

To the south of the granite is a deep, drift-filled depression and at the southeast corner of the same claim and a short distance to the south are several porphyritic dikes intruding green schists. The texture and granitic or dioritic composition of these relate them to the granite rather than to the earlier quartz porphyry. Some red felsitic stringers with porphyritic phases also penetrate dark Keewatin rocks. Several small quartz stringers have been found in the vicinity of these dikes, and in some of them native gold has been observed.

On claim K. 1,430 and on the southern part of K. 1,425, a lenticular intrusion of micropegmatite occurs. To the north of this is another depression, on the sides of which splashes of quartz may be found in green schists. This depression extends along Florin (Clara) lake and has been drilled by the Dome interests without yielding any satisfactory results. Several small porphyry dikes occur along the south shore of Florin lake, but no large quartz veins accompany them.

Considerable trenching and some drilling has been done on these claims, on which the Dome Mines held an option or working agreement.

### Coniagas Mining Company

These claims (K. 1,526-29) lie a short distance south and east of the Howey claims. Considerable prospecting over them has revealed only small stringers of quartz, in which sulphides are sparsely disseminated. The northern part of the claims is occupied largely by much altered diorite, which intrudes Keewatin, and a few small intrusions of fresher quartz diorite. Barren quartz stringers are associated with these. A wide band of amygdaloidal lava extends across the central part, and to the south are rhyolitic flows.

### Victoria Syndicate

The Victoria Syndicate holds a group of claims south of the Howey and one to the north on the lake shore. On none of these have any discoveries been made. A deep pit was sunk in a drift-filled depression, which occurs along the strike of a porphyry dike on the Howey claims, but apparently did not penetrate to the rock surface. On the southern claims are several small intrusions of quartz diorite porphyry, which has been correlated tentatively with the quartz porphyry. This porphyry has been somewhat sheared but not fractured, and no quartz veins are associated with it.

### Lang

On claims K.R.L. 40-42, some trenching has shown a few glassy quartz veins in a highly altered diorite. This rock contains some quartz, but thin sections show that it is closely related in composition and degree of alteration to the older, pre-porphyry diorites of the region.

### Noranda Mines, Limited

On the Noranda claims (K. 1,479 to 1,486) wide networks of trenches, 3,000 feet in all, have been cleared. These expose a few narrow quartz porphyry dikes and a few narrow quartz stringers in basaltic flows of the Keewatin. There appears to be no mineralization with the quartz porphyry intrusions.

### Huronian Belt

The Huronian Belt Company did exploration work on two groups of claims. One group lying north of Chukuni river in the township of Balmer is in a heavily drift covered area, and exposures are not abundant. Considerable trenching was done, and several porphyry dikes were uncovered, but no discovery of promising veins has been reported.

The other group comprises claims K. 1,408 to 1,411, to the south and west of Coin lake. Considerable trenching on these claims has uncovered a few small quartz veins with sparse sulphides. What appeared to be copper in very tiny foils was found in some of the surface quartz and was probably secondary. On claim K. 1,411, a narrow band of sericite schist occurs in greenstones and is highly impregnated with fine sulphides and magnetite. The rock is highly altered, consisting largely of sericite, some rusty carbonates, fine quartz, and a little chlorite and epidote. A few remnants of altered plagioclase may be recognized and identify the schist with an acid igneous rock, probably a porphyry.

The claims are almost entirely underlain by Keewatin basalts and intrusive altered diorites.

### Chukuni Red Lake Syndicate

This syndicate holds a group of claims on the south bank of Chukuni river in the township of Balmer. The country is fairly high, but rock outcrops are not very numerous. Greenstone is intruded by granite porphyry dikes and masses. Some of these have been stripped for some distances, and in other places where no rock outcropped trenches have been dug down to solid rock. On claim K. 1,201, near the No. 4 post, a contact between the porphyry and the greenstone is exposed. Along the contact there is a lenticular vein ranging from six inches to a foot in width. It has been traced for a distance of 50 feet and strikes northwest. The gangue material is quartz, in which lie irregular lenses of calcite, the largest being a foot in length by eight inches in width. Similar lenses lie in the schistose greenstone near the vein. A little pyrite occurs in the quartz.

### Dunlop Red Lake Syndicate

The claims (K.R.L. 118-47) belonging to this syndicate lie north of Chukuni river, west of Balmer creek. The claims are surveyed. Outcrops are not numerous, as will be seen from the map. Much deep trenching on the southern claims has exposed some large porphyry dikes. A fracture zone in greenstone shows a sparing mineralization, in which the chief metallic mineral is chalcopyrite.

### Toronto Red Lake Syndicate

These claims (K.R.L. 109-117) lie immediately north of the Dunlop Red Lake Syndicate. On the hill west of Balmer creek at the outlet of Balmer lake, the rock is a dense grey felsite, which is probably a quartz porphyry. From the exposed knob at the top of the hill, trenches have been extended into the drift-covered area in all directions. One trench has been carried to the lake, a distance of about 300 feet.

### Patricia Group

The Patricia claims (K.R.L. 100-108) lie west of Balmer lake. Across the northern claims there is a heavy band of iron formation, and much development work has been concentrated on some massive pyrrhotite which occurs in it. On K.R.L. 102, a band of iron formation has been exposed by trenches for six chains along its strike and for two chains in width. In some places, this is very dense and homogeneous; in others, it shows heavy banding with silica and some pyrite. The whole surface of the rock is heavily coated with iron oxides.

### Beaumout

This group (K.R.L. 534-51) lies west of Balmer lake, between the Patricia and the Mesaba groups. A good deal of thorough prospecting has been done, and several promising-looking quartz porphyry dikes and quartz veins have been discovered. Unfortunately, so far, the gold assays have not been sufficiently high to claim any of these as ore bodies. Porphyry dikes have been stripped on the northeast corner of claim No. 550, and three prominent dikes averaging 25 feet in width and 40 to 50 feet apart, strike southeastward across No. 536 on to No. 547, where they disappear under the drift. Also on Nos. 540 and 545 other porphyry dikes have been opened up. Along the north side of the northern tier of claims is the continuation of the band of iron formation which occurs on K.R.L. 102.

### K.R.L. 1,516 and 1,517

These claims lie between East bay and the main body of Red lake. In the northwest corner of No. 1,517 and the northeast corner of No. 1,516, a bluff of rock slopes down to swampy ground to the north and west and continues southward as a soil-covered ridge. The main ridge is in part massive greenstone, in part pillow lavas. The two types are interbedded and strike N. 70° E. At the foot of the bluff, a band of soft schistose talc rock has been exposed by trenching for a width of 10 feet. South of the talc rock, the greenstone shows some fracturing. Where an open cut has been made in the rock on claim No. 1,517, there are a great many tiny irregular cracks, which are filled with calcite; cutting across these are larger veins, some of which reach a width of half an inch. The latter consist of calcite along the edges and quartz in the centre. Pyrite occurs chiefly in the quartz vein filling or along the margins between the quartz and calcite. Sphalerite of a deep-purplish colour is found scattered through the fracture zone but is seldom in great amount, a lens two feet in length with a maximum width of two inches being the largest solid mass seen in place at the time the workings were visited. An interesting feature of the mineralization is the presence on some of the fracture planes of a thin coating of cobalt bloom, perhaps derived from a small quantity of cobalt in the pyrite.

In an open cut on No. 1,516, 200 feet west of the working on No. 1,517, the greenstone shows a series of roughly parallel larger fractures with tiny parallel transverse fractures connecting the large ones, so that the whole rock is a network of veinlets. The vein filling is calcite. A few quartz veins, with maximum widths of one inch, cut irregularly through the whole. Metallic minerals are very sparingly present in this part.

The fracture zone is roughly parallel to the banding of the rocks and occurs in a massive greyish-green rock, which is somewhat crystalline. It is probably of slightly different composition from the other bands of greenstone and perhaps somewhat more brittle, so that it has retained fractures.

The development work on these properties consists of a thorough stripping of part of the face of the hill and trenching southward in several places into the drift cover. Pits have been opened up in the most fractured part of the greenstone, just south of the band of talcose rock.

### K.R.L. 1,022

This claim lies east of the channel between Mackenzie island and the mainland.

The rock is massive greenstone. Six chains south of the northern boundary of the claim, a band of carbonate rock, 45 feet in width, strikes northeast through a knoll of greenstone. The carbonate rock contains many small quartz stringers, in some of which tourmaline was observed. Gold can be found in the quartz and, in places, in what seems to be unfractured and fresh carbonate. Other metallic minerals are rare. The carbonate rock is sufficiently high in iron to produce a thick coating of rust over the surface of the dike, and naturally in this rusty material the native gold is most abundant. It is difficult, until pits have been sunk through the rusty rock surface, to estimate what the value of this deposit may be.

The work done on this claim and others adjoining it, belonging to the same owners, consists of extensive stripping of the outcrops and some shallow test pits. On claim K.R.L. 300, a large quartz porphyry dike has been uncovered. This is intruded by a narrow lamprophyre dike crossing it at a small angle. Neither dike has undergone much fracturing.

### Dome Mines

In addition to work on the Howey claims during the period of the option, Dome Mines prospected other claims north of the Hudson's Bay store and also a group of claims staked for the Dome on the southwest side of the Mackenzie island boss of granite. On one of these latter claims, K.R.L. 1,540, gold was visible. On the right (east) bank of the creek flowing into the large bay crossed by the south boundary of Dome township, the rock rises in an almost continuous bluff across claim No. 1,540. An old burned area made prospecting somewhat difficult, but in spite of that all of the outcrops were carefully examined and the covered knolls were systematically trenched.

The rock is massive greenstone with only a few narrow porphyry dikes. The granite of the Mackenzie island boss lies approximately two miles to the northwest. Along the face of the bluff toward the creek valley, the greenstone has undergone some fracturing, and quartz veins three to four inches wide fill these fractures. The veins, however, are comparatively short, tapering out both ways, but other veins commence after an interval of some feet, usually with an offset between the ends. The whole is a sort of fracture zone, but it is very irregular, and the direction of its extension was doubtful at the time it was visited. In some of the quartz veins, gold occurs rather plentifully. It is practically the only mineral other than quartz in the veins.

As noted above, the only intrusive into the greenstone near the gold occurrence is a one-foot dike of quartz porphyry, which does not seem competent to have caused the fracturing, nor is the rock near it fractured to any greater extent than that farther away. It seems likely that, owing to some slight difference in various parts of the greenstone, one particular zone was more brittle than the others and, during a slight doming action as the granite was intruded, spaces for the veins opened up and were filled by the gold-bearing solutions from the cooling magma.

### Tyrrell Red Lake

Claims K.R.L. 2,081 to 2,098 are held by the Tyrrell Red Lake Syndicate, of which J. W. Tyrrell, D.L.S., of Hamilton, is president. These claims include the original staking mentioned on page 51. On these claims there are several isolated remnants of greenstone surrounded by porphyritic granite. In one of the greenstone masses, the old shaft was sunk. Stripping and trenching in the vicinity of the shaft shows the following conditions: Fifteen feet north of the shaft, the vein has a width of seven feet of sugary quartz in a coarse-grained chloritic rock. Pyrite occurs in the quartz and in the wall rock. The vein is nearly vertical and strikes S. 27° W. Thirty feet northward from the shaft, the width of quartz is fourteen feet. Ten feet north of the stripping, there is an old pit and two new pits, showing a width of only one and a half to two feet of quartz. At this point the vein swings slightly to the west of its average strike and is not traced farther; but 15 chains N. 10° W. from the shaft, other trenches show a quartz vein with widths of as much as 10 feet, striking S. 10° E. In this vein, also, there is some pyrite. The wall rock at this point is massive diorite or porphyritic granite. The vein, if it is a continuation of the one at the shaft, cuts across the porphyry greenstone contact. One hundred and twenty-five feet farther north, across a total width of 15 feet of country rock, four stringers of quartz have a total width of one foot. Other parallel stringers are more widely spaced, and one vein has a width of 14 inches of quartz.

One chain S. 10° E. from the shaft, a pit shows a two-foot vein of quartz, in which there is considerable pyrite. Farther south there are some lenses of quartz, but the vein is not continuously traceable on the surface in that direction.

In addition to the trenching and stripping that has been done on the vein at the old shaft, test pits have been sunk along the shore on a highly pyritized siliceous zone.

### Martin

On claims west of the north end of Slate bay, deep trenches have been dug across a very acidic rock that outcrops to the east along the shore of Slate bay. The hand specimen contains considerable quartz that is visible to the naked eye. The microscope shows, however, that the rock is not a porphyry, but that the quartz is irregular in distribution having much the arrangement that the interstitial quartz in a granite has. In the rock, however, the feldspars, if they ever were present, have been so completely altered to sericite that no trace whatever of them remains, and the rock is entirely quartz and sericite. It is believed, however, that it was originally a binary granite. No other rock is in contact with the quartz-sericite rock, but it is probably a dike. Southward across the creek, greenstone outcrops. In the pits the rock shows some fracturing with the introduction of chalcopyrite. On the north side of the bay, an acidic igneous rock that has been stripped shows quartz veins that contain a little galena, pyrite, and chalcopyrite. The veins are irregular and have a maximum width of three inches.

### Northern Mineral Areas

Most of the claims of Northern Mineral Areas on which work has been done are located on the south side of the long bay north of Wolf narrows. The rocks of the central part of the divide between this bay and the main body of the lake consist of greenstone with some rather heavy bands of iron formation. Along the shore of the bay the rock is a coarse conglomerate formed chiefly of rounded or subangular fragments of iron formation. The matrix is composed of finer fragments, and the whole is heavily iron-stained. Much trenching has been done on the properties, chiefly on these iron-stained bands of fragmental rocks.

### Foley Red Lake Syndicate

These claims lie west of the west end of Trout bay. Work has been done on a large quartz porphyry dike that extends northwestward from the end of Trout bay. This dike has been severely compressed and has developed an extremely evenly banded structure. In places the porphyry has altered to a highly foliated or crumpled sericite schist. In others, the schist is black, perhaps from the shearing of included basic rocks. Parallel to the banding, quartz lenses occur which have a width as great as a foot and a half and lengths of two to three feet. Smaller irregular quartz veins cut across the foliation. Pyrite occurs in both quartz and schist, but is not abundant.

Development work consists of extensive trenching across this dike with some shallow test pits. An attempt has been made to reach the south wall, but in that direction the clay overburden was found to be very deep.

### Dupont

Along the west side of Pipestone bay, some sheared zones have been discovered in the great mass of quartz porphyry occurring there. In one of these zones a quartz vein, three inches wide at the water level, narrows to two inches a short distance from the lake and disappears beneath the soil in a hollow about 50 feet from the shore. Pyrite occurs in the quartz and as veinlets, both parallel to the quartz vein and cutting across it. In places these veinlets contain tiny vugs, which are filled with small pyritohedra of pyrite. Gold pans freely from the decomposed rock, but the unaltered material, both quartz porphyry and quartz, contains only small quantities of gold.

To the east of Pipestone bay, the original greenstone has been almost completely altered to secondary carbonates. Large masses of quartz porphyry occur to the east, and the porphyry on the west side of the bay may extend eastward a considerable distance beneath the lake. In this area of carbonate rock, there are many dikes of porphyry. Some of these have been stripped and opened up by test pits. The most promising one is three feet in width and cuts through a highly talcose carbonate rock. Along both walls of the dike are quartz veins which reach maximum widths of three inches. Both dike and walls are impregnated with pyrite.

Development work has also been done on the holdings of this group north of Pipestone bay near the main granite contact, but so far as known without any encouraging results.

### Scott

On K.R.L. 1,719, south of Pipestone bay, a number of quartz veins have been exposed. At one place two quartz veins, each with a maximum width of 18 inches, strike north and south. They are separated by 15 feet of greenstone. At the south end both terminate abruptly as if faulted. Both quartz and greenstone wall rock carry pyrite abundantly. Fifty feet to the north, a northwesterly-striking series of veins have a total width of 15 feet. At the northeast side of the zone, one vein of solid quartz has a width of three feet. Of the other 12 feet of the 15-foot zone, about one-half is quartz. The country rock is a coarse-grained, dioritic-looking type, possibly formed by the secondary development of crystals in the greenstone. Both quartz and wall rock are sparingly pyritized.

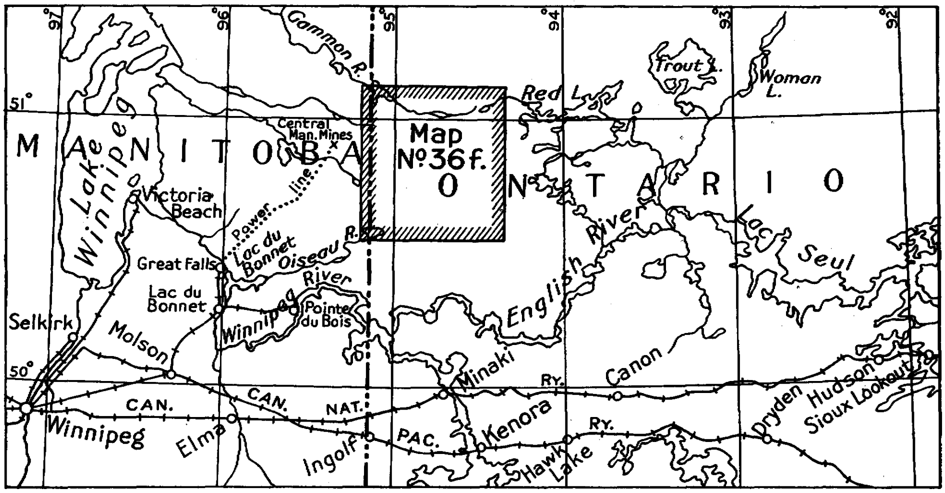
On K.R.L. 1,710, a large dike of acidic rock has been cross-trenched and stripped for some distance. It is similar in character to the dike west of the north end of Slate bay and consists of sericite, which is probably the result of the complete alteration of feldspar, and quartz, which still has the interstitial arrangement it had in the original granitic rock. In the dike are numerous veinlets of vitreous quartz with a maximum width of three inches. The veins contain little but quartz, but the rock of the dike is well sprinkled with pyrite, much of it in small, well-formed pyritohedra.

# Gammon River Area and Rickaby Lake Schist Belt, District of Kenora (Patricia Portion)

By Geoffrey Gilbert

## INTRODUCTION

The area dealt with in this report lies to the west and southwest of Red lake It is a roughly rectangular area extending from meridian 94° 20′ W. (the western edge of the Red Lake sheet) to the Manitoba border (95° 09′ 06″ W). The northern boundary is the Gammon river (known until recently as the south branch of the Bloodvein river), which heads almost due west of Red lake and flows westward. The southern boundary is a line joining Snowshoe lake, on the Manitoba border, with Sydney lake, at the head of the Sturgeon river.




Key map showing position of Gammon River area. Scale, 50 miles to the inch.

The field work on which the report is based was essentially a reconnaissance survey. A series of gold-bearing volcanic and sedimentary rocks, the Rice lake-Bulldog lake schist belt, covers a wide area just to the west of the Manitoba boundary and extends eastward into Ontario. The part immediately east of the border was mapped in 1912 by Moore[1] and in 1921 by Burwash.[2] In the spring of 1926 prospecting became active on the Ontario side, and a large number of claims were staked in the neighbourhood of Rickaby and Bee lakes. As the eastern end of the schist belt had not been defined, it seemed possible that it might extend for a considerable distance, and might even connect with the Red lake belt; or, at least, that an appreciable part of the intervening area might be underlain by schists. The writer was, therefore, instructed to make a reconnaissance of the region, giving special attention to the country around and east of Rickaby lake. This was done during the summer of 1926.

[1]E. S. Moore, Geol. Surv. Can., Sum. Rept., 1912, pp. 262-70.
[2]E. M. Burwash, Ont. Dept. Mines, Vol. XXXII, pt. 2, 1923.

The geology of the country near the border was known in some detail from the reports of Moore and Burwash, and from the later work of J. F. Wright[1] on the Manitoba side. The geology of the country farther east was unknown, but the topography had been accurately mapped by aerial surveys. The map accompanying this report is a reproduction, on a larger scale, of parts of the Pointe du Bois and Carroll Lake sheets of the Topographical Survey of Canada, with some corrections and with such additional information as could be obtained during the work.

The results, on the whole, were disappointing. The Rickaby lake belt was found to end within a few miles of the provincial border, and no other schist areas were discovered. The remainder of the territory is underlain by granite and gneiss; the reconnaissance was thorough enough to establish the fact that it can contain no schist belts large enough to be of any importance.

### Acknowledgments

I am indebted to J. F. Wright, of the Geological Survey of Canada, for details of the route between Garner and Glenn lakes.

W. H. Hansen, of the University of Toronto, rendered excellent service as senior assistant. The junior assistants were W. B. Mather and F. Beamish of McMaster University.

### Means of Access

There are several routes leading into the area. The Rickaby lake country is reached most easily from the southwest, by way of Lac du Bonnet and the Oiseau river. Starting from the town of Lac du Bonnet, on the Canadian Pacific railway, one can travel by motor boat down the lake to the mouth of Oiseau river (a distance of twenty miles) and up the river as far as the first falls, about five miles from the mouth and two miles above Bird River P.O. From this point travel is by canoe, along a very good route. The first portage is slightly over a mile in length, but a horse and sled are available for transporting supplies. Between this portage and the east end of Snowshoe lake, a distance of approximately forty miles, there are eleven short portages and lift-overs totalling 84 chains. For the first fifteen miles the river averages two to three chains in width, and the current is negligible. For the remainder of the distance it consists of a series of fair-sized lakes (Oiseau, Tulabi, Elbow, McGregor, and Snowshoe) connected by short stretches of river. To reach Rickaby or Bee lake, one leaves the Oiseau river just east of Snowshoe lake and crosses two portages (12 and 87 chains) into Wingiskus lake. To reach the eastern end of the schist belt, one continues up the Oiseau to Chase (Fishing) lake. In this upper stretch there are six portages totalling 30 chains.

Another route leaves railhead at Pointe du Bois, Man., goes eastward up the Winnipeg river for ten miles and then northward through Birse and Booster lakes to Oiseau lake, thence up the Oiseau river.

Rickaby lake can be reached from Lake Winnipeg by the Manigotagan or Wanipigow rivers. Farther north, another route from Lake Winnipeg leads up the Bloodvein and Gammon rivers to Carroll lake.

The map-area can be entered from the south by way of the Sturgeon river, which can be reached by various routes from Minaki or other points on the main line of the Canadian National railway.

[1]J. F. Wright, Geol. Surv. Can., Sum. Rept., 1922, pt. C, pp.45-82; Sum. Rept., 1923, pt. B, pp. 86-104.

## Routes within the Area

Travel within the map area is facilitated by the enormous number of lakes. Practically every part of the region can be reached with comparative ease by canoe. A study of the map will always enable one to trace out a route without any large amount of overland travel; and where two lakes lie close together, there is usually a portage already cut. Further, in most places the bush is so light that even if no definite portage exists a canoe can be taken through with little effort.

There is a surveyed route along the northern edge of the map, connecting Carroll lake with Red lake. The western half of this route consists of a chain of large lakes (Carroll, Donald, Hammerhead, Gammon) which form the upper Gammon river. The eastern half contains several long portages and two bad stretches of narrow creek. Altogether, between Carroll lake and Pipestone bay, there are 23 portages totalling six miles.

There is, however, a much better and apparently newer route from Carroll lake to Red lake. This goes through Donald and Hammerhead lakes and then turns southeast, passing through Rostoul, Hansen, Glenn, Optic, Telescope, and Embryo lakes, which form a chain draining into Gammon river. This route enters Red lake via Douglas lake and Trout bay. It is about the same length as the other, but contains only 16 portages totalling two and a half miles.

A party going from Red lake to the Manitoba schist belt can take the route just referred to as far as Hansen lake, and then swing off to the southwest through Wrist (Wright), Welkin (Welcome), and Beamish lakes, reaching the provincial boundary at Garner lake. To reach the Ontario end of the belt, they should diverge from this latter route at Welkin lake, turning south into Aegean lake and descending the Oiseau river.

Haggart river forms a good north-south route a few miles east of the provincial border, and Talon river provides easy access to the southeastern part of the area. The only part of the entire region that offers any obstacles to canoe travel is the country south of Optic and Telescope lakes.

## Drainage

The area is a part of the Nelson River basin, and all the streams within it flow eventually to Lake Winnipeg, but they do so by way of four different river systems. As might be expected in a region containing the headwaters of several rivers, the drainage pattern is complicated, with many small streams and no very large ones. An attempt has been made to indicate on the map the position of the various watersheds, but it will be understood that these are only approximations. Broadly speaking, the flow is outward in all directions from the centre of the map.

The greater part of the area drains north into the Gammon river, which forms the north boundary of the map and which flows westward into Manitoba, where it joins the Bloodvein. A few square miles around Indian House lake, in the northeast corner, drain directly into the Bloodvein.

Another small area near the northwest corner contains the headwaters of the Wanipigow, and a larger area along the provincial boundary drains into the Manigotagan. Both of these rivers flow almost due west into Lake Winnipeg.

The southern part of the map lies in the Winnipeg River basin, but this also can be subdivided. The southwest corner is drained by the Oiseau river, which joins the Winnipeg at Lac du Bonnet, while the southeast corner discharges into the Sturgeon, which flows south into the English, a tributary of the Winnipeg.

Finally, a very small area along the east edge drains into the English by way of Red lake and the Chukuni.

## Physiography

The region exhibits the features characteristic of the Canadian shield. It is a well-developed peneplain, with little relief; few of the hills rise as much as a hundred feet above the nearest lakes. In detail the surface is irregular, low knolls or ridges alternating with small areas of drift or muskeg. In the schist belt, where rocks of different hardness lie in approximately parallel bands, the ridges and valleys are well defined; and this is also true of those areas of granite in which the gneissic structure is most pronounced. Where the granite is massive, the country is often conspicuously flat, with very low, rounded knobs of bare rock rising above shallow lakes or drift-filled basins.

The area contains an exceptionally large number of small lakes. Many of these are quite irregular in shape. Others are long and narrow, and in some part of the map these show a more or less definite tendency towards parallelism.

The lakes are, of course, of glacial origin. They are the result of the disorganization of the pre-glacial drainage systems, mainly by the blocking of valleys by drift. The reason for their abundance would appear to be the flatness of the pre-glacial topography. The surface over which the ice-sheet passed was a gently rolling one, a peneplain dissected only to a slight degree. The deposition of morainal material, therefore, caused the formation of many small lakes with complex shorelines and numerous islands. The long, narrow lakes, on the other hand, were formed by the blocking (and to a minor extent by the over-deepening) of pre-glacial linear valleys. These valleys, which are a well-known feature of the Canadian shield, are most frequently attributed to erosion along fault lines, and this is probably the explanation of some of the linear valleys in this area. Others, however, have a trend parallel to the gneissic banding of the granite and appear to have been formed by the erosion of the weaker belts of gneiss.

## Timber

The most important trees are jackpine, spruce, poplar, and birch. On the rock ridges jackpine is almost the only species found and it grows abundantly, though usually only to small size, wherever it can find crevices in which to take root. In the muskegs scrub jackpine and spruce are found. On the drift-covered areas, and especially on the lower ground along the larger lakes, jackpine and poplar often attain considerable size. Balsam is fairly common, though much less so than spruce. White pine, red pine, and cedar are almost if not entirely absent.

As a rule the undergrowth is very light, a feature which makes bush travel comparatively easy. In some of the swampy areas alders and other shrubs are thick enough to impede progress, and in other places the scrub jackpine and spruce form troublesome thickets, but generally the trees are rather widely spaced. The large jackpines and poplars, widely spaced and free from underbrush, form beautiful natural parks, especially on some of the level drift-covered areas.

## Game

Deer are abundant through most of the region and are often met, especially along the rivers. Moose are common, and several caribou were seen. Bears are rather numerous. Other fur-bearing animals are reported to be fairly plentiful, and a certain amount of trapping is done. Beaver, however, seem to be very scarce; few signs of their work were observed, and scarcely any that appeared to be of recent date.

Pike abound in most of the lakes, and pickerel are usually obtainable. Most of the larger lakes are said to contain lake trout.

Ducks are plentiful on all the larger streams and many of the lakes. Spruce and birch partridge were seen fairly frequently, especially the former, but they are not as common here as in many other parts of Northern Ontario.

## GEOLOGY

The general geology may be summarized in the following table:—

| | |
|---|---|
| PLEISTOCENE: | Till |
| | *Great unconformity* |
| PRE-CAMBRIAN | |
| ALGOMAN (?): | Granite and granite gneiss |
| | *Intrusive contact* |
| KEEWATIN-TIMISKAMIAN (?): | Congomerate, greywacké, slate, iron formation, etc. Lava flows and pyroclastics. |

Much the greater part of the map-area is underlain by granite. The only non-granite area is the southwest corner, which contains the Rickaby lake schist belt. The schists are undoubtedly older than the granite, and are intruded by it. The relations of the members of the schist series are uncertain, but it seems improbable that they can be separated into a lower volcanic series and an upper sedimentary series; that is to say, the terms Keewatin and Timiskamian, as ordinarily used, do not apply strictly to this region. They are inserted in the table simply to bring out the fact that the schists are older than the great granite complex by which they are surrounded.

### Rickaby Lake Schist Belt

The Rickaby lake belt consists of a group of volcanic and sedimentary schists running nearly eastward from the provincial boundary. Its width at the boundary is about six miles, its length (in Ontario) about sixteen. Between Wingiskus lake and Chase lake, it is split into two unequal parts by an elliptical intrusion of granite. East of Midway (Lower Eagle) lake it again splits; the two forks become more and more granitized and die out altogether within a few miles. In fact the whole lower fork, from Chase lake east, is cut up by numerous dikes of granite, and the southeast contact as shown on the map is only an approximation. The northern fork is similarly intruded at its east end. Successive outcrops in this neighbourhood show alternations of normal schists, granitized schists, granite with inclusions, and fresh granite; and again the contact could be drawn only roughly.

The remaining contacts are defined, except in a drift-covered area just north of Chase lake. Along the northern boundary of the belt, the granite is usually very gneissic and the sediments are granitized to some degree, so that there is a transition zone in which it is difficult to tell whether one is dealing with a granite gneiss or a sedimentary gneiss. The granite in the small embayment east of Midway lake is also coarsely gneissic. The south contact is generally sharp, and the gneissic structure of the granite not pronounced.

The rocks of the belt fall roughly into three groups, as follows:—

1. A southern area of siliceous sediments.
2. A central area of basic and intermediate volcanics.
3. A northern area consisting chiefly of sediments, ranging from conglomerates to slates, but containing interbedded acidic pyroclastics and perhaps lava flows.

### Southern Area

This consists essentially of the region south of the outlet of Wingiskus lake and south of the granite intrusion which splits the belt farther east. It is underlain by a rather uniform series of quartzose sediments, which are typically developed in the area west of Wingiskus lake. They are dark-grey, fine-grained siliceous rocks, obscurely bedded. In the coarser phases the quartz grains are sometimes recognizable; the finer phases are micaceous, sometimes passing into muscovite or biotite schists. Very little conglomerate was noted, and but little slate; the dominant type is a greywacké or impure quartzite.

The microscope shows the most typical specimens to be composed mainly of subangular quartz grains, with occasional grains of feldspar, magnetite, garnet, etc., in a matrix of brown biotite, sericite, and quartz. The rocks are undoubtedly derived from somewhat impure sandstones.

In the eastern part of the belt the rocks are similar, though a quartz-biotite schist is the commonest type. The change is probably due to the increasing degree of metamorphism by the granite rather than to any marked difference in the nature of the sediments themselves.

### Central Area

The rocks mapped as volcanics form a band two or three miles wide in the neighbourhood of Rickaby lake and Odd and Ninety lakes, and the north bay of Wingiskus lake. Farther east, south of Eden lake, this band narrows and perhaps dies out altogether, but it widens again in the region east of Eagle lake. They are mainly a series of dark, heavy greenstones, showing considerable variations in structure and texture. They are generally massive, but frequently schistose and sometimes banded. The evidences that they are volcanic are usually obtainable, though not always obvious. Pillow structure was noted at one locality south of the east end of Bee lake. Amygdules are fairly common, and small phenocrysts often stand out on the weathered surfaces. Occasionally coarse phases occur with a texture which is definitely igneous, but these are rare.

Near the border, in the vicinity of Odd and Ninety lakes, the prevailing rocks are light-green, rather soft, with numerous small rounded feldspar phenocrysts. The specimens of this rock examined microscopically contained abundant feldspars, usually so much calcitized and saussuritized that their composition is difficult to determine, though most of them are certainly plagioclase. The groundmass is a fine-grained, murky intergrowth containing feldspar, some quartz, epidote, much calcite, and some kaolin-like material.

Farther east the rocks appear darker and more basic. Under the microscope they are seen to be composed of predominant amphibole in small needles with parallel orientation, intergrown with fine-grained quartz and feldspar, usually untwinned. The amphibole is generally green hornblende but sometimes a feathery variety with low bi-refringence. Calcite is usually plentiful. Chlorite, epidote, serpentine, and magnetite are the chief accessories. Biotite occurs in some specimens. The textures revealed by the microscope are not definitely igneous. Whatever the original mineral composition of the rocks, they must have been thoroughly recrystallized. However, their general composition, and especially the occurrence of hornblende rather than biotite as the main dark-coloured mineral, corroborates the field evidence that the rocks are essentially andesites and basalts.

### Northern Area

This contains a much greater variety of rocks than the other two. They are essentially clastic sediments of various kinds, from conglomerates to slates, with lesser amounts of volcanics.

The conglomerate is exposed most abundantly in the neighbourhood of Eden lake, but it is found also to the west on Bee lake, and to the east on Midway lake. The coarser phases contain pebbles, several inches in diameter, of granite, felsite, schist, quartz, etc., in a matrix of smaller quartz grains and biotite. In the finer phases the pebbles are chiefly quartz, and the rocks grade into normal quartzites. The quartzites in turn range from coarse-textured, highly siliceous rocks, in which the individual grains are readily distinguishable with the naked eye, to finer grained, dark, micaceous rocks resembling the greywackés of the southern area. Slates and phyllites were noted at several localities, chiefly around the east end of Eden lake. They are soft, usually dark-grey or purplish, with splintery fracture and fairly definite cleavage. Of two specimens examined microscopically, one was composed almost entirely of sericite and quartz; the other contained large amounts of chloritic material.

In addition to these easily identifiable sediments, there are large amounts of fine-grained, glassy-looking rocks whose origin is more doubtful. They are usually grey to black on fresh surfaces, sometimes greenish, with smooth fracture, and in most cases carry pinhead crystals of quartz and more rarely of feldspar. They weather very light. The weathered surfaces in many places show a definite banding suggestive of stratification; in other places they are quite massive. All of them are hard and obviously very siliceous. In some cases, rocks composed chiefly of such material contain abundant pebbles or fragments of felsite.

These fine-grained rocks are difficult to identify in the field. Any given exposure may be a quartzite, a volcanic agglomerate or ash, a rhyolite, or an intrusive quartz porphyry, and frequently a very detailed examination of its behaviour when traced both along and across the strike is necessary to settle the question. In all probability most of them are quartzose sediments. Nevertheless, specimens of many of the doubtful rocks, when examined microscopically, have a distinctly volcanic appearance. Feldspar crystals are usually present, sometimes sharp, sometimes rounded, sometimes fragmented, but nearly always suggesting phenocrysts rather than clastic grains. The fine-grained matrix of quartz, feldspar, epidote, and indistinguishable murky material often resembles a recrystallized glass. Even in the case of some of the pebble-bearing rocks, the groundmass has this igneous appearance; and they are, therefore, considered to be agglomerates. Some of the massive rocks may possibly be quartz porphyry intrusives, but none of them was definitely ascertained to be so; and the fact that they were observed only in this northern area, interbedded with sediments and pyroclastics, makes it more probable that they are flows.

Iron formation was noted at several places on Eden lake and at the east end of Bee lake, occurring in at least two distinct bands in the sedimentary rocks. One of these bands follows the north shore of Eden lake, appearing on one of the islands and on two points on the mainland. The magnetic disturbance has been traced under the northwest bay, and the band outcrops just south of Macaroni creek (the short creek between Eden and Bee lakes) and appears again on a point on the north shore of Bee lake. The other band is visible at two or three places along the south shore of Eden lake. On the peninsula between Eden and Bee lakes, the compass aberration is very noticeable, and the band is reported to occur again west of the Wingiskus–Bee lake portage.

Where observed, this iron formation consists of slates and other indeterminate schists, usually rather contorted, carrying bands of ferruginous chert and of quartz-magnetite, with occasional narrow bands of high-grade, fine-grained magnetite. The usual width of the whole belt is from 20 to 50 feet. The high-grade portions are only a few inches wide; and, so far as observed, the formation is much too lean to be of any possible economic value, except perhaps in the distant future.

#### Structure

The structural relations, and hence the relative ages, of the various members of the schist complex were not determined with any certainty. As a rule the dips of the bedding and schistosity are vertical or nearly so. In the southern area the regional dip of the sediments is steeply to the north, and apparently they pass under the volcanics of the central area. This would suggest that the general structure is synclinal, with the sediments underlying the lavas. Such an interpretation, however, would imply that the sediments of the northern group correspond to those of the southern group; whereas in fact they are of a distinctly different type. The southern group is a rather uniform series of quartzites and greywackés, while the northern contains much greater amounts of other kinds of sediments. Perhaps the structure is essentially monoclinal, with the oldest rocks to the south.

Moore, in his original reconnaissance of the belt, divided the schists into two series. The older of these, the Rice Lake, was essentially volcanic; the younger, the Wanipigow, was essentially sedimentary. The more detailed work of J. F. Wright on the Manitoba portion of the belt has shown the relations to be more complex than was at first supposed. His final results, as yet unpublished, will probably throw much light on this question.

North of the main schist belt, a small band of volcanics crosses the provincial boundary between miles 95 and 96. East of the line this grows narrower and quickly dies out into a granite with basic inclusions. A somewhat similar small band is exposed on the creek just north of Reahil lake.

### Algoman (?) Granite

Except for the Rickaby lake belt, the whole map-area is underlain by granite or granite gneiss. The granite in contact with the schists shows intrusive relations, and it is, therefore, classed doubtfully as Algoman, though it is by no means certain that it is all of one age.

The granite complex shows all the usual variations. The commonest phase is a moderately fine grained, slightly gneissic, grey or pinkish rock, composed of the feldspars, quartz, and subordinate biotite or muscovite. There are, however, all sorts of variations in texture, colour, and composition. In places quartz is entirely lacking, and hornblende sometimes replaces mica as the dominant ferromagnesian mineral. The gneissic banding may be well developed or it may be entirely absent. The strike of the gneisses varies greatly but most commonly lies between east and northeast.

In many parts of the area the granite contains inclusions, and locally they are sometimes very abundant. They are bands or blocks of a dark rock, in most cases biotite schist. They sometimes show typical *lit par lit* relations to the granite; more often they are simply angular or subangular fragments completely surrounded by granite. They are, without much doubt, the altered remnants of the roof under which the intrusive solidified. They weather more easily than the granite, and the rocks along the lake shores often show pits caused by the partial erosion of the blocks.

There are no areas of these rocks large enough to be mapped; and it would, in any case, be impossible to draw definite contacts. Even where the inclusions are largest and most abundant, an adjacent outcrop may show perfectly normal granite. They were noted at many places over practically the whole area, but they are perhaps most numerous in the southern and eastern parts. They are especially noticeable in a belt along Embryo and Telescope lake and in the region west and northwest of Kilburn lake.

In the area between Snowshoe lake and the main schist belt, there are two fairly well defined bands of this kind. They are composed of coarse granite gneiss and biotite schist in approximately equal amounts. One of these bands runs through the small lake just north of Snowshoe; the second runs through Johnston lake. Each of them parallels the main contact, but they are separated from the main belt and from each other by areas of normal granite. They are apparently pendants from an extension of the schist belt, which has been removed by erosion.

No evidence was secured to indicate that there was more than one period of granitic intrusion. The complex shows the differentiation characteristic of any large intrusive mass, and occasionally contains pegmatite dikes which are younger than the main body; but these may well be subordinate features of a single period of injection. Careful mapping of the schist inclusions and of the directions and degrees of development of the gneissic structures would undoubtedly throw light on this question, and perhaps reveal the existence of a number of distinct batholiths; but in a reconnaissance survey nothing of this sort could be attempted.

A noteworthy feature is the complete absence, throughout the region, of the diabase dikes which are so common in the eastern parts of the province.

## Pleistocene

The whole region has been heavily glaciated by an ice-sheet moving in a general southwesterly direction. The hills consist in the main of rounded polished rock, in some plates bare or covered only by moss, in others carrying a thin veneer of glacial drift. The smaller basins between the hills are for the most part filled with drift, or else have been filled in since glacial times by the washing down of sand from the higher ground. They are usually badly drained and hence form swamp or muskeg. The lower ground is often deeply covered by drift, but there are few areas of any size without rock exposures. Aqueo-glacial action is not conspicuous. Small sand plains are fairly common, but no large clay areas were noted.

## ECONOMIC GEOLOGY

### Gold

The activities of prospectors in this area have been directed almost entirely to the discovery of deposits of gold. The part of the schist belt which lies in Manitoba has been prospected more or less actively for several years, and several groups of claims have been and are being developed with encouraging results. The first excitement on the Ontario side came during the winter of 1925-26, at the time of the Red lake rush. A discovery on Rickaby lake led to the location in February, 1926, of a group of claims along its south shore, and subsequently to the staking of a solid belt extending from Wingiskus lake to the provincial boundary in the neighbourhood of Odd and Ninety lakes. In the early summer the country farther east, along the same strike, received attention, and in particular the area around the east end of Eden lake was staked solid. In August another discovery just west of the boundary line was followed by the locating of a number of claims north of Ninety lake and west of Bee lake. The total number of claims recorded during the year in the Ontario part of the belt was approximately 236. Of these 61 were reported abandoned by the end of the year.

The total amount of stripping and development work done on the claims was not large, and the results in general were disappointing. The ground staked included various members of the schist complex. The earlier claims were mainly in greenstone. At many places stringers and short gash veins of quartz were exposed, but they were ordinarily entirely lacking in sulphides or other evidences of ore mineralization. The claims farther east were chiefly in sediments and the associated acidic volcanics. Certain beds or bands contained appreciable amounts of pyrite disseminated through a tight rock, and also small quartz veins or stringers, but so far as the writer is aware no major "breaks" nor important zones of mineralization were discovered. The assays of which the writer has any knowledge were rather uniformly low. The quartz specimens commonly ran nil or a few cents, and the occasional specimens which approached commercial grade were for the most part from unexpected places in the country rock.

These remarks should not be construed as a wholesale condemnation of the area. Owing to the limited amount of time available the writer's work was chiefly in the nature of a reconnaissance, and certainly not thorough enough to warrant any such generalizations. The results so far have been mainly negative, but as already stated only a small amount of intensive prospecting has been done, and it is quite possible that important discoveries may yet be made.

The whole schist belt can of course be regarded as a region of possible ore deposits, and only a comparatively small part of it was staked during 1926. The southern sediments, apparently, were hardly looked at; and although the writer's field work disclosed no particular evidences of mineralization, it would seem that they are worth a more careful examination than they have yet received. It will be noted from the map that an elliptical intrusion of granite lies under and to the east of Wingiskus lake. In the area just west of this intrusion, between Wingiskus lake and the boundary, the sediments are cut here and there by granite dikes, and on theoretical grounds this might be expected to be favourable territory.

Another promising area, as yet unstaked, is the east end of the north fork of the belt, a mile or two east of Eagle lake. Here the rocks are much broken up by small intrusions, and there seemed to be an unusual abundance of quartz stringers, while small amounts of sulphides were noted at a few places.

The following notes on particular properties make no pretense at completeness.

#### Anglo-Canadian

The "original discovery" on Rickaby lake was a discontinuous vein of practically pure, fine-grained quartz, with a maximum width of a few feet, apparently a band of silicified schist. This was exposed on the south shore of the lake and was exposed by stripping and test pits at several places near the shore farther east. Small amounts of sulphides were noted in some of these pits. The claims are reported to have been abandoned.

#### Minerals Finance Syndicate, Toronto

This syndicate has a group of 16 claims in the peninsula between Rickaby, Bee, and Wingiskus lakes, mainly in greenstones. Work on these claims during the summer of 1926 is said to have uncovered a vein of mineralized quartz and sulphides several feet in width. A galena-calcite vein is also reported. The writer had no opportunity to examine either of these veins. A trench near the south bay of Bee lake exposed banded magnetite and considerable quantities of pyrite. H. N. Darling was in charge of operations.

#### Edwards Claims

A syndicate led by G. M. Edwards of Toronto holds a block of about 30 claims around the east end of Eden lake, chiefly in sedimentary rocks of various kinds. When the writer visited these claims at the end of June, a small amount of trenching had been done a short distance east of the lake. This disclosed some lenses of quartz, carrying pyrite, lying in the contact between a narrow band of iron formation and a feldspar porphyry which appeared to be a dike.

#### Pioneer Mining and Exploration Company, Winnipeg

This company has nine claims near Hutch lake, to the southwest of Eden lake, in greenstone. P. W. Hutchinson was in charge of operations.

#### Newton Claims

W. S. Newton, of Winnipeg, has three claims on the narrow peninsula south of Macaroni creek, between Eden and Bee lakes. A narrow band of iron formation runs along the creek. South of this is a belt of rhyolitic rock, forming the backbone of the peninsula, and south of this a belt of conglomerate. He also holds a group of six claims between Eden and Kangaroo lakes. Trenching was in progress on each group, under the direction of Capt. N. Evans-Atkinson.

#### Winnipeg Syndicate

This syndicate holds six claims on the west shore of Midway lake, adjoining the Edwards group. The rocks are chiefly sedimentary, but a band which appears to be an altered porphyry runs in a general easterly direction across the claims. Prospecting had disclosed disseminated pyrite, small veinlets of pyrite, and stringers of quartz at several places. R. A. Black was in charge.

## Iron Formation

As already stated, there are at least two bands of iron formation exposed in the neighbourhood of Eden lake, but these do not appear to be of economic interest.

## Other Minerals

No other economic minerals are known within the limits of the map-area. To the southwest, on the Oiseau river, nickel-copper deposits have been found in the schists. More recently the discovery of important lithia-bearing pegmatites on the Winnipeg river, and reports of finds of cassiterite in this general region, have directed attention to the possibilities of the granite areas. Pegmatitic phases are observable at a good many places in the granites, and it is probable that in future they will receive more attention than they have in the past

# Woman and Narrow Lakes Area, District of Kenora (Patricia Portion)

By J. W. Greig

## Introduction

In the fall of 1925, an important gold discovery was made in the Red Lake area. This made it desirable to investigate the neighbouring schist area which lies to the east of Trout lake. The writer was instructed by Thos. W. Gibson, Deputy Minister of Mines, to make a geological exploration in that section.

The field work was carried out during the summer of 1926. As a base on which to plot the geology, there was available at the beginning of the season an aerial map[1] of the country as far north as Slate lake. The Topographic Survey, in conjunction with the Royal Canadian Air Force, was to continue the mapping to the north. In the early part of July, a sketch map compiled from preliminary photographs was supplied. This map, on a scale of approximately one mile to the inch, showed the route from Woman lake to Gull lake through Shabumeni and Birch lakes. On the 8th of August, a map was received which covered the area from Ross's line eastward to Springpole and Sesikinaga lakes and from Confederation (Clearwater) lake north to the southern part of Birch lake. This map,[2] which was compiled from plottings of oblique aerial photographs without the advantage of the control traverse, was used for the remainder of the season and found both accurate and complete. These maps, made from aerial surveys, because of the great amount of detail shown, especially in the country between the main waterways, are particularly adapted to the work of the geologist and the prospector. In doing detailed work the geologist can make much use of the photographs themselves in planning his inland sections; and if a map on a large scale is desired, it may be quickly constructed by running a skeleton traverse and filling in the detail by plotting the photographs.

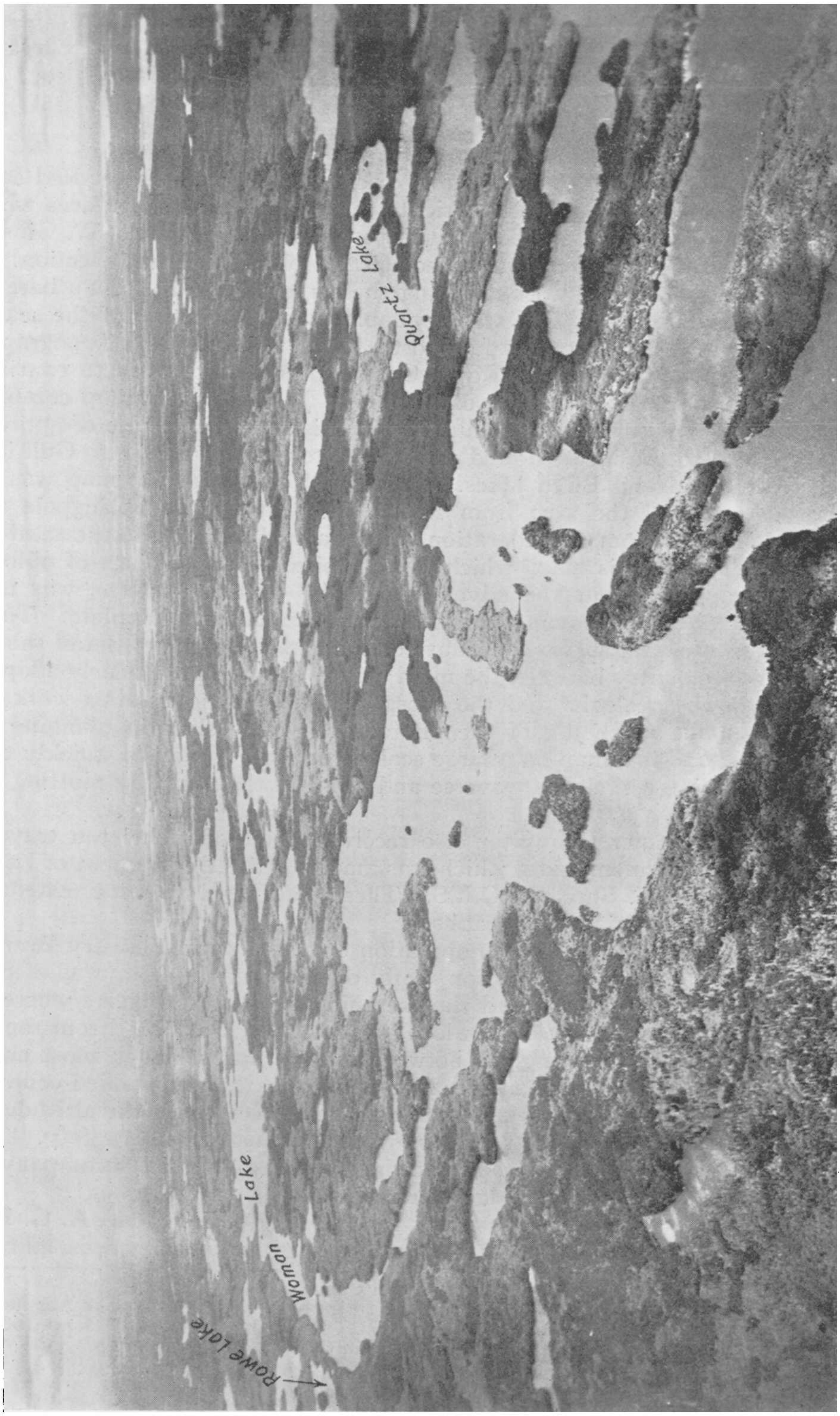
During the summer the writer also received plans of a skeleton traverse of Woman and Shabumeni lakes, which was made for the Department of Lands and Forests by H. W. Sutcliffe, O.L.S. These were used to some extent in conjunction with the aerial photographs.

Thanks to the courtesy and co-operation of the Ontario Forestry Branch, the writer was able during the season to fly over the area. This was of considerable service, since it permitted the sketching of lakes and rivers where no map was available, and also aided in locating the granite areas. From the air it was found possible to distinguish between granite and schist in most cases. In burned, bare country this is, of course, much easier than in wooded country. The difficulty of distinguishing the rocks increases rapidly with the altitude, so that for this work it is desirable to fly as low as is consistent with safety. The opinions formed in the air were checked on the ground, so that the accompanying map shows only the results of ground work.

In the field work able assistance was rendered by G. D. Furse, A. G. Ballachey, and H. D. Ball. During a part of the season the party was split, so

[1]The Lac Seul sheet of the Topographic Survey of Canada.

[2]For a brief description of the methods, *see* J. W. Pierce, O.L.S., D.L.S., The Adaptation of Aerial Photographs to Surveys and Maps, Ann. Rept. Ont. Land Surveyors, 1925, pp. 168-79; *See also* Gerard H. Matthes, Oblique Aerial Surveying in Canada, Geog. Rev., Vol. XVI, 1926, pp. 568-82.




Looking southwest across the main body of Woman lake just north of the narrows. Woman river and Bear lake may be seen in the distance.

that a good deal of the mapping was done by Mr. Furse. The writer wishes to take this opportunity of thanking the many persons who in various ways aided in the work. He is particularly indebted to J. W. Pierce, O.L.S., D.L.S., of the Topographic Survey, chief of the party which ran the control traverse for the aerial survey; to J. C. Ruse, A. T. Cheeseman, F. J. Stevenson, and J. T. O'Gorman, of the Ontario Forestry Branch; to the officials of the Hudson's Bay Company; and to Geo. Swain.

#### Position and Means of Access

That part of the district of Kenora (Patricia portion) covered by this report lies to the north of Lac Seul (see key map, Fig. 1). The southern portion of the area drains into the English river, the waters of which reach Hudson bay by way of Lake Winnipeg and the Nelson river; the northern portion drains into the Albany river.

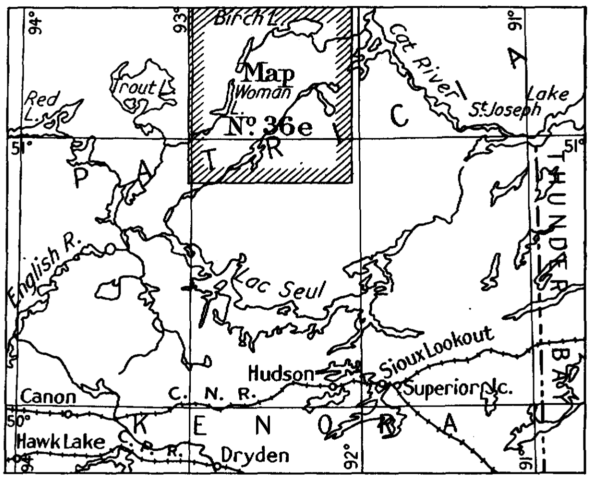



Fig. 1—Key map showing position of Woman and Narrow Lakes gold area. Scale, 50 miles to the inch.

The region is readily accessible from the Canadian National railway. Although there are canoe routes from several stations, almost the entire traffic enters by way of Hudson. Between this station and Pine Ridge, at the outlet of Lac Seul, a distance of roughly 110 miles, large motor boats can navigate. The only obstruction on this stretch is the Manitou rapid, down which such boats can run and up which they also run except at time of high water when, the current being too strong, they are winched up. Regular passenger and freight service between these points was commenced in the spring of 1926 and maintained until freeze-up. In passing it may be noted that there are two canoe routes from Hudson to Lac Seul post, by way of Canoe lake, which are much shorter than that which the motor boats take and also more sheltered.

From Pine Ridge, one has the choice of two water routes. One of these is down the English river to the mouth of the Chukuni, up the Chukuni to Pakwash (Shallow) lake, across Pakwash lake and Bruce or Little Pakwash lake to the Trout Lake river, up this river to Woman river, which is followed up to Woman lake. Two short portages or one long one are necessary around the Ear falls at the outlet of Lac Seul. No further portages are necessary until Trout Lake river has been ascended about twelve miles, after which there are eight portages before Woman lake is reached.

During the past season the Hudson's Bay Company put a motor boat on the English river below Ear falls, and maintained a regular freight and passenger service between this point and Snake falls on the Chukuni river, a short distance above its mouth at the north end of Pakwash lake. Toward the end of the summer, they established a post on Woman lake and commenced a freight and passenger service between Snake falls and Woman lake by means of large canoes equipped with outboard motors.

There is another canoe route up the Wenasaga river, which flows into Lac Seul about two miles east of Pine Ridge. This is shorter to most parts of the area than the other and, although not so much used, is a good canoe route.

The area may also be reached by air. Throughout the past season the Patricia Airways and Exploration Company operated a Curtis Lark plane from Sioux Lookout, on the Canadian National railway, and maintained passenger, mail, and express services to all points in this and the neighbouring Red Lake area. Since the trip from the railway to Woman lake, which by water requires three days at best, may be made in less than two hours by plane, much time may be saved. During the past season this air service proved a real convenience in countless ways to those in the area.

Supplies may be purchased at Sioux Lookout or Hudson, where complete outfits may be obtained, at Pine Ridge where there are now several general stores carrying a fairly complete line of goods appropriate to the country, or even within the area at the Hudson's Bay Company's post at Woman lake, or at Swain Post on Swain lake.

### Canoe Routes

The following are brief descriptions of some of the main routes in the area:—

*Woman River.*—The route from Lac Seul by way of the Woman river has already been sufficiently described. Outboard motors may be used on all parts of this route.

*Wenasaga River.*—The Wenasaga river is a good-sized stream almost to its headwaters and is in frequent use, so that the portages are all well cut out.

*Uchi River from the Wenasaga River to Perrigo Lake.*—From the Wenasaga river to Ben (Sucker) lake, the current is not strong. Above Ben lake to the portage to Fly lake, the river is narrow, has a good current, and meanders sharply in a sandy valley. In this stretch a motor could not be used to advantage in 1926. The river is deep, however, and if the logs which are in it were removed, it would be a good route even in low water. Leaving Ben lake there is a portage of 52 chains to avoid several falls and rapids, and between this point and the Fly lake portage there are three short rapids. Immediately above the Fly lake portage there is a 7-chain portage before entering Uchi lake. Two portages are required to reach the next small lake. A short creek drains Perrigo lake into this. None of the portages on this route are through swamp, and all are well cut out.

*Uchi River to Confederation Lake.*—This route is much used, and the two portages are consequently in good condition.

*Confederation Lake to Swain Lake.*—This route is much used and the portages are well cut out. The stream draining Washagomis lake is narrow with a good current, and an outboard motor may be used on it.

*Woman Lake to Birch Lake.*—From Woman lake the route is up a small, fast stream to Swain lake. No portaging is required, and outboard motors may be used. From Swain lake there is a choice of three routes: The first of these is by way of Shabumeni lake. A 58-chain portage leaves the lake at Swain Post. The first half is over muskeg, but poles have been laid; the rest is over high ground. Two short portages must be made on the Shabumeni river. Another route leaves Swain lake from the east end and leads to the southwest bay of Birch lake. There are two portages, of 60 and 70 chains, which lead to a small lake, which is drained by a creek into the bay. The route is down this creek, which has been cleaned out. In high water it is navigable, but not in low water. Another route from the east end of Swain lake leads to the south bay of Birch lake.

*Shabumeni Lake to Shabu Lake.*—This route is up the Shabumeni river. From Shabumeni lake to the first lake, the stream is broad, deep, and sluggish. A 7-chain portage must be taken at the outlet of this lake. Above the second lake, the stream is narrow with a good current and meanders sharply through willows and alders. There are two short portages on this stretch. A 23-chain portage then leads to a small lake, into which Shabu lake drains through a short creek.

*Birch Lake River to Margaret Lake.*—This route leaves Birch Lake river at the most southerly part of its course between Birch lake and Springpole lake, and leads up the small stream that drains Bertha (Boulder) lake. Three portages are necessary on this stream. The third leads to a small lake with swampy shores. This lake is connected by a narrow channel with the main body of Bertha lake, which is crossed to the southeast. A narrow channel almost filled with boulders enters the lake here. It widens at once to a muskeg channel, which leads to the next small lake. About a mile west this contracts to a channel about three chains wide, which leads to a second expansion. From the southwest part of the expansion, another narrow channel leads to the third expansion. A weedy muskeg creek enters here on the west side and is ascended to Bumpy lake, a 6-chain portage being made just at the lake. At high water, with a light canoe, a shorter, 3-chain portage may be made. The portage from this lake on the Albany river system to Cook lake on the English river system is 25 chains in length through jackpine. Two routes are available from Cook lake to the next below it. One is by a portage which leaves a small bay about the middle of the southeast shore. For 33 chains the portage is through moderately open spruce muskeg, which is soft even in the dry season; the rest is over a sand plain through jackpine. The portage leads to a muskeg lake, from which a muskeg creek drains to the lake below Cook lake. The creek was interrupted in 1926 by two small beaver dams, over which the loaded canoe could be eased. The other route is by a portage, about a third of a mile in length, from the outlet of the lake, thence down the stream to the next lake. The stream is small and has a fair current; since it flows in a sand plain, it meanders sharply and is shallow, so that at low water the canoe and load must be constantly lifted over the logs and shallower spots. The other route appears to be the more travelled. From this lake to Margaret lake, the stream is of good size. Four portages are necessary on this stretch, which makes ten in all from the Birch Lake river.

**History and Earlier Reports**

In the early days of the fur trade, posts were established on Red lake and Cat lake. Mackenzie's map[1] shows these posts, Red Lake House and Catt Lake House. The routes from Catt lake to Lake St. Joseph by way of the Catt Lake river, from Lake St. Joseph to Lake Sol, and also from Red lake through Lake Prince of Wales (Gullrock lake) and Lake Paquash to Lake Sol are likewise shown. The only feature shown in the country between these routes is a range of mountains running west of and parallel to the Catt Lake river. These trade routes have since remained as they were then.

The country is still much as it was in those early days. The building of the Grand Trunk Pacific provided an outlet from Lac Seul, and for some years now a little fishing has been done on that lake, but beyond that there was no change. The discovery of gold on Red lake in the fall of 1925 and the consequent rush, followed by the rush to Woman, Confederation, and Narrow lakes in the spring and summer of 1926, brought many prospectors into the area, and a small village sprang up about the old Hudson's Bay post at Pine Ridge; now called Goldpines post office.

A number of reports have been made on the area. In the summer of 1885, Thomas Fawcett, D.T.S., ran a line with transit and micrometer from the Canadian Pacific railway at Rat Portage (since renamed Kenora) to Osnaburgh House at the east end of Lake St. Joseph and then from Lake St. Joseph to Cat lake, up the Cat river. The season being far advanced and the freeze-up imminent, he returned by the most direct route, that of the Wenassaga river. His report gives a brief description of the route.[2]

In 1893, D. B. Dowling made a geological exploration, the eastern part of which included the western part of this area. His report[3] is accompanied by a geological map on a scale of eight miles to the inch. He made two traverses through the area, "from Shaboomene lake through Woman lake and down the Trout Lake river, and again from Trout lake eastward via a long narrow lake to Woman lake, and thence up stream to Clearwater lake, directly south upstream to Fly lake, and thence down by the Wenassaga river to Lac Seul."

In 1902, A. W. G. Wilson and J. F. E. Johnston made a reconnaissance traverse from Lac Seul to Cat lake by way of the Wenassaga river.

In 1904, Charles Camsell made a traverse along the east boundary of the schist area to Cat lake, and from Cat lake westward through Birch lake to Shabumeni lake.[4]

Wilson's report[5] was published in 1910, accompanied by map No. 1089 (9A), which was a compilation of the data, both topographic and geographic, then available.[6] The map also covers a large territory to the north and east of the section under consideration.

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[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 Chipweyan 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 Pacific Oceans in 1789 and 1793, by Alexander Mackenzie, London, 1801.

[2]Ann. Rept., Dept. of the Interior, 1885, pt. II, pp. 30-38.

[3]Report on the Country in the Vicinity of Red Lake and Part of the Basin of Berens River, Keewatin, Geol. Surv. Can., Vol. VII, pt. F, 1894, pp. 5-54.

[4]Country around the Headwaters of the Severn River, Geol. Surv. Can., Vol. XVI, pt. A, 1904, pp. 143-52.

[5]Report on a Traverse through the Southern Part of the Northwest Territories from Lac Seul to Cat Lake in 1902, Geol. Surv. Can., Publication No. 1006.

[6]The reports of Dowling, Camsell, and Wilson were republished in Vol. XXI, pt. 2, Ont. Bur. Mines, 1912.

In 1919, E. M. Burwash made a geological reconnaissance of the Wenasaga river route to Gull lake; from there he ascended the Birch Lake river to Springpole lake, portaged into Birch lake, and after mapping a portion of that lake returned by way of Shabumeni and Woman lakes. His report[1] is accompanied by plans showing the geology of Whitemud lake, of the southwestern part of Birch lake, and of his route from Gull lake to Birch lake.

## General Character of the Area

Travelling by aeroplane northward from Lac Seul over this area, one sees a level plain stretching out beneath. The monotony is broken here and there by lakes, by the different shades of green of the forest, and by occasional bare brulé patches, but never by hills. As the flight is continued farther north, the same level country is seen, but the number of lakes increases until the waters form a labyrinth of channels running aimlessly over the land, and it becomes difficult to determine to which lakes the various channels belong.

If one travels back over the same country by canoe it will be seen that, although the country is essentially level, the lake shores, especially where lakes are numerous, are usually rocky and that back from the lakes rounded rock hills are frequent. The country is also well wooded, so that it presents a pleasing and far from monotonous aspect.

The consolidated rock surface is a plane, in general nearly level, in detail quite irregular, having been carved into steep low hills and shallow valleys. The glaciers have left the surfaces smoothed and rounded and have scattered over them a thin covering of boulders, sand, and clay, which is covered again in places by reworked water-laid materials. This rock surface is slightly warped, sloping gently away from the height of land and to the southwest passing beneath a deposit of clays and silts until only a few rock hills protrude above the level of this mantle.

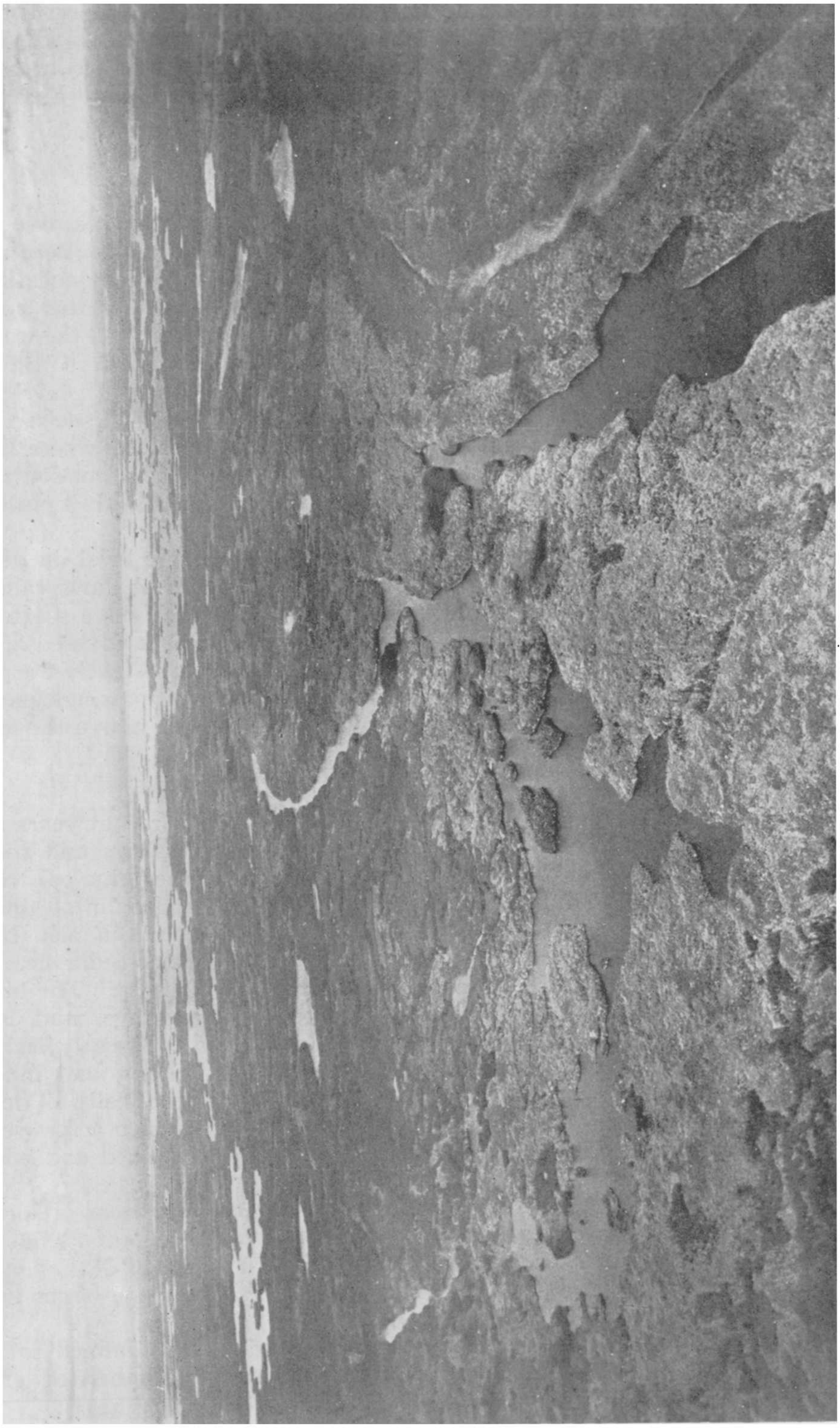
### Forests

The greater part of the area has not been burned over in recent years and is consequently well wooded, with the exception of the muskegs and rocky places. Spruce, poplar, and jackpine or banksian pine are the principal trees; birch is also common. Canada balsam, or balsam fir, and balm of gilead, or balsam poplar, are less plentiful. White cedar and mountain ash, both small, are found along the lake shores throughout the area, but no cedar swamps were seen. Willows and alders commonly grow along the streams. The black ash is sparingly distributed. Everywhere through the muskegs, and here and there on old burned places, a great number of young and apparently healthy tamaracs are growing. Earlier reports speak of large tamaracs, and indeed there are numerous good-sized tamarac stubs, but these are practically all dead, having been killed by the depredations of the larch saw-fly, which a few years ago spread over the country. The northern limit of both the red and white pine appears to be at Lac Seul.

Generally speaking the timber is not big. There are large areas of spruce of pulpwood size; and small patches of good-sized trees are common, but no tracts were seen which were suitable for lumber. There is a good deal of jackpine on sand plains between Bertha and Perrigo lakes, but only the larger trees would be suitable for railway ties.

Blueberries grow well but are not well distributed, being confined to the burned areas. Raspberries, gooseberries, and high-bush cranberries grow

[1]A Geological Reconnaissance into Patricia, Ont. Dept. Mines, Vol. XXIX, 1920, pt. 1.



Narrow lake, looking west along the long narrow arm of the lake to Trout lake, which is seen in the distance.

throughout in favourable places. In the muskegs a few cranberries, *Vaccinium macrocarpon*, are found, but the most plentiful berry is the mountain cranberry, *Vaccinium Vitis-idaea*, which abounds in mossy places. Red cherries are common on the burned-over rocky hillsides.

### Game

Although the country is largely free from burned areas, game is not abundant except in the southern section. Red deer are plentiful along the English river and in the southern clay-covered region, but are scarce in the rockier country to the north. Moose are occasionally encountered throughout the area, but more especially in the southern section. Woodland caribou were seen on Okanse lake and were reported on Woman and Shabumeni lakes. Ruffed grouse and spruce partridge are moderately plentiful, and many ducks nest in the area.

Pelts of the following animals form the furs shipped from the area: fox, mink, beaver, muskrat, otter, weasel (ermine), fisher, lynx, bear, wolf, skunk.

### Fish

Many of the lakes are of the clearwater type in consequence of the small size of the muskeg area draining into them. Fly, Confederation, Washagomis, Perrigo, and some smaller lakes are of this type. The waters of Woman and Birch lakes are fairly clear. The water of other lakes is quite brown from organic matter. Fish abound in the clearer lakes and are found to a lesser extent in the others. Pickerel or doré, jackfish or pike, whitefish, and suckers are the most important. Lake trout are plentiful in Confederation lake and are also taken in Woman lake.

### Agriculture and Water Powers

The agricultural possibilities of the area have been reported on by Burwash.[1] Briefly it may be said that there are no considerable tracts of land suitable for agriculture in the northern part of the area, but to the southwest there is a large section of bedded clays and silts. This is an easterly extension of the clay belt of the English River valley,[2] and will be farmed in the future. Snake lake marks the approximate north limit of this area. From here the boundary swings off to the southeast.

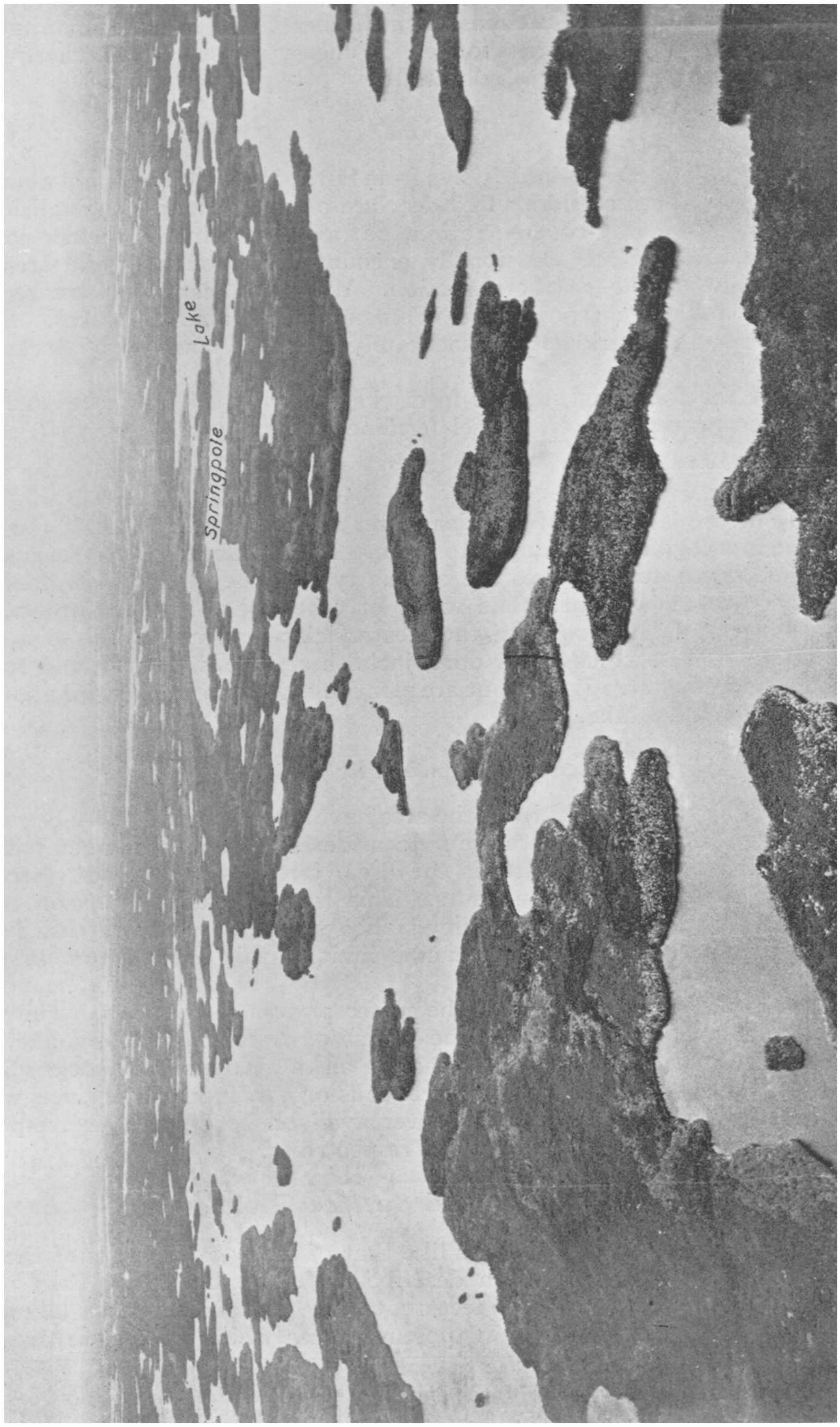
Burwash has also reported on the water powers of the area. The three largest sources are: the two falls on the Wenasaga river below Bluffy lake, with a drop of approximately 50 feet; the canyon on the Woman river below Snake lake, with a drop of 65 feet; and the three falls on the Trout Lake river, with a drop of 85 feet. He estimated the power available to be 1,025 horse-power, 530 horse-power, and 1,740 horse-power, respectively.

## Topography and Surface Geology

The topography of this region is like that of many other parts of the pre-Cambrian shield which have been described. It is even flatter than usual. The highest hill measured was 160 feet above the level of the nearby lakes, and it is unlikely that there is a hill in the entire area which rises more than 200

[1] Op. cit.

[2] *See* E. L. Bruce, Geology of the Upper Part of the English River Valley and Geology of the Basin of Red Lake, District of Patricia, Ont. Dept. Mines, Vol. XXXIII, pt. 4, 1924.




Birch lake, looking south of east from near the centre of the lake toward Springpole lake.

feet above the neighbouring lakes. Rock forms the highest elevations; no large morainal hills were seen.

This topography is the result of the action of the continental glaciers on an already level country. The ice removed all the residual soil and overlying decomposed rock, and left a floor of fresh unweathered rock Since the retreat of the ice, only a thin surface film has been affected by weathering. The rock floor as a whole is flat, but the surface is quite uneven. In the areas of schists and gneisses, it has been carved into long, low ridges and shallow valleys, which follow the strike of the rocks. In the more massive granite areas, the hills are more hummocky. The whole is rounded and smoothed and even polished, particularly on northeast slopes against which the ice advanced. The control of the structure over the erosion of the ice is reflected in lake shores, which in the rocky areas generally conform to the strike. This is well shown on the accompanying map, No. 36*e*. Commonly, in long narrow valleys extending in a direction not too far from that of the prevailing movement of the ice, grooves and striae are found to deviate notably from the general direction toward that of the valley, showing that here the structure exerted a control over the movement of the lower part of the ice.

The ice left a mantle of unassorted boulders, sand, and clay spread over the rock floor, thin or absent on the tops and northeast slopes of the hills, but thicker in more sheltered places. In some parts, this deposit becomes so great as to form low hills and completely bury the solid rock. Such an accumulation is seen on Shabumeni river and south of Shabu lake. It is probably the east edge of the morainal deposits noted by Dowling around Trout lake. Lying on this unassorted material there are also, in many places, water-laid deposits, clays, sands, or gravels. Thus along the Trout Lake river and the lower Wenasaga, there is a continuation of the clay belt of the English river. In the eastern part of the area, there are large tracts covered by sands, often interbedded with clay. Bedded deposits of small extent are found locally in hollows throughout the area. Frequently they are overlain by swamps or muskegs.

A glance at the map shows that lakes are unusually numerous. Many are in rock basins and are broken by numerous islands. Most of the lakes are held at their present level by rock barriers, over which the escaping water falls. Birch lake, the largest in the area, is an exception, the outlet being over boulders. The lakes are for the most part connected by streams in which reaches of sluggish water are interrupted by falls and short rapids. This, coupled with the large number of lakes, makes the area particularly easy of access by canoe.

## Consolidated Rocks

The consolidated rocks of the area consist of a series of interbedded sediments and lavas, and possibly a younger sedimentary series. These have been folded into vertical attitudes, converted into schists, and otherwise metamorphosed. They are intruded by various small bodies of igneous rocks. This complex has been invaded by granite and since eroded to such a depth that the schist area of sediments and lavas floats, as it were, on a sea of granite.

The rocks are all pre-Cambrian in age, and the lavas and associated sediments probably early pre-Cambrian. They cannot from the nature of the case be definitely correlated with rocks of other areas, but tentatively the lavas and interbedded sediments may be considered the equivalent of the Keewatin.

There are numerous dikes, sills, and irregular bodies of igneous rock intrusive into the sediments and lavas. As a rule the relative ages of minor intrusives are not known. None of them were found cutting the granites.

The latest rocks are granites and quartz-feldspar porphyries. Although the various granite masses have different characteristics, they may possibly be all of one age. Some granite formed part of the surface before the upper sediments were laid down, since they contain granite pebbles; but they are themselves intruded by granite, and no granite was found which could be shown to be older than these sediments.

For the purpose of description, the area is arbitrarily divided into sections.

#### Narrow, Car (Caribou), and Shabu Lakes

North of the granite which lies to the southwest of Narrow lake, there is a band of rocks which, in part at least, is sedimentary. Northeast of these, there is a wide band of lavas in which pillow structures are frequent. All these rocks are green. Schisted zones occur, but for the most part the rocks are fairly massive. A microscopic examination of one of the pillow lavas outcropping on the north-south channel near the south part of the band shows it to consist of a fine-grained mass of felted, fibrous green amphibole and chlorite, a fine mosaic of quartz, and a few minute tattered remnants of feldspar. There is also considerable carbonate. With the exception of the feldspar remnants, the minerals are apparently all secondary. Many of the lavas resemble the pillow lava described below from another part of the lake. It is possible that there are some sediments included in the band.

To the northeast of the lavas, along the west side of the bay from which the portage to Woman lake leaves, there is a narrow band of sediments, which include conglomerate, made up almost entirely of pebbles, resembling the lavas, and rare pebbles of green schist and quartz, greywacké, or arkose; slates with much pyrite; and some lean, banded iron formation A fresh looking, light-green rock, about the colour of many of the lavas but showing distinct bedding, which outcrops on the west side of the bay, was found under the microscope to consist of subangular grains of alkaline feldspar and grains resembling the groundmass of the lavas and porphyries. This rock may have been derived from the lavas and porphyries by mechanical disintegration and with little transportation. It may be a sedimentary tuff. An exposure near the west side of this band on the south shore shows a gradation from coarse to fine grained toward the east. This is repeated in several beds and indicates that the top of the series is to the east.

Northeast of the sediments are more lavas. Outcrops showing excellent pillow structure occur across the north end of the bay. A sample from a pillow lava near the southwest edge of the band was examined microscopically. It shows laths of feldspar, probably albite, with a trachytic structure. The groundmass is fine grained and altered, consisting chiefly of chlorite and a fine mosaic of quartz, with possibly a little feldspar. There is much carbonate. The rock is of a somewhat lighter green than the average greenstone. There are large areas of rocks which resemble it closely, and it appears probable that rocks of this type are quantitatively the most important of the lavas in the vicinity of Narrow, Woman, and Confederation lakes. At the extreme southern part of this bay, feldspar porphyry occurs which resembles the lava in appearance but which shows no pillows. The large island in the middle of the bay is entirely of sediments.

Beyond the lavas, there are more sediments extending to Woman lake. They vary from coarse conglomerate to finely bedded rocks and, for the most part, are light green on the weathered surface. The boulders in the conglomerate are chiefly of dense, light-green lavas and of feldspar porphyry; there are no deep-seated igneous rocks represented. Many of the beds are of fairly well rounded pebbles, and as a rule there is considerable quartz in the matrix between the pebbles. A characteristic is the rapid change in the size of the grains from bed to bed; an exposure on the south side of the portage from Woman lake shows this well: Here within a few feet are conglomerate, gravel beds, and rock so finely bedded that 40 laminations were counted in one inch. A thin section of this rock shows it to consist of a fine-grained mosaic of quartz and a little alkaline feldspar, with a great deal of sericite uniformly distributed through it. These sediments are well exposed along the two small expansions of the Narrow Lake river.

The amount of overburden increases to the west and north. For this reason there are fewer exposures, and the geology is correspondingly less certain. Along the trail from Narrow lake to Car (Caribou) lake are numerous outcrops that appear to be lavas like those on Narrow lake. On Car lake there are well developed pillows, and on the two small lakes north of the main body of Narrow lake there are numerous exposures of light-green pillow lavas, frequently spherulitic. North of Car lake there is much swamp, with scattered outcrops of chloritic rocks, which occasionally show spherules and pillows. North of these, about one mile south of the next small lake, are some light-weathering, quartz-bearing rocks that look like rhyolites. To the east of the south end of this lake, there are more light-weathering rocks, which are in part fragmental. It was not determined whether these rocks were porphyries or sediments. A section of the groundmass examined microscopically might be either a sheared feldspar porphyry, with a little quartz in phenocrysts, or a sediment. It is now much altered and contains a good deal of sericite and carbonate.

Farther north as the granite is approached, there is considerable biotite and hornblende developed in the few rocks that outcrop.

Although the shores on the main body of Shabu lake are mostly boulders, there are quite a number of good outcrops, mostly sediments. On the southeast bay lean iron formation occurs, and inland northeast of it conglomerate like that to the east of Narrow lake. This conglomerate is intruded by fresh-looking, grey quartz-feldspar porphyry. South of Shabu lake, the schists are intruded by small masses of granite and porphyry. There is much drift over the rock, and numerous small hills composed largely of boulders from the granite to the north.

### Woman Lake

Along the west side of the main body of Woman lake, the rocks are much contorted and schisted, many of them being sericitic and chloritic schists. It is difficult, and often impossible, to distinguish sediments from lavas. Strikes are not obtainable, as the bedding is usually obliterated and when visible is frequently contorted. The rocks are lavas and sediments that range from conglomerates to siliceous slates, with the metamorphosed derivatives of both. Breccias also occur, and it is frequently difficult to decide whether they are agglomerates or actually parts of flows. There are a number of intrusives. The rocks along the east side of the lake are much more massive, and some of the freshest-looking sediments in the whole area occur there. Toward the southern part of the lake, the rock surface is lower and except in the granite areas is largely covered with soil.

Pillow lavas outcrop on the shores of the small bay at the northwest corner of the lake; along the west shore of the main body of the lake, medium-green lavas with some breccias and a little quartz porphyry continue to the bay into which the Narrow Lake river empties.

To the west of the chertlike rocks, north of the narrows, lie conglomerates. These are best exposed on the two peninsulas which jut out from the west shore and on the south side of the large island north of them. To the west of these, there is a band of feldspar porphyry, which on the east carries roughly spherical grains of quartz. The rock is a medium-green and shows the feldspar phenocrysts on the weathered surface. In thin section, the feldspar phenocrysts are seen to be near albite in composition, and the spherical quartz grains are seen to be composed of quartz mosaic probably filling vesicles in the original rock. To the west of the feldspar porphyry, there is a narrow band of sediments including arkose and conglomerate, and west of these dark greenstones with pillow structures, grading westward into coarser dioritic-looking rocks.

On the east side of the large island north of the band of cherty rocks, the rock, which is greenish-yellow, is a sericite schist, which has been partly silicified. In places it is quite definitely fragmental; as conglomerate lies immediately to the west, it is probably a sediment. On the east side of the large island next to the north, cross-bedding in the sediments indicates that the top of the beds is to the east.

Along the east side of the lake runs a band of sediments comprising conglomerate, arkose, greywacké, and slates. They are like the sediments east of Narrow lake. The pebbles in the conglomerate are almost all of dense, light-green lavas and feldspar porphyry; some of them are of feldspar-quartz porphyry and rare green schist and vein quartz. The arkose and some of the greywacké might be mistaken for quartz porphyry, especially when the quantity of quartz is small. The associated conglomerates and slates give the clue to their true nature in such cases. These sediments are separated from those to the east by a band of pillow lavas.

The rocks of the basement complex outcropping on the shores of the expansion south of the narrows are largely pillow lava and diorite. Lean, banded iron formation may be traced down the north bay, and what appears to be part of the same beds forms a gull rock in the middle of this expansion. This rock is referred to in older reports as Medicine rock. On one side there is a good deal of pyrite. Burwash had the material assayed and found not a trace of gold.

There are a number of intrusives along the west side of Woman lake; diorite grading to quartz diorite cuts the lavas and sediments on the mainland and on the southwest side of the large island three miles northwest of the narrows. A little to the south, a much altered granite porphyry occurs, resembling in many ways the altered porphyry sill of Confederation lake. Dark-green dikes are frequent. Lighter green, rusty-weathering dikes, now largely carbonate in well-developed rhombohedra, are also common.

*Chertlike Rocks.*—There are rocks in several parts of the area which appear in the field to be cherty. They vary from light-grey to almost black and in places are yellowish or reddish. They are dense and hard, breaking with a conchoidal fracture. The largest area of these cherty rocks, and the only one of importance, is that which lies to the west of the long narrow part of Woman lake and extends northward along the islands into the main body of the lake; the boundary of this area as shown on the map is necessarily somewhat arbitrary.

As to their origin, it may be stated with considerable confidence that they are secondary, having been formed by replacement of the rocks which originally occupied this position. To the north of these rocks, and striking toward them, are sediments, conglomerate, arkose, and greywacké, made up chiefly of alkali feldspars and quartz and now greatly altered. On a small island north of the narrows, the rock, now all cherty, retains the shapes of pebbles, forming a bed which strikes in the same direction as the sediments to the north of the prolongation of the strike. This in itself is good evidence of the replacement of these sediments to form the chertlike rocks.

A few specimens were studied in the laboratory. Microscopic examination of material from a conglomerate to the west of the best developed of these rocks shows a very fine grained mosaic, mostly quartz, and some material of lower index of refraction and lower bi-refringence. Scattered thickly through this and giving a rude linear pattern are small sericite grains. Phenocrysts of quartz with typical shapes are the only original minerals left. There are areas of clear quartz mosaic that have the shape of feldspar phenocrysts, which they have evidently replaced. Numerous veins of quartz mosaic coarser than the groundmass cut across the section. The specimen is evidently a pebble of a feldspar-quartz porphyry. A sample of dark mottled variety shows in thin section a somewhat coarser mosaic than that mentioned above. There is little sericite, but there are patches which have a fair amount of fine-grained green mica. A few grains of quartz are evidently original. A specimen of light-grey, streaked rock shows an exceedingly fine grained mosaic. The darker streaks are almost entirely quartz and coarser grained than the remainder, which contains a great deal of the material with the lower index of refraction. The original minerals, with the exception of quartz, have entirely disappeared from these rocks, and the composition has evidently become much more siliceous.

Certainly then the chertlike rock is a replacement, and in part at least the original rock was a sediment. Whether or not it was entirely a sediment or in part a flow or sill cannot be stated.

*Carbonate Rocks.*—Carbonate rocks occur in several parts of the area. Some are secondary, others have the appearance of sediments. In areal extent, they are insignificant. The most important occurrence is in the narrows of Woman lake, where they lie to the west of the chertlike band of silicified rock. Scattered outcrops, which occur at the water's edge on both sides of the narrows, are characteristically dark-brown, almost black, on the weathered surface and are ribbed with contorted bands of silica, frequently in two directions. They appear conformable with the other rocks of the series, although the contact is irregular. Part of the silica, at least, must have been introduced, since the ribs are in two directions. On Shabu lake, at two places, lighter coloured rock was observed. Here the silica ribs are parallel to the strike of the sediments. This rock looks like many dolomites in the pre-Cambrian. At the entrance to the long west bay of Narrow lake, there are similar rocks exposed on both sides of the channel. They are not contorted and look like sediments. Immediately to the north are quite schistose ellipsoidal greenstones. Along the contact there is an unusually large amount of carbonate in these pillow lavas; in places they appear almost completely replaced.

Along the west side of Woman lake there are occasionally irregular, roughly oval shaped areas, a few feet in diameter, of carbonate ribbed with silica and presenting an appearance almost identical with that of the carbonate rock at the narrows on Woman lake. A short distance south of the bay into which the Narrow Lake river empties, there are several small zones of carbonate cutting across the strike. These send out irregular veinlets into the surrounding rock. Fine-grained quartz stringers cut the wall and the carbonate zone and run across the strike of the zone. The weathered surface here looks like that at Woman lake narrows.

The rocks at the narrows on Woman lake, on Narrow lake, and on Shabu lake may well be sediments, but the resemblance of other occurrences that are certainly not sediments to that at the narrows makes a secondary origin for these not improbable. A decision on these rocks must await further work.

### Confederation and Washagomis Lakes

To the east of Woman lake, in the neighbourhood of Washagomis and Confederation lakes, the rocks are mostly massive. All the rocks of Washagomis lake are lavas, varying somewhat in colour but always chloritic. The same may be said of the rocks on the small lake to the south. On the main body of Confederation lake, most of the rocks are also lavas, commonly having pillow structures. Many of these resemble the light-coloured greenstone described at Narrow lake; others are darker green. A series of dark-grey, dense rocks, showing a few small quartz grains, crosses the narrow channel which joins Lost bay to the main body of the lake. These continue to the north, and similar rocks were found near Okanse lake. Certain markings on the weathered surface suggest filled vesicles. In thin section, the rocks are seen to contain euhedral quartz phenocrysts and phenocrysts of graphically intergrown quartz and feldspar. Some feldspar laths occur in the groundmass. The dark colour is due to fine-grained secondary biotite and hornblende; they are probably rhyolites. On Lost bay more green pillow lavas occur and are the principal rocks. A band of conglomerate and associated finer grained sediments extends up the bay. As was the case on Narrow and Woman lakes, the pebbles show little variety. No deep-seated rocks are represented. Quartz porphyry pebbles are conspicuous here, in which respect this conglomerate differs from those on Woman and Narrow lakes.

Extending up the main body of Confederation lake is what appears to be a sill of granite porphyry. The rock varies in texture from almost granitic to fine grained and, as a rule, is distinctly green, due to chlorite, and shows quartz grains. It is usually schistose. Just north of the narrows, on a small island at the west side of the band, there is a good exposure, which shows it to be intrusive into a dioritic rock lying to the west of the porphyry. The rock here is coarse textured and fairly fresh. A thin section shows that it is characterized by a coarse intergrowth of quartz and feldspar. Microcline and plagioclase near albite are the feldspars present, and the rock is almost entirely composed of these minerals. There are a few alteration products and little carbonate. In sections from other parts of the mass, carbonate replaces the feldspar, and the structure tends toward a graphic intergrowth of quartz and carbonate. Chlorite is also present in small amounts. On the east of the large islands north of the narrows, the rock is finer grained and somewhat resembles a lava. This poprhyry is cut in several places by later fresh quartz-feldspar porphyry dikes and also by dark-green dikes. To the west of the porphyry band, there are coarse-grained dioritic rocks, the relation of which to the lavas was not determined.

### Shabumeni Lake

Next the granite which lies to the west of Shabumeni lake, there is a band of dense, dark-grey, finely banded rocks which extend across the full width of the lake at the north. As the granite is approached, small pink feldspar crystals appear in these schists and gradually increase in size. Microscopically, the rocks are seen to consist of a fine mosaic of quartz and alkali feldspar, and small green hornblende crystals arranged parallel to each other in planes, giving the rock its banded appearance. Their origin is doubtful, but they appear, on the eastern side of the lake, to lie on the prolongation of a series of thin-bedded sediments to the south and may be the equivalent of those rocks, which are light-coloured on the weathered surface, thin bedded, and minutely crumpled. A thin section of a specimen shows it to be composed of a very fine grained groundmass of quartz and some feldspar, having fine-grained mica, sericite, and light-coloured biotite thickly distributed through it. The banded and crumpled appearance of the rock is due to the arrangement of the mica. The difference in mineral composition between these rocks is probably to be attributed to the granite intrusive. To the east of these rocks lie conglomerates. On the islands in the main body of the lake and on the south shore, chloritic pillow lavas are the principal rocks. Asciated with these in fairly well defined bands is a rock of a peculiar appearance. The weathered surface is grey and commonly covered with lighter coloured knobs more resistant than the rest. When the rock is broken, it is seen that the more resistant material has roughly the form of small, flattened, cigar-shaped bodies, which have their longer axes nearly vertical. A thin section shows that these bodies are composed of a fine-grained mosaic, largely quartz, evidently filling what once was a cavity. The groundmass is too altered to determine the nature of the original rock. On the portage to Woman lake, similar rocks show structures that look like pillows. It appears probable that these rocks were vesicular lavas. Dark-coloured quartz porphyry, also apparently a flow, forms high bluffs to the east of the portage.

### Birch Lake River and Seagrave (Burnt Island) Lake

Along the Birch Lake river above Springpole lake, conglomerates and associated finer grained sediments outcrop in many places. At the west end of the 10-chain portage from the first expansion of the river, there is an excellent exposure of conglomerate. Most of the pebbles here are of dense, light-green lavas and feldspar porphyry, but there are also pebbles of granite, green schist, lean iron formation, and vein quartz. The associated sediments are mostly light coloured: arkose and greywacké.

If we go south from the granite across Seagrave (Burnt Island) lake and continue to the lake to the south of it we have a section, across the strike, of earlier to later strata. Along the north shore of the lake, there is a finely banded series of dark hornblende schists. On the large islands there is massive dioritic rock such as is commonly associated with greenstones and pillow lavas. Along the south shore of the bay which extends to the west and in the smaller bay to the south of this, pillow lavas are well exposed. South from the lake the proximity of granite is manifest by the altered condition of the schists. There are numerous small pink aplite dikes and some feldspar quartz porphyry dikes. Much fine-grained hornblende has been developed in these schists. Two-thirds of a mile south of the lake there is a band of conglomerate, about 10 chains wide, which is so much altered that it looks very little like the conglomerate seen on the Birch Lake river; yet it is almost certainly the same.

There are granite boulders here over two feet in diameter—the largest boulders seen in the conglomerates of the area. The rocks to the north and south of the conglomerate are too much altered in appearance to correlate them with the rocks to the west. Many exposures are well banded.

### Bertha and Uchi Lakes

On Bertha lake the outcrops are poor. The rocks are largely recrystallized with much hornblende and mica. To the south they become coarse micaceous schists, and in places feldspar has formed in them until their schistose appearance is lost and they approach an igneous rock in appearance. Micaceous schists continue to the southwest along the chain of lakes which roughly parallels the granite contact as far as the granite mass of Perrigo lake. Small bodies of granite occasionally intrude these schists, and pegmatite dikes are common. The rock outcrops are infrequent, as the country is largely covered with sand. The granite which lies to the southeast is pegmatitic and contains frequent and large inclusions of mica schist.

To the west of the granite of Perrigo lake, the rocks are again less recrystallized. A narrow band of fine-grained sediments extends up Uchi lake, swinging abruptly to the north at the upper end of the lake. These continue to the west of the granite. At the northwest corner of Perrigo lake squeezed, pebbly rocks outcrop.

To the northwest of the sediments of Uchi lake, there lies a massive, medium-green rock occasionally showing fragments of lighter colour. These rocks are probably lavas. To the south, on Leg lake, dark-green chlorite schists occur, such as are frequently associated with pillow lavas.

### Slate Lake

On the south shore of the most southerly bay of Slate lake there are outcrops of a series of dense fine-grained greywackés. Toward the south and east, they become coarser and more foliated with much biotite apparent. Considerable granitic material has been injected into them. On the south shore of Ben lake, west of Slate lake, similar dense greywackés outcrop and are probably the continuation of these rocks. The intervening country is heavily drift covered. North of the greywackés on Slate lake, there is a band of dark greenstones showing pillow structure. Toward the east these pillow lavas have a coarse texture with large hornblende crystals showing on the weathered surface. This is evidently a recrystallization phenomenon attributable to the granite. North of these lavas lie more greywackés and slates in a narrow band. Judging from the gradation in grain in the beds of the greywackés, the top is to the north.

North of the slates and greywackés and occupying most of the bay to the south of the main body of the lake is a series of conglomerates with interbedded arenaceous greywackés. These extend to the west and cross the main body of the lake near the west narrows, but the band is here much narrower. There is a greater variety of pebbles than in the conglomerates of Narrow, Woman, and Confederation lakes. A great number of the pebbles are of the types abundant in those conglomerates, that is feldspar porphyries and dense, light-green lavas. Thin sections show them to be rocks with phenocrysts of alkali feldspar and a groundmass usually trachytic in structure. Rarely the phenocrysts and feldspar laths of the groundmass become as basic as oligoclase. Granite porphyry pebbles showing, in thin section, an intimate intergrowth around the phenocrysts are also present. Pebbles of vein quartz and of lean banded iron formation are common.

There are also rather scarce pebbles of somewhat altered pink granite, both coarse and fine grained. The above pebbles are, except where the conglomerate is greatly squeezed, quite fresh in appearance. There are also pebbles of dark-green schist which were less resistant to the squeezing and are consequently much more flattened. Burwash reports pebbles of a grey slaty rock with rounded grains of feldspar and quartz grains in lesser amount, also pebbles of biotite-muscovite gneiss. These range in size from gravel to boulders a foot in diameter. The matrix is an arenaceous greywacké made up of angular grains of quartz and feldspar and a few grains of fine-textured rock. In some places mica and a little hornblende has been formed. In this connection it may be noted that the conglomerate is cut by a few narrow stringers of pink aplite, indicating the proximity of granite. The description above applies to the less schisted conglomerate. To the west of this bay it is much more squeezed, the pebbles being greatly drawn out and having their longer axes in the direction of the dip.

Although these beds have been called conglomerate, there is much variation from bed to bed. Many beds are entirely arenaceous; some are of pebbles the size of gravel, while others are of boulders as much as a foot in diameter. The most striking thing about these rocks is that in the otherwise uniformly arenaceous beds there are here and there large boulders. In this respect, as well as in the angularity of the grains and the composition of the greywacké and conglomerate, the rock resembles the Cobalt conglomerate of the great Huronian belt of sediments west of Lake Timiskaming[1] and north of lake Huron,[2] and also the conglomerate of the Sudbury series[3] and the Bruce conglomerate of the north shore of Lake Huron.[4]

North of this conglomerate there is a series of thin-bedded sediments, quartzites, greywackés, and slates, now largely converted to fissile schists, which occupies the main basin of the lake. North of this again is a chloritic series which toward the east becomes hornblendic. In places these rocks look like lavas, but no decisive evidence was found. Beyond these again, crossing the small expansion of the river immediately above the lake, there is another band of greywackés.

As far as could be seen, there is no angular unconformity between these various rocks, and if such exists it is small. All the rocks are replaced by carbonate.

### Structure of the Schist Complex

Since the dips are almost vertical over most of the area, it would be necessary to determine the tops and bottoms of beds and flows over the whole area before the structure could be completely determined. The contacts of the granite are generally parallel to the strikes of the sediments. This, since the granite advanced from below, makes it probable that the schist complex has the general structure of a syncline, resting on the underlying granite. The strikes of the sediments show that this structure is not simple but complex, made up of many close folds.

### Origin of the Sediments

The sediments of Narrow, Woman, and Confederation lakes have already been described. It is evident that the materials for these sediments were not produced by deep erosion, since only surface types are represented in the conglomer-

[1] *See* descriptions in numerous reports by the Ontario Department of Mines and the Geological Survey, especially W. G. Miller, Ont. Bur. Mines, Vol. XIX, pt. 2, 1913, and W. H. Collins, Geol. Surv. Can., Mem. No. 33.

[2] W. H. Collins, Geol. Surv. Can., Mem. No. 143.

[3] Ibid., p. 24.

[4] Ibid., pp. 45-46.

ates. Nor was the material carried far, since the grains are angular and the variety of pebbles small. The lavas and associated porphyries with which the sediments are interbanded are the same as those which furnished the material for the sediments. The size of the grains changes abruptly from bed to bed. The disintegration which produced the material for the sediments was rapid and entirely mechanical, for the feldspars are just as fresh as those of the rocks from which they came. Breccias of angular blocks of lava and undoubted flow breccias occur which, upon being formed, would be rapidly and easily disintegrated and carried away by water to be deposited in nearby basins, then covered by later flows. It is probable that this is the way these sediments originated. This is supported by the interbanding of the lavas and sediments as they were interbedded. The areal distribution of lavas and sediments can, of course, be explained by supposing all the bands of sediments to be synclines in a lower and earlier lava series. To decide definitely between these possibilities would require the complete determination of the structure. The shortness of the time available, together with the wooded nature of the country, rendered this impracticable. The first possibility appears to explain the known facts more satisfactorily than the second.

The sediments observed along the Birch Lake river and south of Seagrave lake, as well as the conglomerate of Slate lake, have a greater variety of pebbles than those discussed above. The conglomerate of the former locality resembles in its pebble composition that of the latter, which contains many pebbles of lavas and porphyries identical with those of the conglomerates of Narrow, Woman, and Confederation lakes. Granite pebbles also occur, although not plentifully. These sediments represent deeper erosion and probably were derived from a more extensive terrain than the others. It is also likely that they are younger than, though not necessarily unconformable with, the others. The angularity and freshness of the grains indicate that the disintegration which produced them was essentially mechanical and that they were not transported any great distance by wind or water.

The Birch Lake river sediments were not studied in thin section, so the matrix cannot be compared with that of the Slate lake conglomerate. No examples of isolated boulders in otherwise uniform and fine-grained beds were seen in the former sediments, but this does not preclude their occurrence, since the examination was hasty and very incomplete. Burwash has expressed the opinion that the conglomerate that occurs on Birch lake north of the portage from the upper end of Springpole lake is the same as that on Slate lake, and it seems probable that further work will show that the beds along the Birch Lake river are equivalent to the conglomerate on Slate lake.

It has already been stated that the Slate lake conglomerate resembles in several ways the Cobalt conglomerate as well as the Bruce conglomerate and the conglomerate in the Sudbury series. Regarding the origin of the Cobalt conglomerate, there has been much discussion, some of which is pertinent here.[1] Whether or not that conglomerate is due to continental glaciation, it seems at least clear that large boulders dropped into otherwise uniformly fine grained,

[1]A. P. Coleman, Am. Jour. Sci., Vol. XXIII, 1907, pp. 187-92; Bull. Geol. Soc. Amer., Vol. XIX, 1905, pp. 347-66; Jour. Geol., Vol. XVI, 1908, pp. 149-58.

W. H. Collins, Geol. Surv. Can., Mem. No. 33, 1913, pp. 55-58; Mem. No. 143, 1925, pp. 73-74.

W. G. Miller, Ont. Bur. Mines, Vol. XIV, pt. 2, 1905, p. 41; Vol. XVI, pt. 2, 1907, pp. 57-58; Vol. XIX, pt. 2, 1913, pp. 85-87.

M. E. Wilson, Geol. Surv. Can., Mem. No. 39, 1913, pp. 88-98.

water-laid sediments such as those on Slate lake require the agency of floating ice. This implies that the temperature in the remote days when that conglomerate was formed was not greatly different from that of Canada to-day.

#### Quartz-Feldspar Porphyry

The youngest rocks of the region are granites and porphyries, which intrude the earlier schists. The porphyries are light-grey on the weathered surface and darker on the fracture. They vary in texture. Nearly always quartz crystals can be distinguished, and in the case of the coarser ones glistening feldspar cleavages show. These rocks are usually fresh in appearance. They cut all the sediments and are consequently younger. They also cut the silicified rocks of Woman lake and are younger than the silicification. They intrude the altered granite porphyry of Confederation lake and appear younger than the alteration of that rock. They also cut the granite south of Woman and Confederation lakes.

A specimen from a dike on Rowe lake was examined microscopically. Abundant zoned phenocrysts of sodic plagioclase and some rounded quartz phenocrysts are set in a fine-grained matrix in which quartz and feldspar are plainly recognizable. The rock is little altered. This appears to be similar to the Algoman quartz-feldspar porphyry of the Porcupine area.[1]

These quartz-feldspar porphyries occur in almost all parts of the area. None were observed however in the micaceous schists along the pegmatitic granite on the east side of the area. To the south of Shabu lake, porphyry occurs as small irregular bosses. Dikes of porphyry are frequent along the south bay of Woman lake, along the south bay of Confederation lake, and in the country to the south of the lake. Several dikes occur on Rowe lake, and dikes cross the narrow channel joining Lost bay with the main body of Confederation lake. Along the east side of the granite on Found (Elbow) lake and south of this on Lost bay, similar porphyry dikes are found. Most of the porphyry dikes are too small to be shown on the map.

#### Granite

Granite practically surrounds the schist area, and several large and numerous small masses are found within it. The various masses of granite encountered differ from each other in many ways. It is outside the scope of this report to do more than mention a few of the more typical and prominent characteristics.

The large granite mass lying to the northwest and forming the boundary of the schist area from Shabu lake to Mink lake is porphyritic with large pink phenocrysts of feldspar, in some parts as much as three inches in length. The porphyritic character continues as far into the mass as the work was carried, four miles from the contact. Along the contact the granite becomes schistose with more biotite than in the main mass of the rock. The schistosity is parallel to the contact. Even here the rock has a porphyritic tendency. In places it grades rapidly into the schist in which pink feldspar crystals have been formed. In other places the contact is sharper.

The granite of Perrigo lake varies in appearance, but is always massive. Along the east and south shores of the small lake south of Perrigo lake, the granite is grey and porphyritic with good-sized crystals of white feldspar. On Perrigo lake it varies from this to a pink granite which, generally speaking, lies to the west. Both biotite and hornblende occur in the pink and in the grey granite.

[1]A. G. Burrows, Ont. Dept. Mines, Vol. XXXIII, pt. 2, 1924, pp. 30-36.

The granite of Springpole lake is distinctly gneissic along the contacts, small pink feldspar crystals arranged in lines giving it this appearance. Toward the south side of the lake, this gneissic nature is much less apparent and the rock becomes a coarse porphyritic granite resembling that to the west of Lake Shabumeni.

The granite mass, which is in contact with the schist at Bumpy lake and Margaret lake and extends to the south and east across the Wenasaga river, is characteristically very pegmatitic. Pegmatite dikes are common in the schists along this granite, and inclusions of mica schist are common in the granite.

The granite on Okanse lake and on Found lake is a pink to red hornblende granite, frequently with a great deal of hornblende, especially near the contacts.

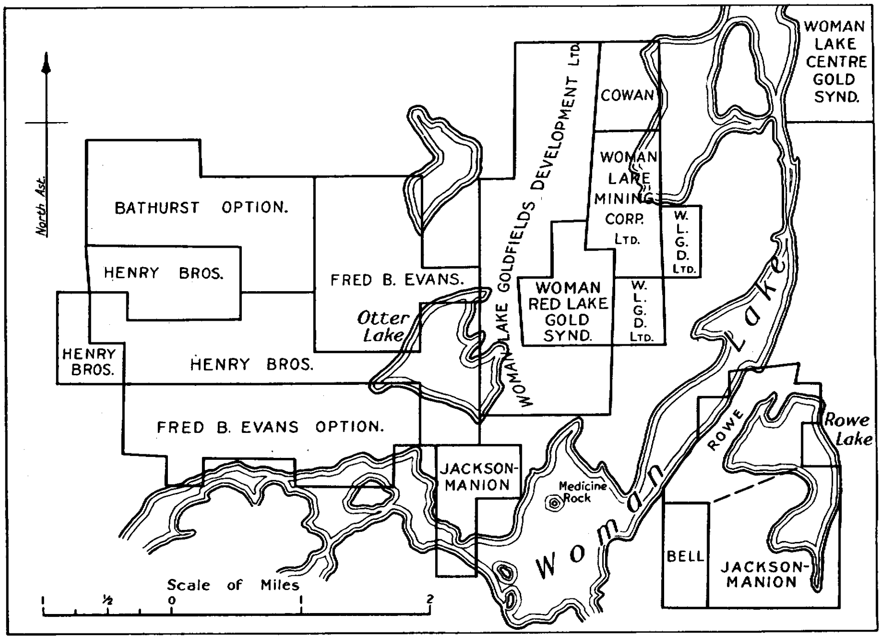



Fig. 2—Sketch showing approximate positions of groups of claims in the vicinity of the Jackson-Manion property.

The granite to the south of the area is variable, being frequently gneissic and again massive. Outcrops in this section are scattered.

## Economic Geology

In the fall of 1925, the Howey brothers made an important gold discovery on Red lake. This led to a rush to that area during the following winter. As a natural consequence attention was directed to the neighbouring schist area to the east of Trout lake. In the spring and early summer of 1926, many prospectors visited this area, much ground was staked around Woman and Confederation lakes, and some discoveries of gold-bearing quartz veins were made. In June, discoveries on Narrow and Car lakes turned attention to that quarter.

The writer visited a number of prospects during the course of the field work. There follows a brief description of the more important of them.

It will be seen from these descriptions that much work must be done on even the most hopeful of the discoveries before it can be known whether or not it will make a mine. There is no doubt that there is gold in the country. The question is as to the size of the deposits and their number; it is encouraging to note that the geological features are similar to those in the productive camps of Ontario. In judging of the possibilities of the area, it must be borne in mind that although much of the country was staked in 1926 only a very little of it has been prospected, so that we may confidently look for more discoveries with further prospecting.

### Rowe Lake

*Jackson-Manion and Rowe.*—This vein outcrops on the shore of Rowe lake and extends southward, swinging to the east along its strike. When the property was visited late in September, strippings had exposed the vein in a sufficient

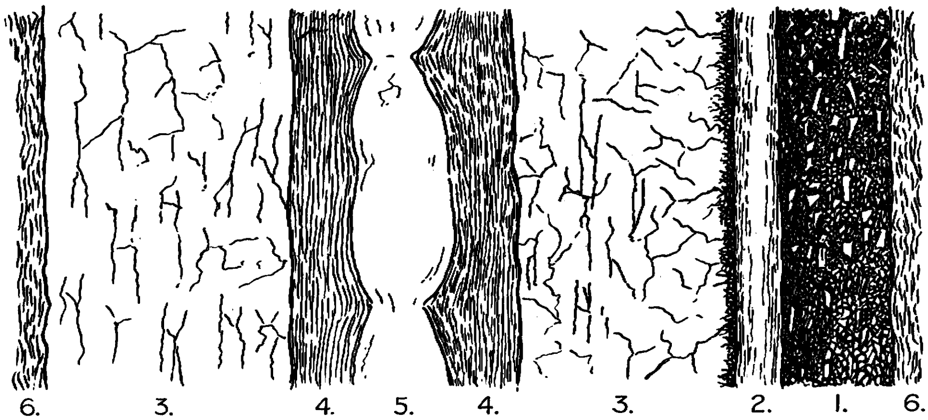



Fig. 3—Cross-section (approximately to scale) of Jackson-Manion vein near south end of stripping. (1) A very dark zone of much brecciated quartz cemented with later quartz carrying a great deal of tourmaline in minute crystals. (2) Quartz brecciated and cemented by later quartz with a little tourmaline. (3) Quartz cut by irregular, hairlike, dark stringers carrying tourmaline and fine sulphides. A little pyrite is visible, and native gold occurs here. There is a narrow, much brecciated selvage on the east which resembles (1). The dark stringers appeared in the field to carry some fine sulphides, although thin sections examined later showed only tourmaline needles along the walls of tiny quartz veins. Both the old and the new quartz is strained. (4) Schist enclosed in the vein, now largely carbonate and chlorite. (5) Quartz. The schist of the wall (6) is much replaced by carbonate; there is considerable pyrite in the schist, and a good deal of quartz has been introduced. Siderite is recognizable in the hand specimen, and it weathers out rapidly, leaving a rusty residue.

number of places to make it reasonably certain that this one vein runs from the outcrop on the lake southward for a little less than three-quarrers of a mile. Over most of the length it is narrow; but toward the south, stripping shows a width of from seven to twelve feet over a length of about a chain; about three chains farther south another stripping shows a width of probably 15 feet for about a chain's length. It then disappears under a swamp. On these two strippings, native gold may be seen in the vein. Running parallel to the vein and apparently continuous throughout its length, there is a light-weathering, much-sheared porphyry dike. Small lenses that resemble much-altered porphyry occur in the vein places. The vein, where it disappears in the swamp at the south, is no great distance from the granite contact.

The Jackson-Manion claims are under option to Noah Timmins, president of the Hollinger mine. By means of diamond-drilling the veins are being tested at depth.

### Confederation Lake

*Heinie, Levesque and Rouillard.*—On claims K.R.L. 4,134 and 4,089, on the northwest shore of Confederation lake, there is a narrow quartz vein in the altered granite porphyry sill, which has been exposed over a length of about 60 feet; the width ranges from seven to fifteen inches. The strike is 175° W., and the dip 55°W. The vein is well mineralized with sphalerite, pyrite, and chalcopyrite, and little galena is present. The wall rock is also mineralized. Fine-grained native gold is visible in many places in the vein. A green dike rock cuts the altered porphyry near the vein. The dike is rusty-weathering and in section is seen to contain a large proportion of carbonate; some fine chlorite, giving it the green colour; and a little fine-grained quartz, probably secondary. There are remnants of feldspar laths, apparently oligoclase-andesine, but owing to the alteration the determination is uncertain. A microscopic examination of the porphyry of the wall shows that the feldspars are sericitized and that a little carbonate has been introduced, but the rock is as fresh as other specimens from the islands of Confederation lake. On K.R.L. 4,089,stripping shows what appears to be a breccia due to a green dike intruding the porphyry. A piece of the porphyry from this breccia is much more altered, the feldspar in places being largely replaced by a mixture of carbonate and sericite. Other nearby strippings on these claims show a green rock, like the above-mentioned dike, with numerous small quartz veins in it. A thin section of this rock showed it to be almost entirely carbonate and chlorite. No original minerals could be distinguished.

*Hill and Hogarth.*—A short distance from the east shore of Lost bay and just south of Gill's base line, a vein outcrops. A forest fire during the summer of 1926 removed all vegetation from the rocks here so that they and the vein are well exposed. The rocks are pillow lavas and associated breccias. The vein is continuous, being traceable southward (strike average about 8 degrees) for a distance of 60 chains to a swamp, under which it disappears. It is narrow throughout, being a mere stringer at the north and having a maximum width of about four feet. Over most of its length it is minutely contorted, the banding showing this up distinctly, and is but sparingly mineralized. The walls and the schist, which is in some places included in the vein, are rusty-weathering, due to carbonate. There appears to be a little native gold in the vein.

The vein lies practically on the boundary between claims K.R.L. 4,502, 4,505, 4,583, and 4,585 to the west and K.R.L. 4,503, 4,506, 4,584, 4,586 to the east, the posts being on the vein.

### Woman Lake

On the west shore of Woman lake immediately north of the narrows on claim K. 1,829 of the Woman Lake Centre Syndicate group, there is a narrow vein striking 170 degrees and dipping vertically. When the claim was visited in July, this vein had been stripped and opened in two places. In the more northerly of these, it was about five inches wide; a little south it becomes two parallel veins, a foot and a half apart. They pinch and swell, the widths ranging from four inches to a foot. The vein, which is banded, is mineralized with pyrite, sphalerite, and chalcopyrite; some iron-rich carbonate is also present. A little fine native gold is visible in the vein. The wall rock is impregnated with fine sulphides and carbonate. Between the two veins at the southern opening, there is a light-green, rusty-weathering dike carrying abundant pyrite. A thin section shows that the dike is now largely carbonate. There is enough feldspar left in patches to show that before the introduction of the carbonate the dike was highly feldspathic. The feldspar was branching, resembling in section frost on a window-pane. The composition was not determinable. It is alkaline, probably a soda feldspar.

### Narrow Lake

*Dunkin.*—In June, 1926, Thos. Dunkin made a discovery on Narrow lake that attracted much attention; it is situated on a narrow peninsula near the west end of the most westerly of the northern bays of the lake. The writer visited the place early in September. A few trenches had been made across the strike over a total length of about four chains. In each of these veins had been exposed, but the trenches were not sufficiently closely spaced to permit joining the veins or forming an idea of the amount of quartz. There are several veins roughly parallel. These are not uniform in width and may be a series of roughly parallel lenses. One of these, which was exposed over a length of about 21 feet and had a width of from three to five feet, showed a good deal of native gold.

The quartz of this vein is of a peculiar bluish colour. The vein is not solid but contains numerous vuglike cavities. In these, there are well-formed crystals of pyrite and a few poorly terminated quartz crystals. Native gold occurs on the walls of some of these cavities and fills tiny cracks extending from them into the quartz. A polished section showed no other mineral with the gold in the crack. A thin section of the quartz shows it to have been much crushed and, judging from the wavy extinction, to be under strain. Thin stringers of white mica cut across the quartz.

Three specimens from the country rock were examined microscopically. One of these, from a place between two veins some 70 feet west of the showing of gold-bearing quartz described above, was found to be completely altered. There is a good deal of chlorite and a little coarse carbonate scattered through a groundmass that is largely quartz, which has evidently been introduced. Irregularly distributed through the quartz there are irregular areas and lanes composed almost entirely of clear, fine-grained alkali feldspar. Another specimen taken a few feet to the north is an altered feldspar porphyry. There are abundant phenocrysts of a feldspar near albite in composition, and one small quartz phenocryst was found in the section. The rock is much altered and contains considerable chlorite and carbonate. A third specimen, from a pit about 12 feet north of the veins, is again a porphyry with feldspar near albite in the groundmass and as phenocrysts. As usual, there is considerable chlorite and carbonate. Quartz veins, with a small amount of carbonate in them, cut the rock. Unfortunately the small amount of rock exposed in the trenches prevents the determination of the geological relations here. These specimens resemble the early feldspar porphyries associated with the lavas. The wall rock of the vein in which the abundant native gold is found is more altered than those described above. It is now a rusty decomposed rock on the surface and evidently largely carbonate.

A small pit, several chains east of the discovery and south of the strike of these veins, also shows gold-bearing quartz.

### Car Lake

*Bathurst.*—This discovery is a short distance west of the northwest bay of Car lake. It is reached by a trail from the small bay of Narrow lake north of the Dunkin discovery, which leads to the south end of Car lake. From here a canoe is used, or a foothpath on the west shore of the lake.

The discovery is what appears to be a broad lens of quartz about 45 feet by 20 feet. On the smoothed surface of and extending into the quartz, there are a number of showings of native gold, the largest of which is about an inch in diameter. These are in a linear arrangement extending over a length of about three feet. The quartz of this lens or dome is fine grained and sugary. Under the microscope it is a uniform-grained mosaic, which is quite unlike the quartz veins already described. Cutting across it are tiny stringers of white mica and chlorite. Feldspar was recognized in the hand specimen. Sulphides are scarce near the gold, but the edge of the lens is well mineralized. Pyrite, sphalerite high in iron, chalcopyrite, and galena were recognized.

When the claims were visited at the end of August, they were being actively prospected. This is made difficult by a heavy covering of drift and bedded sands, which mantles much of the rock. However, several small quartz veins had been found and a larger one, with a maximum width of about 30 feet. On account of the covering, it was not possible at that time to form an idea of the continuity of these veins. A well-mineralized schist zone had also been found a short distance south of the original discovery. The rock here is much decomposed and very rusty. Arsenopyrite and pyrite appear to be the dominant sulphides, although the decomposed nature of the surface makes the identification uncertain. Ancient pillow lavas form the country rock exposed in the neighbourhood of the veins. To the west, the lavas are intruded by massive biotite granite.

There are other veins and schist zones in the neighbourhood. To the north of Car lake a short distance east of the discovery, on a claim staked by C. G. Daimpre, there is a 9-foot quartz vein with a strike of 60 degrees. This is but slightly mineralized. At the northeast corner of the lake, there is a zone of schist, containing quartz stringers, with a strike of 70 degrees and a steep dip to north, which has been stripped, showing about 20 feet at the widest place.

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## Appendix

### Table of Magnetic Declinations, June-July, 1926

(Determinations by J. W. Pierce, O.L.S., D.L.S.)

| Station | Longitude | Latitude | Mean declination for day |
|---|---|---|---|
| Keigat lake | 92° 08′ | 51° 24′ | 4° 34′ W. |
| Birch Lake river | 92 16 | 51 24 | 4 44 E. |
| Shabumeni river | 92 25 | 51 24 | 6 05 E. |
| Shabumeni river | 92 31 | 51 25 | 4 23 E. |
| Shabumeni lake | 92 37 | 51 20 | 4 24 E. |
| South end of portage | 92 41 | 51 16 | 4 21 E. |
| Shabumeni lake | 92 42 | 51 17 | 7 41 E. |
| Woman lake | 92 45 | 51 10 | 5 08 E. |
| Woman lake | 92 53 | 51 05 | 4 43 E. |
| Bear lake | 92 58 | 51 03 | 4 10 E. |

# INDEX, PART III

## K



## L



## M