

CANADA
DEPARTMENT OF MINES

HON. W. A. GORDON, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

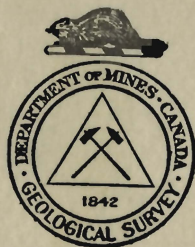
GEOLOGICAL SURVEY

W. H. COLLINS, DIRECTOR

Summary Report 1933, Part C

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OTTAWA
J. O. PATENAUDE
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1934

Price, 25 cents

No. 2347

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GOLD OCCURRENCES OF FLINFLON DISTRICT, MANITOBA AND SASKATCHEWAN

By J. F. Wright and C. H. Stockwell

INTRODUCTION

Detailed geological mapping of Flinflon area was commenced in 1933 and about six weeks were spent in this field, three weeks in June about Phantom Lake and the north end of Schist Lake and three weeks in September about Tartan and Cliff Lakes. The investigation is not advanced far enough to warrant presenting a statement of the geological features of the area, consequently only a general account of the geology of a few of the gold prospects is given at this time.

PHANTOM

This gold occurrence, controlled by Mr. Robert Graham, is at the south end of Phantom Lake and about 5 miles south of Flinflon. The veins are near the southeast corner of the Phantom mineral claim and about 900 feet south of Phantom Lake. In the winter of 1933, probably 500 tons from one lens of quartz were hauled to the Hudson Bay Mining and Smelting Company's plant for flux.

Granite underlies the southwest and basalt the northwest part of the mineral claims. The granite cuts and holds inclusions of the lava. The veins are in the granite about 300 feet southwest of where the contact of the granite and basalt turns from a nearly south to a southeast direction. The granite near the pits is in part aplitic in texture. The fresh surface of much of it is black. Its minerals are greatly altered, for in what appeared to be a fresh specimen of the granite from the hill west of the prospect pits most of the orthoclase and oligoclase are gone to white mica, and the hornblende and biotite to chloritic and carbonate products. Augite forms the centre of some of the hornblende crystals.

Two deposits are opened by prospect trenches and shallow shafts. One deposit strikes south 45 degrees east and dips from 50 to 70 degrees northeast. It is exposed continuously along the strike for 130 feet and continues another 140 feet to the southeast as a body of in part schistose, and in part massive, granite cut by stringers of quartz. To the northwest the deposit passes under waste material and swamp. At a point 50 feet southeast from the northwest exposed end of the deposit a shaft 14 feet deep follows 2½ feet of chloritic schist cut by veinlets of quartz and carrying crystals of pyrite and some iron carbonate. Both the foot- and hanging-walls of this schist body are sharp and are formed by joint planes. The next 80 feet of the deposit southeast of this shaft is exposed by an open-cut averaging about 6 feet deep. At 40 feet southeast from the north shaft, a second shaft extends about 25 feet below the bottom of the open-cut. In this shaft the deposit is a body of black schistose granite 7 feet wide and bounded by

sharp walls. In it quartz is scarce and is distributed in narrow veins. Many of these are along joint planes both parallel and at an angle to the strike of the schist body. Quartz stringers pass from the schist to the massive granite along some joint planes, especially those running about east and west or at 45 degrees to the trend of the deposit. Free gold is abundant in some of the quartz. At 40 feet southeast from the end of the open-pit, a trench 4 feet deep crosses 3 feet of massive, jointed granite with schist seams and quartz veins along joint planes. At 90 feet farther to the southeast this narrow body of jointed and schistose granite joins another striking about east and west and exposed at intervals for 220 feet west and 80 feet east of the point of junction. This latter deposit dips about vertical. No large, continuous body of quartz is exposed along it except at 130 feet west of the junction of the two deposits where a pod-shaped body of quartz is 45 feet long and up to 15 feet wide. It is exposed in an open-cut about 12 feet deep and most of the quartz taken to Flinflon was from this pit. The body of quartz throughout most of its length is bounded by joint planes with slickensided surfaces. The movement along some joint planes was about horizontal. The slickensided joint planes extend into and are younger than the quartz. Where the quartz body is not bounded by joint planes, as at its west end, it passes outward into granite without a sharp and definite wall. Pinkish, white, and grey-coloured quartz are intermixed. Small crystals of pink feldspar are abundant in some of the pinkish quartz, and the pinkish colour may be due to abundant very small bits of this feldspar. A mass of grey, cherty quartz at the west end of the body carries pyrite and is cut by veinlets of white quartz. Sulphides are scarce in the quartz and its average gold content is unknown, but probably is low.

MAHONEY-HENNING

This property of six mineral claims is about 2,000 feet east of the south end of Bootleg Lake and about $4\frac{1}{4}$ miles a little west of south of Flinflon. The mineral claims were staked in July, 1931, by Messrs. P. J. Mahoney and A. J. Henning and they and L. S. Dion control the property. The veins have been explored by eight pits and trenches and a shaft 31 feet deep.

The property lies along the contact of basaltic lava on the west and younger diorite and granodiorite on the east. The gold-bearing veins are in the diorite, within 200 feet of the basalt, and it is reported that a gold-bearing vein has been discovered in the nearby lava since the deposit was examined in June, 1933. Both the diorite and granodiorite are massive, medium-grained, and fresh rocks. The diorite weathers white, grey, and brownish with a mottled black and grey pattern in some outcrops. Its fresh surface is grey to black and the chief mineral is andesine-labradorite. Quartz is absent or present in small quantities. Hornblende is abundant, as is also biotite in some specimens. On the hills on the other side of the drift area south of the shaft, the diorite is cut by dykes of pink granite. About a quarter mile east of the shaft the diorite changes within 100 feet to a more granitic appearing rock carrying pink feldspar. The latter is a granodiorite with abundant quartz, and albite-oligoclase, and some microcline, hornblende, and biotite. This granodiorite forms the central and

apparently the greater part of the intrusive mass lying between Bootleg and Phantom Lakes with diorite and granite along its west and east sides, respectively.

Some trenching has been done on three bodies of jointed and schistose diorite cut by veins of quartz. The most important of these is exposed by trenches and a shaft 31 feet deep for 350 feet along its strike of north 20 degrees east. It may continue to the south another 200 feet or more under the drift. At the surface near the shaft the black, chloritic rock derived from the diorite is 3 feet wide and in it there is about 16 inches of quartz in narrow veins. At 11 feet below the surface the quartz and schist are $3\frac{1}{2}$ feet thick and this body is reported to be gold ore of good grade. Quartz was more abundant in the ends of the shaft below this level. The quartz is a smoky variety and carries abundant chalcopyrite and some of it free gold. About 70 feet south of the shaft the deposit passes under a mantle of boulders and gravel, which in a trench 220 feet south of the shaft is over 20 feet thick with creek sand between the gravel and bedrock. A few round boulders of pyrite, carrying chalcopyrite and sphalerite, are present in this gravel. The body of sheared diorite is not well defined north of the shaft. It has been opened by trenches at three points and there the schist carries pyrite along joint planes and is cut by veins of quartz holding abundant chalcopyrite and some free gold. These narrow schist masses trend in various directions across the trenches and the intervening diorite is massive and apparently little altered. Two other narrow bodies of jointed and schistose diorite between this main deposit and the lava on the west carry vein quartz and free gold. They have been explored by a few trenches and are narrow and do not appear to continue far along their strike. All the quartz veins are narrow and discontinuous. Although these deposits are small their abundant free gold suggests that the area to the north and south along the contact of the diorite and lava should be explored in detail. To date only a small amount of prospecting has been done in the area about Bootleg Lake. Two bodies of schist in the lava, and, respectively, 600 and 900 feet west of the diorite and about 4,000 feet north of the shaft on the Mahoney-Henning deposit, have been opened by a few shallow trenches. The occurrences are veins of white quartz, large bodies of iron carbonate, and schist carrying finely disseminated quartz and pyrite. Some of the quartz of the narrow veins carries abundant free gold, but the average gold content of the large quartz veins, or the large bodies of carbonate or of sulphide-bearing schist, is not known.

TIKKANEN

This deposit is on the hill-side about 300 feet east of Douglas Lake just south of the large, north part of the lake. The deposit is about 3 miles directly southwest of Flinflon and is easily reached by the motor road to the north end of Douglas Lake and thence by canoe about a mile down this lake. The ground was staked in May, 1933, by Mr. John Tikkanen and associates. When the deposit was visited, about the middle of June, it was exposed by two or three shallow trenches, but additional work was done on it in October.

The country rock is basalt with pillows, bombs, and breccia. The deposit is in chloritic schist developed along the contact of two flows. It strikes about southeast and dips 65 degrees southwest. The chloritic schist carries scattered grains of pyrite, arsenopyrite, and sphalerite, and is cut by stringers, veins, and lenses of quartz carrying sulphides and others of massive arsenopyrite with only a little quartz. The schist body, with some parts of fairly massive lava, is up to 5 feet wide, but the parts cut by veins of quartz and of arsenopyrite are only from 6 to 22 inches wide. The body of schist carrying quartz and sulphides is 400 feet long and outcrops of schist to the southeast along its projected strike suggest that it extends another 900 feet in this direction. Both the quartz and arsenopyrite carry gold, but the average gold content of minable widths of schist, quartz, and sulphides is unknown. Drift deposits are not thick over the deposit along parts of its strike and the abundant sulphides in the schist, together with the favourable assay returns from the few samples taken, suggest that more extensive exploration should be undertaken.

EVA-CHANCE-SHEAR GROUP

These mineral claims are north of the northwest bay of Manistikwan (Big Island) Lake and 3 miles east of Flinflon. The bedrock on their east side is basaltic lava and on the west quartz-albite granite. The granite holds inclusions of lava and is cut by dykes of diorite. Parts of it have a porphyritic appearance with eyes of dark quartz and in some outcrops large crystals of white feldspar. The deposits are in the quartz-albite granite, one on the side and top of a hill and from 50 to 200 feet west of the basaltic lava and the second northwest of McWatters Lake about 1,500 feet west of the deposit near the margin of the granite body.

The deposit near the east margin of the granite body comprises a series of narrow, discontinuous quartz veins following along joint planes in the granite. Some of the veins are only 1 inch wide, others are 2 feet wide but extend no more than 20 feet or thereabouts along their strike. They strike in various directions across the trenches. Two or more veins may be present in a width of 4 feet in one trench, and none may be present at points 10 feet along the strike in both directions. The general trend of the deposits is nearly north, parallel the strike of the contact of the granite and basalt. The granite adjoining the veins is massive. Three such deposits have been explored by trenches. The easternmost is on the side of the hill and is exposed in large trenches distributed over a length of 400 feet along the strike. Quartz is abundant in the main trench, but is scarce in the others. The other two deposits to the west are less than 2 feet wide at most points but continue at least 500 feet along their strike. Sulphides are not abundant in the quartz and bordering schistose granite. Vugs several inches across and lined with crystals of quartz are present in the quartz. Free gold is abundant in some of the quartz. The quartz carrying free gold and sulphides, however, is not estimated to be plentiful enough to make ore across minable widths.

The deposits northwest of McWatters lake are in a fine-grained, pinkish, schistose granite forming a body about 500 feet wide and 1,500 feet long. This granite is markedly different in appearance from the typical

quartz-albite granite occurring to the east and west and forming the main part of the intrusive mass. The contact of the two types of granite was not seen. Shallow prospect trenches west of and near the north end of McWatters Lake expose a width of about 200 feet of the schistose granite. It is crossed by narrow veins of quartz following some of the joint planes and the more schistose parts of the mass carry scattered crystals and grains of pyrite. Parts of this body of schistose granite carry some gold. Two other deposits of similar character have been trenched within 1,000 feet to the north. At these localities veins of white quartz and scattered grains of sulphides are more abundant than elsewhere and the granite has been largely transformed to quartz-sericite schist. The large outcrops of this schistose rock have not been trenched systematically, and the low average gold content of the samples assayed has not encouraged further work. If exploration of these deposits is undertaken it should be directed to outline and determine the average gold content of the parts of the large bodies of schist carrying the most vein quartz and sulphides.

NESO AND TWIN LAKES AREAS

Gold deposits have been known on Neso and Twin Lakes for over fifteen years, but no extensive development has been undertaken in these areas. These lakes are 2 and 6 miles, respectively, east of Athapuskow Lake north of Tincan Narrows and are easily reached by canoe from near Athapap on the Flinflon branch of the Canadian National Railway.

The bedrock of these areas is grey and black lava cut by large bodies of granite and dykes of quartz-feldspar porphyry. The lavas are fine grained and for the most part without ellipsoidal or other such structures. Some rocks are dense and cherty in appearance, but nowhere show bedding. Narrow bodies of bedded greywacke, quartzite, argillite, and limestone are interlayered with the structureless rocks considered to be lavas. The sediments strike northeast and dip about vertically. The area of sediments and lavas in the basin of Neso Lake is at least a mile wide and is separated from that on Twin Lake by about a mile of granite. The area on Twin Lake is from $\frac{1}{2}$ mile to at least 2 miles wide. The granite of the large bodies is massive. Some of it adjoining the lavas is fine grained and black. The contact of the lavas and granitic intrusives is sharp, but not straight, for tongues of granite project into the lavas, also small bodies of granite lie within the lavas in front of the main granite mass. The dykes of quartz-feldspar porphyry are more abundant in the lavas adjoining the granite than elsewhere, and these small, intrusive masses most likely are phases of the granite.

The main work on Neso Lake has been done on the Hobson-Smith and Dixie properties. The Hobson-Smith comprises six mineral claims on the point north of the outlet of the lake. They were staked in 1922 and the surface work has been done by Mr. W. F. Smith, who controls a half interest in the property. This work includes two shallow shafts, three large open-cuts, and sixteen shallow diamond drill holes. The shafts, open-cuts, and drill holes are distributed for 1,750 feet along the north shore of the point west from the bottom of the bay. Black lava outcrops at the water-level at a few points on the shore, and the deposit is in

schistose granite carrying inclusions of lava and just south of the contact of the granite and lava. The open-cuts expose sericite schist, schistose granite, and chloritic schist. The sericitic and chloritic schists are cut by veins of white quartz and carry crystals of pyrite and grains of pyrite and iron carbonate. This schist carrying sulphides and quartz does not appear to be in a well-defined body continuous along the strike. Instead it appears that a wide body of rock along the contact of the granite and lava has been altered to schist, and that some parts of it carry more quartz and sulphides than others. Some specimens of quartz carry gold, but the average gold content across 4 to 6 feet is unknown.

The Dixie group is on the east shore of Neso Lake about one-half mile north of the Hobson-Smith claims. This group is controlled by Mr. E. T. Hartnett of The Pas, who in 1932 did extensive trenching along the vein. The bedrock on the property is andesitic lava cut by schistose granite and dykes of diorite. The prospect pits expose andesite and chlorite schist. The vein strikes about east and dips 70 degrees north. It crosses, at about 45 degrees, the general strike of the schistosity of the lava flows. The only exposures of the vein are in two pits near the lake shore. In the pit just above the lake level 5 feet of andesite and chlorite schist carries vein quartz. Free gold and sulphides are present in the quartz. In the next pit, 25 feet to the east, two parallel veins about 6 inches apart and each about 6 inches wide cross the bottom of the pit. The next five pits, distributed at intervals over a length of 375 feet along the strike, are in deep drift and their walls have caved. Some quartz is present on the dump near some of these pits. About 500 feet east of the lake, and along the projected strike of the deposit, the andesite lava is schistose and cut by diorite dykes, but quartz is only sparingly present. The deposit apparently does not extend more than 400 feet east from the lake and no proof of its continuation to the west was noted on the islands in the lake, which are less than 2,000 feet distant from the trenches. Trenches on the hills east of the lake, and about 1,500 feet northeast of the main deposit, expose a fine-grained rock that was either rhyolite or aplite but is now brecciated, altered to sericite schist, and crossed by stringers of quartz and iron carbonate, and the schist and vein quartz carry grains and cubes of pyrite. The gold content of the large bodies of this material is low.

Deposits on the Nemo and Joplin mineral claims on Twin Lake have been explored within the past two years by Messrs. Edward Arbow and F. J. Van Jeelan. These occurrences are about $2\frac{1}{2}$ miles across country from Payuk on the Canadian National Flinflon line. That on the Nemo claim is on the hill south of the east end of the portage from Payuk Lake to Twin Lake. This hill is nearly 300 feet long and 150 feet wide and is surrounded by drift. The rock is a green to greyish, chloritic and sericitic schist, probably originally a lava. At the north end of the hill the schist is cut by narrow, crooked, irregular-shaped bodies of white-weathering, pinkish, aplitic granite that contains veins of white quartz. On top of the hill a trench 100 feet long exposes crenulated schist alternating with bodies of more massive schist. The schists are cut by veins of white quartz and also carry some iron carbonate and pyrite. The iron carbonate and

pyrite are more abundant in the highly fissile schist. The quartz is distributed in veins and lenses through the whole mass. On the west end of the hill a cut 14 feet long exposes 5 feet of greyish, fine-grained quartz bordered by greyish and greenish schist carrying stringers of quartz, bunches of iron carbonate, and grains and crystals of pyrite. On the south side of the hill, about 100 feet north of the main trench on the top of the hill, two trenches each expose 5 feet of intermixed white and dark quartz carrying iron carbonate, feldspar, pyrite, and chalcopyrite. The quartz holds inclusions of schist. The quartz bodies are short and have indefinite walls, except where bordered by joint planes.

About 2,000 feet westward from the occurrence on the Nemo mineral claim three trenches expose green schist carrying stringers and lenses of quartz and grains and crystals of iron carbonate and pyrite. These trenches are about 200 feet apart and are on the sides of small knolls of rock rising about the generally flat, sandy country. In the westernmost trench a width of 4 feet is about two-thirds quartz and one-third green schist containing iron carbonate and pyrite. This is bordered on the east side by 10 feet of green schist carrying scattered veins and lenses of quartz up to 1 foot wide and grains and crystals of pyrite and iron carbonate. Some of the quartz veins cross the strike of the schistosity. The quartz is grey to white in colour and medium grained. Crystals of white feldspar are plentiful in some of it. White iron carbonate is the chief mineral in a few irregularly shaped patches within the quartz. The white quartz of some veins is cut by veinlets of grey, fine-grained quartz and in some specimens free gold occurs in or near these veinlets of younger quartz. The schist body in each of the other two trenches is mineralized similarly to that in the westernmost trench. The ground between the trenches is largely covered. The outcrops near the trenches indicate, however, that the quantity of vein quartz in the schist becomes less within 50 feet along the strike of the deposit. These bodies of vein quartz and schist do not have definite walls and all the lava exposed nearby is somewhat schistose and cut by a few veinlets of quartz. The two trenches are not along the projected strike of the schistosity in the westernmost trench and two or more separate bodies of schist cut by vein quartz probably are present in this locality.

The Joplin occurrence is about 2,000 feet south of the cabin on the south shore of, and about half-way up, the south arm of Twin Lake. The rocks here are basaltic lava cut by dykes of white-weathering, pinkish aplite. The deposit is exposed in a trench and a pit 12 feet deep. In the pit the foot-wall is massive basalt and its dip is 75 degrees east. Above the foot-wall are 4 feet of black chloritic schist with small quartz stringers and 6 feet of chlorite schist cut by veins of quartz, one of which is 18 inches thick. The chloritic schist contains granular pyrite, and the quartz scattered grains and crystals of pyrite together with chalcopyrite, galena, and sphalerite. Samples of the quartz carry very high values in gold. The body of schist and quartz passes under drift just north of the pit. It was found in a trench 100 feet to the north. South of the main pit, schist cut by quartz is exposed at intervals for 400 feet along the projected strike of the deposit. Very little surface work has been done south of

the main pit. Outcrops of schist cut by vein quartz occur at several localities on the Rafrat mineral claims to the south. This area has not been prospected in detail.

TARTAN LAKE AREA

Tartan Lake is about 8 miles northeast of Flinflon and the canoe route usually followed to this area is from Channing on the Canadian National Railway at the north end of Schist Lake. Two portages in this route are each about a mile long and the creek leading northeast from the middle of the northeast side of Embury (Trout) Lake is difficult to pass if the water is low. The country adjoining Tartan Lake has been prospected at intervals during the past fifteen years, and interest in the mineral occurrences of the area was renewed in 1932 following the discovery of free gold in the Ruby mineral claim.

Bedrock is well exposed about Tartan Lake as the forest and moss are burned off large areas. The oldest rocks are basalts that are closely folded. The basaltic lavas are cut by sill, dyke, and boss-like bodies of gabbro, augite diorite, granite, quartz-feldspar porphyry, and aplite. The intrusive mass occupying much of the area between the east and southeast arms of Tartan Lake is a complex of gabbro, diorite, epidote-rich rock, grey granite, aplite, quartz-feldspar porphyry, and albite porphyry in crosscutting relations, the gabbro being the oldest.

Gold occurs in bodies of schist cut by veins of quartz, both in the intrusive masses and in the basaltic lavas. Some bodies of chloritic schist in the complex intrusive mass between the east and southeast arms of Tartan Lake are 100 feet wide, and these masses of schist extend 1,000 feet or more along the strike. They have sharp, definite, straight walls and dip about vertically. Some of the schist is highly crenulated and much of it is laminated. Quartz, in veins up to 4 feet wide, is present in parts of the schist, the most continuous veins being along or near a wall of the body. Lenses and narrow veinlets of quartz are distributed erratically throughout the whole body. Lenses and veins of brown-weathering carbonate and others of black tourmaline are locally abundant. Black tourmaline is present in some of the quartz. Gold is known in only a few of the stringers of white quartz cutting these bodies of schist.

East of and near the north end of the southeast arm of Tartan Lake fourteen trenches have been opened on bodies of schist in the Killarney and Monica mineral claims. Some of the schist bodies are in the lava and others in diorite forming the west end of the complex intrusive mass. Some bodies strike northeast and others southeast. One of the bodies of chlorite schist near the lake is 30 feet wide. This is cut by dykes of aplitic granite from 1 inch to 15 inches wide. The aplite is in part altered to quartz-sericite schist. The chloritic and sericitic schists are cut by veins and lenses of white quartz. Veinlets, lenses, and scattered grains of iron carbonates are abundant in the schist and in some of the quartz. Scattered grains and also crystals of pyrite are plentiful in the sericitic schist and, although not so abundant, also in the chlorite schist and vein quartz. In a body of chlorite schist striking northeast, and about 250 feet from the shore, the quartz vein is from 1 foot to 8 feet wide and 200 feet long. This body of quartz is irregular in outline. The quartz contains only small bits

of carbonate and pyrite. No free gold has been found in the white quartz of these large bodies. Other trenches to the east of this large body of quartz expose chloritic schist cut by quartz veins up to a foot wide, and in addition scattered lenses of white quartz. Pyrite and iron carbonates are scarce in this quartz. Some of the quartz in these schist bodies carries gold, but the whole mass of schist and vein quartz is not gold-bearing.

The Ruby property lies west of the Killarney and between the north-west arm of Tartan Lake and the east end of Ruby Lake. Messrs. Albert Kirkland and Wm. Ferguson control this property. The main work has been done near the top of the hill rising above the low, flat, drift area at the northeast end of Ruby Lake. This work includes an open pit 60 feet long, up to 18 feet wide, and 28 feet deep, and trenches both east and west along the strike of the body of schist and quartz. On the surface the quartz is in stringers and narrow veins, whereas at the bottom of the pit the quartz body is larger and better defined, for the included schist bodies are smaller than they are at the surface. Quartz is more abundant at and near the east end of the pit than elsewhere. In the east end of the pit the north wall is chlorite schist after lava and the south wall carbonate-quartz-sericite schist, probably after quartz-feldspar porphyry. The majority of the quartz veins are in the chlorite schist adjoining the carbonate-quartz-sericite schist. About 50 feet east of the pit along the strike of the schist body quartz is only sparingly present in quartz-sericite-carbonate schist. West of the pit overburden is thick and the schist body and quartz veins cannot be explored easily by trenching. In 1932 Consolidated Mining and Smelting Company optioned the deposit and drilled three very shallow holes near where the main pit was later opened.

In the east end and bottom of the pit quartz is estimated to be as abundant as schist. Some of the quartz is white, a large part of it being greyish in colour. Much of the massive quartz does not carry pyrite. Some masses of chloritic schist in the quartz carry grains and crystals of pyrite. Small branch veinlets from a large body of quartz carry pyrite. Some green chlorite schist is altered to a greyish dense rock, which is cut by veinlets of albite felsite. In narrow zones grey, altered lava, albite felsite, and grey quartz are brecciated and the fragments cemented by white quartz. Both the albite felsite and white quartz are cut by veinlets of white carbonate. Free gold occurs in the veinlets of white quartz and along joint planes in some of the grey and white, massive quartz. In the winter of 1933 part of the quartz and intermixed schist from the pit was hauled by team to the Flinflon smelter as flux.

Dykes of quartz-feldspar porphyry are abundant at intervals in a body of schistose lava about 1,000 feet wide and extending at least $3\frac{1}{2}$ miles west from the west end of the complex intrusive mass on the Monica mineral claim across the Ruby group, along the north shore of Ruby Lake, and through a long, narrow lake north of the west end of Ruby Lake. The quartz-feldspar porphyry is largely altered to sericite schist. The dykes are up to 50 feet wide and some of them at least 1,500 feet long. At other localities a series of parallel dykes and lenses from 2 to 10 inches wide are present across 10 feet of schist. A few bodies of chloritic and sericitic schist have been trenched. They contain veins of quartz from 1 inch to 2 feet wide. Pyrite is plentiful in most of the schist and in some of the

quartz. Iron carbonate is not abundant west of the Ruby group. Free gold has been found in the vein quartz and the rusty capping of many such deposits pans gold. The bodies of lava cut by quartz-feldspar porphyry and veins of quartz should be prospected in some detail.

A number of quartz bodies ranging from 5 to 50 feet in width have been opened by a few trenches on the north side of the west arm and on both the north and south sides of the east arm of Tartan Lake. The quartz bodies are irregular in outline and within 20 feet along the strike may pass from a mass of quartz to a mass wherein quartz and chlorite schist are about equal. Pink and white feldspar are abundant in some of the quartz, also some muscovite and films of a white, sericitic mica along fracture planes. The quartz and adjoining schist contain some pyrite, iron carbonate, and tourmaline. From 1,500 to 3,000 feet north of the centre part of Tartan Lake, bodies of white and grey quartz are present in the lavas along the south side and east end of a body of granodiorite porphyry. Some of these bodies of quartz carry gold and many of them have not been examined in detail by prospectors. In 1922 Mining Corporation of Canada investigated a few bodies of quartz in this area and the average gold content of these proved to be low.

GENERAL CONCLUSIONS REGARDING GOLD OCCURRENCES OF FLINFLON DISTRICT

In Flinflon district the greater part of the surface trenching and diamond drilling has been on sulphide bodies in search of copper-zinc ore similar to that of the Flinflon deposit. Previous to 1923, however, Mining Corporation of Canada, and in later years Hudson Bay Mining and Smelting Company, investigated as a source of flux all the known large deposits of quartz that might carry enough gold to cover a large part of the cost of mining the material and transporting it to the smelter at Flinflon. Within the past two years, however, a number of deposits that are not high in vein quartz have been investigated in a preliminary way as a source of gold ore. These occurrences are in, or within one-half mile of, bodies of granitic rocks. The gold-bearing bodies include masses of either chloritic or sericitic schist with varying proportions of vein quartz, pyrite, arsenopyrite, iron carbonate, and tourmaline, as the chief minerals, and may be grouped as follows: (1) bodies of sericite schist derived from either granite or quartz-feldspar porphyry and carrying crystals and grains of pyrite and arsenopyrite, veinlets of quartz, and small amounts of carbonates; (2) bodies of quartz carrying pink and white feldspar and small amounts of pyrite, and carbonates; (3) bodies of jointed granite, granodiorite, or diorite with narrow veins of quartz carrying pyrite and chalcopyrite; (4) bodies of chloritic and talcose schist carrying small crystals and grains of arsenopyrite, and white pyrite and veins of quartz and of massive arsenopyrite; and (5) veins of quartz carrying calcite and sulphides including chalcopyrite, galena, and sphalerite.

Deposits of group (1) are widespread and a few of them have been explored by surface trenching. They are large and some specimens assay enough gold to encourage more work, but when trenches 10 to 20 feet long are sampled systematically the average gold content is disappointingly

low. The rusty capping over such deposits pans abundant gold, but it is very fine grained, consequently, assay return from samples are not so high as was expected. This very fine gold apparently is liberated by weathering of the sulphides, chiefly the arsenopyrite. Deposits of sericite schist, with pyrite, have little or no gold, and the quantity of gold present is directly related to the amount of vein quartz and arsenopyrite in the schist. Although the result of exploring the large deposits of this type to date is discouraging, all such deposits, nevertheless, must be investigated by a few trenches to determine if vein quartz and sulphides, and hence the gold content, are high enough to warrant more extensive work.

Many quartz bodies of group (2) have been sampled thoroughly. They are abundant around the south side and east end of the body of granodiorite north of Tartan Lake. The quartz is either fine grained, greyish, almost cherty, or medium grained and white. Some bodies of quartz widen from 1 foot to 20 feet within 5 feet along the strike. Lenses of schist occur within the quartz. Crystals of white feldspar and aggregates of crystals of pink feldspar are locally present in this quartz. Pyrite and carbonates are scarce, although they may be plentiful in the schist adjoining the quartz body. Black tourmaline is present locally. Much of the quartz is barren of gold. Quartz of these bodies crossed by veinlets of light-coloured quartz generally carries gold.

Deposits of group (3) comprise bodies of granitic rock cut by veinlets of quartz along joint planes. The quartz is dark in colour and much of it carries chalcopyrite. Two or more parallel or closely parallel veinlets of quartz may be present in a zone 4 feet wide and wherein the intervening rock is schistose, but this, 100 feet along its strike, may be represented by massive rock crossed by only one prominent joint plane carrying a quartz vein less than 2 inches wide. The quartz veinlets zigzag from one joint plane to the other and their dip is variable from low to high angles. Some veins cross each other. Free gold is abundant in some of the narrow veins and bodies of rock wherein such veins are closely spaced are good ore.

In deposits of group (4) the chlorite schist is deep green to black in colour, with some parts of it a greyish talcose schist. This schist is cut by quartz and arsenopyrite in veinlets and lenses. The quartz carries free gold and the arsenopyrite assays gold. The adjoining schist contains fine, granular quartz and arsenopyrite and also assays gold. The quartz carries some galena and sphalerite. Deposits of this character are considered promising, and prospectors should examine all bodies of chloritic and talcy schist that carry quartz and arsenopyrite.

Some quartz veins of group (5) follow bodies of chlorite schist and others cut massive lava or granite. The veins are lenticular with sharp, definite walls. Two or more lenticular veins may be present along the strike in the same body of schist. The schist carries very little vein quartz and sulphides. Calcite may be present in the schist and also as pockets and veinlets in the quartz vein. Galena, sphalerite, chalcopyrite, and pyrite occur in the quartz vein as scattered crystals, bunches of crystals, and also granular. Free gold occurs as a film along cracks in some of the quartz. Much of the quartz is white, fine to medium grained, and without sulphides and free gold.

WEST HALF OF AMISK LAKE AREA, SASKATCHEWAN

By J. F. Wright and C. H. Stockwell

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GENERAL CHARACTER OF THE AREA

In 1932 the geology of the east half of Amisk Lake map-area, bounded by latitudes $54^{\circ} 30'$ and 55° and longitudes 102° and 103° was studied,¹ and in July and August, 1933, that of the west half of the area was mapped by the writers, assisted by R. W. Landes and J. P. Watts. Most points in the map-area are accessible by canoe from Loon Lake on its east side, and from where a fairly good road has been built to Flinflon. Sturgeon-weir River, flowing from north to south through about the middle of the map-area, although swift for short stretches, is a very good canoe route.

The country bordering Sturgeon-weir River from Amisk Lake north to about 4 miles beyond Snake Rapids is low, flat, and in places swampy, whereas, in contrast, that to the north is rocky. West of the river above Birch Portage, hills of bare rock, from which practically all the timber has been burned, rise 175 feet above the river. Only a few hills, however, are this high, in fact many rise less than 50 feet above their surroundings. The general flat character of the surface is well displayed in the area of granitic rocks between Birch Portage and Jan Lake where, inland from the main depressions occupied by lakes, few hills rise 50 feet above the swamps. In areas covered with sand, as east of Scoop Rapid, rock is exposed only on the sides of low ridges that are distributed irregularly and break the generally flat surface covered with an open forest of jackpine. Northeast of Birch Portage the country is underlain by igneous and sedimentary gneisses that form long, narrow, closely spaced, parallel ridges. These trend northwest and north and rock is well exposed on their sides. The southwest corner of the map-area is underlain by Palæozoic strata and is a southward sloping plain broken here and there by escarpments from 10 to 40 feet high, many of which face northeast. The soil is thin over wide areas just back of the escarpments, and here bushes are small but not thick, and the surface is crossed by crevasses from a few inches to 4 feet wide that may extend hundreds of feet along joint planes. Large areas in front of the escarpment are swampy with only small stands of timber, the best timber noted being in those areas underlain by the basal Palæozoic sandstone.

¹ Wright, J. F.: "Amisk Lake Area, Saskatchewan"; *Geol. Surv., Canada, Sum. Rept.* 1932, pt. C, pp. 73-110.

GENERAL GEOLOGY

The rocks recognized in the west half of Amisk Lake map-area are grouped as follows:

- Recent and Pleistocene
 - Silt, peat, clay, sand, gravel, boulder clay
- Palæozoic
 - Ordovician
 - Sandstone, dolomitic limestone, and dolomite
- Precambrian
 - Granodiorite, granite, and pegmatite
 - Granodiorite and quartz diorite
 - Albite syenite and syenodiorite
 - Diorite and gabbro
 - Missi series of sedimentary quartz-plagioclase-mica gneisses
 - Wekusko group of basalt, andesite, dacite, and rhyolite and derived chloritic and sericitic schists and hornblende-plagioclase gneiss; sedimentary quartz-mica schists

WEKUSKO GROUP

Strata of the Wekusko group outcrop extensively east of Sturgeon-weir River and in the basin of Hansen Lake about 6 miles west of this river. From Leaf Rapids to Amisk Lake the Sturgeon-weir follows closely the contact of the Wekusko strata on the east and granite and granite-gneiss on the west. The body of strata on Hansen Lake occupies an area about $5\frac{1}{2}$ miles east and west and 4 miles north and south. It is surrounded on three sides by granite and related rocks and on the fourth or south side by Palæozoic beds. The Wekusko strata include various types of both lavas and sediments. On Hansen Lake clastics are followed to the west by acidic lavas and east of Sturgeon-weir River fine grained clastics are followed to the east by basic lavas holding thin bodies of bedded rocks. Although some of the sediments and lavas are massive in appearance, nevertheless they all carry some secondary minerals as chlorite or sericite and the greater part of the group is of various types of schists.

East of Sturgeon-weir River sediments underlie an area at least 3 miles wide across the strike of the beds. Outcrops are not abundant in parts of the area. The rocks, however, are of the same general character throughout. They are very fine to medium-grained, dark grey to black types, in some outcrops well bedded and in others without bedding. The abundant rock is a mosaic of fairly even-sized, subangular grains of quartz and biotite flakes arranged parallel, which gives the rock its marked schistose structure. Many beds carry small crystals of one or more of the following minerals: garnet, staurolite, chiasolite, tourmaline, muscovite, pyrite, and magnetite. Chlorite is not abundant. The minerals are fresh except a few of the staurolites which are in part gone to sericite. The biotite bends around the crystals of staurolite and garnet and is crossed by the muscovite. Garnet and staurolite hold inclusions of small, round grains of quartz.

At Snake Rapids the sediments are black, fine grained, and have good cleavage and it and the bedding dip 25 degrees northeast. The slaty beds are followed to the east by more quartzose types carrying red garnet. The

high ridges extending discontinuously south for 3 miles from Scoop Rapid and $\frac{1}{4}$ to $\frac{3}{4}$ mile east of the river are of fine- to medium-grained quartzite schist. Many beds near the east side of the body of sediments are black, well-laminated types carrying small crystals of staurolite, garnet, and tourmaline. The quartz-mica schists of this whole area are interpreted as recrystallized, well-sorted, muddy, fine-grained sands. Many of the beds dip 25 to 75 degrees east, only a few dip west. The details of the folds that may be present are unknown. It is clear, however, that south of Scoop Rapid at least 7,000 feet of this type of sediments are represented. On their east side the sediments dip under basic lavas and are considered to be older than this body of lavas. The sediments are cut by a large, lens-shaped body of albite syenite and syenodiorite, and by granite. Small bodies of intrusive rocks such as aplite, pegmatite, and gabbro are not abundant.

The lavas east of the sedimentary quartz-mica-schists are black and greenish black rocks locally displaying pillows, amygdules, flow lines, and flow breccia. Some fine-grained, structureless types are similar in appearance to the non-bedded and more massive black sediments. All the black lavas, however, contain abundant hornblende or chlorite instead of biotite, as do the sediments. Bodies of lavas up to 2,000 feet across are of white and greenish mottled, medium-grained rocks that most likely were basalts, but now are essentially of plagioclase gone to grey materials, and zoisite, together with green hornblende and chlorite mostly formed from augite. The minerals of a few bodies of fine-grained, dense, black lavas are only slightly altered, and their plagioclase is between andesine and labradorite, hence they are basalt. Greenish and greyish lavas carry some quartz with hornblende and andesine. Narrow bodies of bedded rocks represented chiefly by chloritic schist carrying garnet, knots of garnet and quartz, feldspar and quartz, and perhaps other minerals, occur among the lavas. Within one of these deposits, beds 4 inches thick are mostly of calcite in small crystals, the intervening layers being mostly greenish chlorite. Parts of other bodies within the lavas are estimated to be three-quarters red garnet.

The lavas are well exposed except in an area $2\frac{1}{2}$ miles wide and directly east of Scoop Rapid where sand is widespread and the outcrops are all on scattered hills. The schistosity of the lavas and the bodies of bedded rocks dip northeast and east, but the top side of the strata is not known. The strata may, however, represent a part of the west limb of a syncline extending northwest from the west shore of Amisk Lake. If so, the body of sedimentary quartz-mica schists to the west are under and older than the lavas.

The lavas of some areas change along their strike into black and grey banded rocks of medium grain. Lavas of this character are well exposed in bodies a mile or more wide and over 10 miles long that extend northward from the main area of lavas east of Scoop Rapid. These areas of banded lavas are bordered by granite. The banding of the lavas shows best on the weathered surface and results from variations in the relative proportions of white feldspar to black hornblende, or from differences in size of the grains of these minerals from layer to layer. The straight and curved,

black streaks showing on the weathered surface of some outcrops are remnants of the dark, fine-grained border phase of pillows. In other gneiss developed from lava the more or less elliptical pillows are compressed to bodies 2 to 6 feet long and only an inch or so wide. Well-banded hornblende gneiss whose origin cannot be determined from a study of outcrops may pass into non-banded, black rock with pillows on the axis of folds and at points where the strike of the bands changes abruptly. Thus the origin of such rocks can be determined definitely only by following the strike of their banding in search of original structure. The gneisses derived from the lavas, however, are characteristically rich in hornblende, some bodies being about two-thirds hornblende and the remainder either oligoclase or andesine with small amounts of other minerals. Many layers carry small, red garnets. Other gneisses of this character are medium-grained aggregates of brown biotite, large crystals of hornblende, oligoclase, and quartz. These gneisses always present an igneous appearance and the abundant hornblende suggests this origin where remnants of pillows or other structures are absent.

The lavas on the west side of Hansen Lake are grey to black, fine-grained rocks without pillows, but locally exhibiting flow lines and flow breccia. Rock outcrops are abundant. Some are of structureless grey rocks with only small amounts of biotite and hornblende and of the general appearance of quartzite. The weathered surface of some outcrops of this character exhibit small crystals of white feldspar set in a grey, dense groundmass. Small crystals of feldspar, hornblende, and biotite are recognizable on the weathered surface of a few outcrops of the black, dense lava. Eyes of smoky or bluish quartz up to one-fifth inch across are distributed irregularly through large bodies of greyish and pinkish, dense, and slightly schistose rock whose matrix is an aggregate of quartz, feldspar, and white mica. In other outcrops the crystals of white feldspar and the eyes of quartz are distributed in long, thin, parallel streaks, perhaps representing flow lines. Although the greyish and pinkish rhyolite and rhyolite porphyry, underlying the long point extending north from the southwest shore of Hansen Lake, are uniform in character across outcrops 100 feet or more broad, nevertheless they vary noticeably from outcrop to outcrop in size of grain, colour, and degree of schistosity.

A large part of the lavas west of Hansen Lake are dense and black and weather grey or black. They are fine grained and without textures or structures to suggest their origin. In places the rock breaks with a poor, slaty cleavage, but the minerals are not noticeably concentrated in layers nor orientated with their long directions parallel. Hornblende is more abundant than biotite in some of the rock, and quartz and feldspar together are estimated to be about equal to the combined biotite and hornblende. The feldspar is andesine in some of the rock, and it is a dacite. Carbonate, red garnets, epidote, zoisite, and chlorite are present in the specimens studied. Some of these structureless rocks are medium grained and of the general appearance of diorite. Other bodies are greenish black, chloritic schists with spots of garnet, of garnet and quartz, of cordierite, and of brown biotite and muscovite. The bodies of spotted schist lie between more massive, dense, or very fine-grained, slightly porphyritic rhyolite and dacite.

The nature of the folding of the lavas about Hansen Lake is unknown, the schistosity dips steeply at most points to the east. Beds of argillite, slate, and garnet-mica schist occur within the rhyolite on the islands and points in the central part of the lake. Along the east side of the area of lavas, thick-bedded clastics of medium grain outcrop on islands in the main part of the lake. The clastics of this character on the island north of the entrance bay lie along the axis of a syncline and may belong to the Missi series. The acidic character of much of the lava, together with the associated sediments on the east side of the area, suggest that the strata are of the same general character as the beds along the west shore of Amisk Lake north of the mouth of the Sturgeon-weir and probably belong to the upper part of the Wekusko group. The lavas and sediments on Hansen Lake are cut by dykes and bosses of gabbro, diorite, quartz-feldspar porphyry, granite, aplite, and pegmatite. Quartz veins also were noted.

MISSI SERIES

Coarse clastics of the Missi series are well-developed about Amisk Lake and they extend west and northwest into the northeast corner of the west half of Amisk Lake area. The grey conglomerate, arkose, and quartzite about Amisk Lake to the west change along their strike to fine-grained, dark grey to almost black quartzite and arkose. There the basal conglomerate is absent, the bedding and schistosity of the Wekusko group lavas and sediments and of the Missi series clastics are parallel, and, where the strata are overturned, Missi beds dip under Wekusko group lavas. Thus, where the strata are closely folded and largely recrystallized to gneisses, the unconformity established on Amisk Lake between strata of the Wekusko group and of the Missi series is obliterated or at least very difficult to determine.

About Little Wildnest Lake and to the southeast for 5 or more miles the rocks of Missi series are well-banded, fine-grained, quartz-plagioclase-mica rocks. The light grey, weathered surface of many of the layers has the appearance of that of an aplite and the black layers that of a fine-grained diorite. The rock in the different bands is even-granular and abundant grains of quartz are visible on the weathered surface of the lighter coloured layers. The rock of some layers is medium grained, rich in biotite, and holds a few red garnets. That of other of the black layers is very fine grained and almost a slate. The grey and black layers alternate and vary in thickness from less than an inch to a foot or more, thick and thin beds alternating irregularly. This banding is considered to result from the recrystallization of bedded rocks. Quartz is estimated to be less plentiful in these gneisses than plagioclase, which in most specimens is oligoclase and in a few andesine. Brown biotite is abundant in parallel planes either irregularly scattered or concentrated in layers alternating with others carrying abundant quartz and plagioclase. Some of the rock carries red garnet and scattered crystals of hornblende. In some specimens dust inclusions in the plagioclase are abundant, and the feldspars may be in part altered to a white mica. Some of the biotite is gone to chlorite. The banded sediments on Little Wildnest Lake are cut on the west by fine-grained granite and pegmatite and on the east by granite-gneiss.

Long, narrow bodies of grey to black garnetiferous and non-garnetiferous gneiss and schist outcrop along Sturgeon-weir River north of Birch Portage, east and south of Corneille Lake, and about the north and south sides of Jan Lake. These gneisses may be Missi clastics recrystallized. They are cut by many small bodies of granite and pegmatite trending parallel to the banding, and, where the intrusives are abundant, the older rocks are so thoroughly recrystallized that their origin has to be assumed. The gneiss and schist east and south of Corneille Lake are represented by grey, fine-grained rocks carrying a few crystals of oligoclase one-quarter inch long and many of smaller sizes. These lie in a matrix of small grains of quartz, untwinned plagioclase, and flakes of brown biotite and scattered red garnets. The minerals are fresh. Schistose rocks of this character form bodies 100 feet or more across, and miles long. They may be flanked by a banded rock consisting of layers of this same general character alternating with others that are either lighter coloured and more quartzose or are a darker micaceous schist. Along Sturgeon-weir River some layers of black gneiss hold white plagioclase crystals an inch long. Many of the large crystals have a roughly elliptical outline and others that of poorly developed phenocrysts. In some specimens they are oligoclase and in others andesine. The brown biotite bends around these large crystals. The matrix of all these grey to black rocks is of the same general character, and is an aggregate of angular and subangular grains of untwinned feldspar and quartz, with flakes of brown biotite lying with their flat sides parallel. Some of the feldspar of the matrix is microcline, but most of it appears to be oligoclase. These black, plagioclase-quartz-biotite rocks outcrop in layers varying in thickness from several inches to a foot or more and continuing hundreds of feet along their strike. Some such layers carry the large feldspar crystals, others none, some are rich in biotite, some in red garnets, and others are equigranular with quartz and feldspar together about equal to biotite. These banded igneous-appearing gneisses do not show intrusive relations and are cut by quartz diorite, granodiorite, granite, and pegmatite. Their marked, layered character suggests that they originally were sediments, very probably Missi arkose and greywacke, for they lie along the projected strike of bodies of these rocks occurring to the south and southeast.

INTRUSIVES

Diorite and Gabbro

Small masses of diorite and gabbro cut the Wekusko group strata and, although no bodies were seen in the Missi clastics and quartz-plagioclase-mica gneisses in the west half of Amisk Lake area, similar intrusives do cut the Missi elsewhere in the region. The largest single body of gabbro and diorite is at the south end of Hansen Lake. The rock is black, massive, and medium to coarse grained. Crystals of feldspar and hornblende are easily recognized on both fresh and weathered surfaces. In the diorite, andesine and hornblende are about equal in quantity, and in the gabbro, labradorite is not as abundant as hornblende and augite together. The minerals of these rocks are fresh, there being but little chlorite after augite

and hornblende, and zoisite and white mica after labradorite and andesine. Diorite and gabbro are intermixed irregularly in the same mass and no sharp contacts were seen between the two types.

Albite Syenite and Syenodiorite

A roughly elliptical intrusive body of the mineral composition of albite syenite and syenodiorite lies less than a mile east of Sturgeon-weir River from Scoop Rapid south to near Snake Rapids. This intrusive body is less than half a mile across near its north end and widens to 3 miles across near its south end. It is about $8\frac{1}{2}$ miles long. Rock is well exposed within the area of this intrusive mass, the surface is comparatively flat, and the swamps are small. The underbrush, also, is not thick, so that travel is easy across this part of the area. This intrusive body is described in some detail as it is the only one of this character known in this region.

The typical rock is medium to coarse grained and massive. It is black, grey, and pink depending on the relative amounts of feldspar and black minerals and also the variety of the feldspar present. Some feldspar-rich varieties weather with a characteristic, irregular, black and white pattern. The minerals are not granulated, but some of the larger crystals are bent. In parts of the mass, large crystals of plagioclase are scattered through a matrix of medium-sized, equigranular feldspar and black minerals. The long direction of many of these crystals is parallel and their long axis plunges from 40 to 70 degrees north, suggesting that the magma moved upward from this direction. The strike of the bedding and schistosity of the quartz-mica schist of the Wekusko group tend to bend around the south and wide end of the mass. The dip of the beds and of the schistosity, however, is to the east on both the east and west sides of the intrusive mass.

The pinkish rock from this body contains abundant albite and orthoclase with hornblende and some chlorite, perhaps after biotite. The orthoclase is not so abundant as the pinkish albite. Brown titanite is an important accessory in this and all the specimens studied from this intrusive mass. No quartz is recognized in the pink albite syenite. In the grey to black rocks, hornblende is abundant and some of it has cores of augite. Fresh biotite is also present. The feldspars include oligoclase, microcline, and orthoclase. The last two together are not as abundant as the oligoclase. Deep brown titanite, calcite, and apatite are abundant accessories. In the light grey to white weathering types oligoclase-andesine and andesine are abundant, with some orthoclase, augite, hornblende, and biotite. The rocks of this body thus vary in mineral composition from albite syenite to syenodiorite, using the latter term to include rocks intermediate in mineral content between syenite and diorite. Parts of intrusive bodies in the area between Amisk and Wolf Lakes have phases with very much the same appearance as the albite syenite and syenodiorite east of the Sturgeon-weir. The syenitic and dioritic appearing rocks in the granitic bodies, however, carry 10 per cent or more of quartz, whereas quartz is not known to be that abundant in the intrusive body east of the Sturgeon-weir.

The albite syenite and syenodiorite body cuts sedimentary quartz-mica schists of the Wekusko group. Inclusions of these rocks are small and only

occur to within a few hundred feet of the margin of the mass. The contact against the schists is sharp and on the east side dips about 70 degrees east and parallels the schistosity and bedding of the sediments. The dip of the west contact is unknown. Where the river bends west just south of Scoop Rapid, the intrusive rock is schistose 25 feet or more away from the contact. The different phases of the body represented by pink, grey, and black rocks are irregularly distributed and outcrops of several types may occur within one-quarter mile, whereas at other points the rock is uniform for a mile. The pink albite syenite appears more abundant in the wide south part of the mass. No sharp line of contact was seen between the different varieties. All types are cut by narrow dykes of pegmatite and aplite. The pegmatite may be a medium-grained, white, albite type, or a pinkish, irregular-grained rock consisting of pinkish microcline carrying quartz graphically intergrown. Many of the narrow, albite-bearing pegmatite and albite dykes cross the mass at an angle to its long axis and follow tension joints. Syenodiorite is cut by pinkish grey granite along the east contact of the body at a point about 7,000 feet south of Scoop Rapid.

Granodiorite and Quartz Diorite

The high hills west of the Sturgeon-weir just above Birch Portage and to the east of the river farther north are of a massive pinkish and greyish intrusive that is distinct in character from the granites of the large area to the west and is easily recognized and mapped as a unit. The body of this rock is 2 miles wide at a point 2 miles north of Birch Portage and it is at least 10 miles long extending from a mile south of Birch Portage north to and beyond the north side of the map-area.

Two main types of rock are recognized in this body. The one is grey and pinkish with eyes of oligoclase up to $1\frac{1}{2}$ inches long, the majority, however, being less than $\frac{1}{2}$ inch in greatest dimension. A few large crystals of blue-green hornblende occur with the oligoclase. The groundmass is of small flakes of green biotite, hornblende, untwinned feldspar, quartz, and epidote. Some of these minerals are granulated, and the long direction of the large crystals of feldspar and hornblende are orientated parallel and with a tendency to lie along certain planes. The biotite flakes of the even, granular rock also are somewhat alined in layers to give a poor foliation. The other main type of rock of the body is pinkish, medium grained, and massive, or only very slightly foliated. Quartz is abundant in some of it. In other specimens, large crystals of dark green hornblende are in a groundmass of oligoclase, microcline, orthoclase, and quartz. These massive, or only slightly foliated, rocks cut and hold inclusions of the grey gneisses considered to be recrystallized Missi sediments. The age relation to the large body of granite and grey-banded and schistose granite and granodiorite so widespread west of the Sturgeon-weir, is unknown.

Granodiorite, Granite, and Pegmatite

Granitic rocks occupy the northwest corner of the area. These rocks are variable in texture, colour, and mineral content from locality to locality. Some outcrops are grey and only slightly foliated, other grey types are

highly foliated and the grey rocks are cut by pink, massive granite. All the different varieties, however, may be phases of the same large body of magma. No body of granite in the west half of the map-area was proved to be older than the Missi sediments, although some of the granite may be older and the granites cutting members of the Missi series may be of several ages.

Pinkish grey, medium-grained, massive, or only slightly foliated granite and coarse pegmatitic granite outcrop at a few points along the Sturgeon-weir to about a mile above Snake Rapids. This granite is followed to the west by grey to black, layered, and massive granodiorite and granite, which outcrop along the west side of the Sturgeon-weir from 2½ miles northwest of Snake Rapids to near Scoop Rapid. This body of granodiorite is several miles across and is well exposed about the east side of Hansen Lake. The minerals are fresh except biotite, which is in part gone to chlorite. Oligoclase, biotite, and quartz are abundant with some orthoclase and hornblende. Microcline is abundant and hornblende absent in the foliated grey rock. Red garnets are abundant in some of it.

In the central part of the large area of granitic rocks between Hansen Lake, Birch Portage, and Jan Lake the grey granodioritic types are cut by pink, massive, or only slightly foliated granite. In it microcline is abundant and oligoclase scarce. Quartz is plentiful and some of it and microcline are intergrown. Some of the bodies of pink granite are well defined and large enough to map separately from the grey type. Dykes of pink and grey aplite and pegmatite are abundant near some areas of the pink granite. Near the bottom of the northeast bay of Hansen Lake, pinkish, massive, pegmatitic granite and pegmatite cut with sharp contact the schistose, layered, dark grey granodiorite carrying eyes of bluish quartz and phenocrysts of feldspar. Dykes of pegmatite are numerous along a zone up to a mile wide and extending from near the north end of Hansen Lake to the south end of Corneille Lake.

Granite and granite-gneiss occupy long, narrow bodies alternating with gneisses derived from sediments and lavas in the area between Birch Portage and Wildnest Lake. The granite of many of these bodies is layered and, in this respect, has the general appearance of the gneisses derived from Missi sediments. Much of the granite is aplitic or fine to medium-grained, pinkish to greyish, and non-schistose. The contact of the layered intrusive rock is sharp against the gneisses derived from lavas and sediments. Both the layered granite and the older gneisses are cut by pegmatite. The bodies of layered granite extend for miles along their strike and follow the general structure of the older rocks.

PALÆOZOIC

Nearly horizontal beds of dolomite, dolomitic limestone, and sandstone occupy the south part of the map-area and west of Hansen Lake extend north nearly half-way across the area. The beds are exposed along an escarpment up to 70 feet high, but with talus along the base so that the basal beds are nowhere exposed. At Amisk Lake the lower beds exposed are dolomite, whereas, to the northwest, west of Hansen Lake, a few feet of

greyish and reddish sandstone underlies dolomite. This basal sandstone may be 35 feet thick, but only the upper 8 feet of it are exposed above the talus in the escarpment between the inlet creek and the south bay of Hansen Lake. This is followed above by about 3 feet of purplish tinted, sandy limestone, and then by 14 feet of white, bluish-weathering, dolomitic limestone. Some beds of the dolomitic limestone and dolomite carry a few fossils that, according to Miss A. E. Wilson, suggest that these beds are Richmond. The basal sandstone outcrops over an area at least one-half mile wide west of the second lake on the canoe route west from Hansen Lake. In parts of the area, beds a foot or more thick of buff and greyish weathering, hard dolomite cap and outcrop for one-half mile or more behind the escarpment. No large outcrops of Palæozoic strata were found north of the main area in the country west of the Sturgeon-weir. Angular blocks of dolomite that have not moved far are present, however, on the sides and tops of hills throughout the whole area, and are especially numerous at certain localities.

RECENT AND PLEISTOCENE

The Recent and Pleistocene deposits are unconsolidated boulder clay, gravel, sand, silt, and peaty material. In most of the area they are widespread and thin, but locally may be hundreds of feet thick. In the higher rocky country, as west of Birch Portage, these deposits are limited in extent to low areas about lakes or to broad depressions. The Pleistocene deposits of boulder clay, gravel, and sand rest on bedrock and were formed during the retreat of the last ice-sheet, which advanced from the northeast and whose front during retreat probably extended about east and west. These deposits are largely covered with peaty materials. An interesting deposit is that of sand extending from between Scoop and Leaf Rapids east and northeast to and beyond the west end of Johnson Lake. In this area, 2 to 3 miles or more wide, bedrock is exposed only on a few ridges and between these the surface is flat or only gently rolling. The sand is pure and very fine grained. The details of the outline of the area, the surface features, and the character of the sand suggest an outwash glacial deposit that was modified by wind action before being covered with vegetation. Recent deposits of peaty material, in places at least 10 feet deep, cover large areas and underlie both the wet and dry muskegs so abundant in parts of the map-area.

MINERAL PROSPECTS

The west half of Amisk Lake area has not been prospected carefully, as most of the work in this district has been confined to the country adjoining Amisk Lake. The most likely prospecting territory in the area studied in 1933 lies east of Sturgeon-weir River from Snake Rapids to Birch Portage. This is a continuation westward of the area of lavas and sediments bordering Amisk Lake. Drift deposits are widespread in parts of this area of lavas and sediments, swamps are large northwest of Wolf Lake, and farther northwest sand is widespread. The larger part of the prospecting territory is from 2 to 5 miles inland. The lavas locally are

altered to highly fissile chlorite schist and this carries stringers of quartz and grains of pyrite and arsenopyrite. Veins of white quartz, 2 to 3 feet wide, cut the more massive lava. Some bodies of glassy quartz are 5 to 10 feet wide. No free gold was seen in the samples examined hurriedly and no pits or other evidences were noted to indicate that the veins of quartz and bodies of sulphide and quartz-bearing schist had been explored. No dykes of quartz or feldspar porphyry were recognized in this part of the area. The grey to black lavas about Hansen Lake are cut by quartz veins, but sulphides are scarce here. Dykes of quartz-feldspar porphyry cut the lavas on the point in the central part of the lake. The black and grey mica and garnet-bearing phases of the granodiorite east of Hansen Lake are schistose along certain zones and these carry sulphides including small quantities of chalcopyrite. The large area of granodiorite and granite in the northwest corner of the map-area, however, is not likely to contain large bodies of ores of gold and copper. These granitic rocks, however, are cut by dykes of pegmatite, which are numerous in certain areas, as in the grey gneisses surrounding bodies of pink granite and in the narrow area from the north end of Hansen Lake to the south end of Corneille Lake. A few of these dykes were examined hurriedly for such minerals as beryl, cassiterite, lepidolite, and other of the rare minerals characteristic of the pegmatites, but none was found. Some bodies of pegmatite west of the second lake on the winter road leading northwest from Birch Portage contain pockets of magnetite up to a foot across and others flakes of muscovite 6 inches and more in diameter.

No extensive exploration was in progress on the deposits about Amisk Lake during 1933. Several prospectors did assessment on their holdings and a small mill was run for five or six months on the Graham deposit. This work was stopped in July. Some deposits along the West Channel of Amisk Lake are capped by a body of rusty, decomposed material, in places less than 1 foot, and in others over 6 feet, deep. This rusty material at some localities is covered by fresh glacial drift and is localized in depressions on the sides of hills where the scour of the glacier was not intense. This oxidized material formed from the weathering of sulphide and quartz-bearing schist. This schist carries small amounts of gold, some specimens are reported to assay \$10 or more in gold, whereas the average of a minable body apparently is probably \$1 to \$2 a ton. The rusty material above such deposits pans fine, free gold. A sample of about 100 pounds of the oxidized materials above the Sonora deposit, collected by the owners under the direction of Mr. E. B. Webster, Department of Natural Resources, Regina, and assayed in the Ore Dressing and Metallurgical Laboratories of the Department of Mines, Ottawa, averaged 0.0625 ounce gold a ton and 50 pounds collected by Mr. George Bottoms from the Amisk Gold Syndicate deposit averaged 0.52 ounce gold a ton. In the summer of 1933 the prospectors tried several types of washing machines to recover this gold, but without success. If a cheap and easily operated plant could be built to recover the gold in the rusty cappings, the local prospectors working in a small-scale way probably could produce gold profitably.

GRANVILLE LAKE DISTRICT, NORTHERN MANITOBA

By G. W. H. Norman

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INTRODUCTION

Prospecting for gold in recent years has extended to areas in northern Manitoba where the known geological conditions afford hope of making discoveries of the metal. In Granville Lake district belts of greenstone and sediments occur as well as granite and gneiss which form the prevailing rock over wide areas of the Canadian Shield. The presence of these belts of bedded rocks presents possibilities of gold discovery and on this account geological work was undertaken in order to provide information that might serve as a general guide to prospecting.

Granville Lake is an expanded portion of Churchill River which flows northwest across northern Manitoba to Hudson Bay. The lake lies 40 miles east of the Manitoba-Saskatchewan boundary and about 180 miles north of The Pas. The area described in this report lies immediately north of Granville Lake and forms a portion of the eastern half of the area represented on the Granville sheet, No. 64C, scale 4 miles to the inch, obtainable from the Topographical Survey of Canada, Ottawa. The country immediately south is represented by the Kississing sheet, No. 63N, of the Topographical Survey of Canada. Together, these maps show the drainage and serviceable water routes of the country north of the Flinflon and Sherridon branches of the Canadian National Railway.

Granville Lake is about 150 miles distant by water route from Sherridon, the nearest railway station. Sherridon is the northern terminus of the Canadian National Railway branch line from The Pas. A road 2 miles long leads from Sherridon to the village of Kississing (Cold Lake) on Kississing Lake, which is the starting point of the principal water route to Granville Lake.

This route crosses Kississing Lake and follows Kississing River to Flat Rock Lake; it crosses Flat Rock Lake to Churchill River and follows

this river to Granville Lake. The journey takes from four to five days with loaded canoes, depending on conditions of travel. The most arduous part of the journey is along Kississing River, where there are in all twelve short portages with a total distance of 102 chains. Many of these portages can be avoided by shooting the rapids. During the summer of 1932 the Manitoba Government greatly facilitated travel along the river by building wharfs at the portages and clearing the channels of the rapids of rocks. On Churchill River three short portages have to be crossed, two at Twin Falls and one at Granville Falls. Devils Rapids, which lie between these falls, can be successfully navigated by lining accompanied by short lifts.

In 1933 the ice is reported to have entirely disappeared from Granville Lake by June 10 which is apparently in accordance with conditions in other years. After the middle of September the weather tends to become unsettled and may turn wet and cold. Freezing conditions and the formation of ice to hamper travel by canoe are reported to commence early in October, but the date probably varies from year to year.

The district forms part of the Canadian Shield and its surface features are those typical of a large part of this region. The most striking feature is the presence of innumerable lakes scattered throughout the whole area, and forming possibly as much as 40 per cent of the total surface. The lakes are linked by streams many of which are navigable although interrupted by rapids and falls. The largest waterway is Churchill River and its expanded portion known as Granville Lake. The lake lies at an elevation of 850 feet above sea-level. The hills surrounding the lake are rounded and rise to an elevation of about 300 feet above the lake. The two principal waterways to the north of Granville Lake are Keewatin and Hughes Rivers. These water routes tap the country north of the Granville map-area and according to report can be followed to Reindeer Lake. Several other water routes connect those already mentioned and can be followed readily with the aid of the Granville sheet.

The country away from the waterways is rough. Rounded ridges and hills composed of the harder rocks occur interspersed with narrow, steep-walled valleys, low, muskeg-filled depressions, and small lakes bounded by either muskeg or rock and connected by small, swampy streams. There is a remarkable coincidence between the character of the drainage and the rock structure. Where the country is underlain by massive rocks such as granite, the lakes tend to be irregular of outline and to contain many islands. Where the rocks are cleaved or bedded the lakes are elongated. Sickle Lake is a splendid example of a lake following the bedding around the nose of a synclinal structure.

The country south of a line running roughly east from the northern end of Sickle Lake to Eden Lake is more rugged than the country to the north. In the southern part rocky hills and ridges are prominent features, especially in the burned areas. In the northern region the relief is probably not much greater than 100 feet and the horizon presented by the shores of the larger lakes is flat. The difference between these two regions has been accentuated by glaciation; in the northern part sand, gravel, and

boulders form extensive sheets and numerous ridges which obscure the rocks over large areas; in the southern part, although deposition of glacial debris is widespread, the scouring and erosion action of ice is extensively displayed.

PREVIOUS WORK

In northern Manitoba and Saskatchewan prior to 1912 only rapid reconnaissance work was undertaken, chiefly by Bell, Cochrane, Dowling, McConnell, and McInnes, all officers of the Geological Survey. They traversed the main water routes, but did not attempt to trace rock boundaries inland. The information they collected is related in the annual reports of the Geological Survey and was incorporated by William McInnes in Memoir 30.

After the discovery of gold at Amisk Lake in 1912 more detailed reconnaissance work was undertaken away from the main water routes south of Churchill River by Bruce (1), Alcock (2), and Wright (3), at various times; and Stockwell (4) in 1928 examined the shores of Reindeer Lake. Discovery of the Flin Flon, Mandy, and Sherritt-Gordon sulphide deposits during this period further centred attention on the mineral possibilities and geological features of the region.

In 1932 detailed reconnaissance was begun in Granville Lake district by J. F. Henderson. He made a thorough examination of the geology of Granville Lake. He also made a traverse up Keewatin River to Sickie Lake; north of Sickie Lake he crossed overland to Hughes Lake and returned to Granville Lake along Hughes River. He established many of the relationships of the major rock groups and furnished a valuable basis for further work. In 1933 the geological mapping of the district was continued by the writer with the efficient assistance of J. F. Henderson, M. S. Hedley, and G. M. Proudfoot.

GEOLOGY

GENERAL ACCOUNT

The following table gives the relationship and character of the major rock groups.

Table of Formations

Cenozoic	Glacial		Varved lake clays and silts; outwash sand and gravel deposits; eskers; morainic boulder ridges; boulder clay
Precambrian		Post-Sickle granitic intrusives	Pegmatite and aplite Granite Diorite and quartz-oligoclase diorite Granulose diorite, quartz diorite, granite, and quartz-feldspar porphyry
			Diorite and gabbro
		Sickle series	Arkose, greywacke, feldspathic quartzite; biotite gneiss, biotite-hornblende gneiss and granulite derived from the foregoing clastics; conglomerate; biotite gneiss derived from conglomerate
	Unconformity		
		Pre-Sickle group	Massive to schistose greenstone derived from andesite flows, agglomerate; breccia and tuff; with interbedded quartz porphyry, rhyolite and trachyte flows (and related intrusive bodies grading into granite?), and iron formation; massive amphibolite hornblende schist and gneiss derived from the volcanics

The rock groups of this district and their relationships resemble those of northern Manitoba and Saskatchewan between Amisk and Wekusko Lakes as described by Wright (3). The two regions have had a similar history, which suggests that they form parts of a single geological province within the Canadian Shield. In both districts the oldest rocks are greenstone and highly altered basic volcanic rocks, but a close correlation between them is not implied because their succession and possible subdivision are not known with any certainty. The basic volcanic group at Amisk Lake includes well-defined bands of sediments, but sedimentary bands were not recognized at Granville Lake. In both districts sediments

—Missi series at Amisk Lake, Sickle series at Granville Lake—rest unconformably on the greenstone. The sediments are cut by large masses of granite and pegmatite and over wide areas are transformed into gneiss. The Missi and Sickle sediments may not be exact equivalents, but their lithological similarities, together with the unconformity that occurs immediately beneath them, suggest that they are of the same general age.

PRE-SICKLE GROUP

The oldest rocks of the area are basic volcanic rocks (greenstone), but they include bands of acidic types, trachyte and rhyolite, and rarely iron formation. These rocks are grouped as the Pre-Sickle group which comprises all the rocks below the unconformity beneath the basal-conglomerate of the Sickle series.

As indicated by the accompanying map the greenstone and associated rocks occur in belts between granite or between granite and sediments. The belts have a maximum width of about 4 miles and an average width of 2 to 3 miles.

The greater part of the pre-Sickle group consists of rocks, popularly called greenstone, which accumulated as a thick series of basic lavas, agglomerates, breccias, tuffs, and intrusive bodies related to the lava. In part, the original volcanic structures are preserved, although the mineralogical composition has been changed. In part, recrystallization over wide areas adjacent to granite masses has changed the greenstone into medium to coarse-grained amphibolite which has locally the appearance of diorite. Intrusive diorite was not recognizable as such in many areas of amphibolite, but may occur.

The greater part of the lavas are fine-grained, massive, green rocks; locally they are sheared into schistose types. In places they retain ellipsoidal markings, 18 inches by 6 inches on the average, which represent pillow structures. Occasionally these markings are associated with porous bands that may indicate ropy parts near the surface of flows. They are in part porphyritic. The phenocrysts are altered feldspars accompanied by secondary quartz, which stand out well on the weathered surface and give the rock a white-spotted appearance. Amygdaloidal structures occur occasionally with highly squeezed amygdales of calcite which weather out giving the rock a pitted surface. Medium to coarse-grained flows occur in the greenstone belt west of Anson Lake; these have a rather heterogeneous assortment of textures which vary from fine to medium coarse grained. The feldspars of the coarser grained varieties stand out as white, splotchy masses in a matrix of green amphibole.

Pyroclastic rocks are well developed, particularly on the southeast side of Barrington Lake and also in the narrow belts of greenstone northwest of Sickle Lake. Coarse, fragmental types are very common among the pyroclastic rocks. The fragments range from 1 to 6 inches in diameter and are as a rule highly squeezed. They are light green and well peppered with small, white spots of feldspar and secondary quartz. The matrix forms about 50 per cent of the rock. It is dark green and slightly porphyritic. These rocks are in part flow breccias with angular fragments

that differ little from the matrix, and in part agglomerates which contain foreign material and exhibit a greater variation between matrix and fragments. Well-banded, fine-grained tufts interbanded with coarse pyroclastics and lavas occur in the greenstone belt in the northwest corner of the map-area. The bands are a few inches in width and show a decided gradation from a coarse to fine grain across each individual band. It is probable that the finer grained parts represent the upper part of each bed and if so indicate that the rocks that dip here towards the northwest are not overturned.

The greenstone consists of a fine-grained, felted mass of amphibole set in a base of small grains of feldspar and quartz. The amphibole usually forms 50 per cent or more of the rock. Secondary calcite, epidote, and magnetite are present and also a little biotite in some rocks. Small phenocrysts of andesine occasionally occur and are largely altered to epidote, zoisite, and sericite. Where it was possible to determine the feldspars of these rocks they were for the most part andesine, only in one thin section was the feldspar labradorite. The character of the plagioclase suggests that the greenstone group was originally of andesitic composition although it probably includes basaltic rocks.

The change from typical greenstone to medium-grained amphibolite is perhaps best illustrated in the rocks at Cockeram Lake. Fine-grained, massive to schistose greenstone with ellipsoidal markings outcrops on the southeastern part of the lake. As the granite contact to the northwest is approached along the southwest side of the lake, the texture of the greenstone tends to become medium grained, although the boundaries of the individual minerals are not clearly defined in hand specimens, and numerous small dykelets of quartz and feldspar crisscross the greenstone in all directions. Nearer the granite contact the altered greenstone is a massive, green to dark grey, crystalline rock with a variable texture which grades quite abruptly from fine to medium grained. Rocks of this character are extensively distributed, especially in proximity to granite masses. They consist, in about the following proportions, of hornblende 40 to 50 per cent, andesine 40 per cent or less, biotite 10 per cent, and quartz up to 10 per cent. Adjacent to some of the granite masses the greenstone is altered to hornblende schists and gneisses. Locally the gneiss is intruded by abundant granite dykes and sills and forms typical injection gneiss. The mineral composition of the hornblende schist and gneiss is similar to that of the massive amphibolite except that garnet is often present in the schist or gneiss.

The altered greenstone and associated rocks, which occur on the northern side of the granite mass south of Lasthope Lake and also west of the granite east of Sickie Lake, form a complex group of rocks that are believed to be partly derived from the greenstone and partly intrusive. The rocks derived from the greenstone are banded, medium to fine-grained, hornblende to biotite-rich rocks; they locally exhibit types that in other localities can often be traced into typical greenstone. The intrusive rocks are of two types, one grey and high in feldspar and often quartz, the other green and high in hornblende. The grey, intrusive rocks are clearly related to the neighbouring granite and form a complex stock-

work of crisscrossing dykes and dykelets. The basic green intrusive rocks are medium to very irregularly coarse grained and have often a very ragged texture. They have definite crosscutting intrusive relations with the medium to fine-grained biotite to hornblende-rich rocks, and contain inclusions of them, but they form only small, splotchy, intrusive masses with irregular boundaries. They consist, in about the following proportions, of hornblende 50-60 per cent, andesine 35 per cent, biotite 10 per cent, with magnetite, epidote, zoisite, and white mica. The impression is gained from the outcrops that these basic intrusive rocks may have developed from the greenstone during the plutonic metamorphism of the rocks. Direct proof of such events is difficult to obtain, but that the greenstone has played an important role for the localization of these particular types of basic intrusive rocks is suggested by their absence from the contact of granite with the sediments.

Acid volcanic rocks form only a small proportion of the pre-Sickle group. They outcrop at a few points on Barrington Lake, and on Keewatin River a short distance north of Sickle Lake. One particularly continuous band about 300 feet wide occurs on the southeast side of the large lake on Hughes River 2 miles northwest of Hughes Lake. It was traced along the lake and to the southwest of the lake over a distance of 4 miles and may extend much farther. The rocks of this band are quartz porphyry and trachyte. They are fine-grained, whitish grey to pale green rocks with or without small phenocrysts of quartz or quartz and feldspar. The quartz porphyry is a variety of soda rhyolite, with small phenocrysts of quartz and albite, in a microcrystalline aggregate of quartz and feldspar with white mica, calcite, and a little biotite. The trachyte consists of variously oriented oligoclase laths much replaced by actinolite; a small percentage of quartz and biotite are present as well as considerable secondary epidote, zoisite, and calcite. Two miles south of the lake the quartz porphyry and trachyte band is flanked to the southeast for half a mile at least across the strike by quartz andesite of a distinctive type not recognized elsewhere in the district. The quartz andesite is a massive, dark grey to greenish grey rock with small phenocrysts of quartz and feldspar. It consists of variously orientated laths of andesine that form 50 to 60 per cent of the rock, and secondary chlorite, biotite, and zoisite.

Small dykes and intrusive masses of red, medium-grained granite with a granulose structure cut the greenstone on the west side of Hughes Lake, but were not observed in the Sickle conglomerate. These granitic rocks are mineralogically similar to the soda rhyolite of the acid volcanic band above mentioned, which lies a short distance to the northwest and may be the intrusive phases of these acid volcanic rocks. The Sickle conglomerate rests with a sharp contact against one of these granite bodies on the west side of Hughes Lake, but is not metamorphosed by the granite even a few inches from the contact, which suggests that the conglomerate overlies the granite unconformably. The occasional granite pebbles in the conglomerate may have been derived from small granitic bodies of this type rather than from extensive batholithic intrusions of granite.

Iron formation was observed in the pre-Sickle group at only a few isolated localities in the greenstone belt that lies a few miles to the east and

southeast of Chicken Lake. It forms apparently a continuous band 50 to 100 feet wide with a southeasterly strike parallel to the sediments. This band lies a few chains east of the diorite sill which comes up here along the contact of the Sickie conglomerate with the greenstone. It consists of thin bands, a few inches thick, of grey chert with a variable content of magnetite, and narrower interbeds of green, chloritic material studded with large, red garnets. Small bands of yellow, rusty-weathering siderite are also included in the band locally.

Apart from the iron formation no definitely sedimentary rocks were observed in the pre-Sickie group. Rocks that were tentatively considered of sedimentary origin occur in the group on Keewatin River 2 miles north of Sickie Lake. These rocks are grey to green, massive, fine-grained types with well-defined laminations and bands. They are feldspathic and quite siliceous, some approaching quartzite in appearance.

SICKIE SERIES

A lithologically distinct series of bedded, quartzo-feldspathic sediments, here given the name Sickie series, rests unconformably on the pre-Sickie group of greenstone and associated rocks and is the youngest Precambrian bedded group in the district. This upper series is—so far as is known—one continuous succession of rocks without any conspicuous or important intervening break in deposition. A massive conglomerate that contains pebbles of pre-Sickie rocks occurs at the base of the series, and forms an important, easily recognized horizon; but the upper limits of this series are removed by erosion and cannot be defined. This bedded series of quartzo-feldspathic rocks is lithologically similar to the Missi series of sediments that are developed 150 miles or so to the southwest between Amisk and Kissinging Lakes, and is probably of approximately the same age.

The strata lie in a synclinal structure with a sinuous trend, which extends southward from Sickie Lake beyond Granville Lake. At Sickie Lake the synclinal structure is comparatively simple and is well defined by the basal conglomerate that rims the outer border of the lake. South of this lake the structure becomes more complex and is a composite of several minor folds in a general synclinal structure. The rocks of this series south of Ghost Lake are transformed into gneiss which is cut by pegmatite and aplite. A second synclinal structure of the Sickie series extends westward from Sickie Lake, but was not traced far in this direction. A third synclinal structure of the Sickie series occurs at Hughes Lake. The northern end of this syncline is well defined by the conglomerate. South of Hughes Lake the structure swings sharply to the west, but its continuation in this direction was not determined as the region has few outcrops. Isolated outcrops of the conglomerate occur on the east side of Keewatin River east of Anson Lake, but their probable original connexion with the conglomerate at Hughes Lake is broken by intrusive granite.

The basal conglomerate of the Sickie series is a massive, tough rock which tends to stand out above the overlying sediments as resistant ridges.

On the south side of Lasthope Lake it appears to act as a protection barrier between the invading granite and the overlying sediments. For a short distance here the granite comes in contact with the conglomerate, but the alteration of the conglomerate is confined to a narrow width at the contact. The conglomerate elsewhere may well have acted in a similar protective manner. The conglomerate probably varies in thickness. South-east of Lasthope Lake it reaches an apparent maximum thickness of 1,000 feet, but on the southeast side of the adjoining lake to the west it is represented by only a few thin conglomerate bands in the sediments. At this latter locality part of the conglomerate may be cut out.

The pebbles of the conglomerate consist of fine-grained, reddish to grey felsite and quartz porphyry, white vein quartz, and grey chert probably derived from iron formation. In some localities pebbles of medium to coarse-grained, red granite occur; in others fine-grained, greenish brown pebbles, probably derived from the underlying greenstone, are abundant. The pebbles are greatly elongated, although they appear to have been originally well rounded. South of Lasthope Lake the pebbles are oval in one cross-section with average diameter of 1 inch to 2 inches and a maximum of 3 inches by 6 inches. In a vertical cross-section these pebbles are drawn out to 12 or 18 inches. The matrix surrounding the pebbles is recrystallized into a fine-grained mixture of quartz and feldspar with shreds of white mica and biotite or chlorite. At Hughes Lake the matrix is gritty and composed of sheared out grains of quartz with a little feldspar set in a very fine-grained aggregate of white mica and chlorite.

The conglomerate contains thin interbeds of arkose and arkosic sandstone a few inches to a few feet in thickness. The conglomerate passes gradually into the overlying sediments with an increase in the number of sandstone interbeds and a decrease in the number of pebble bands which appear here and there in the lower part of the overlying sediments.

The sediments overlying the conglomerate are fine to coarse-grained, recrystallized, feldspathic sandstone, and greywacke, which grade into impure quartzite with an increase in the quartz content. They are light grey to brown weathering rocks, but are grey to dark grey on fracture. They are for the most part exceedingly massive with little or no indication of bedding, although often lined by fine laminations that sometimes contain magnetite. The laminations are in many cases much contorted. Banded and well-bedded varieties also occur that often display well-defined crossbedding and occasionally ripple-marks. The sediments consist of quartz, feldspar which is mainly oligoclase, in some cases with microcline, muscovite, biotite, calcite, and often abundant magnetite or hematite, in various proportions in the different types of rock. In the greywacke up to 20 per cent amphibole is present and the quartz content is low. The outlines of the original mineral grains are effaced by enlargement and intergrowth of the minerals, but the rocks still have for the most part a granular texture produced by irregular grains varying in size from 0.01 to 0.2 mm., which suggests a sedimentary texture.

Rocks that in the field were tentatively considered to be derived from volcanic rocks, occur east of the long, narrow lake that lies about 3 miles

west of Ghost Lake and also on the river that drains this lake into Granville Lake. They are greyish to greenish brown, medium to fine-grained rocks with a granulose structure. They consist largely of oligoclase with, in about the following proportions: quartz 15 to 20 per cent, amphibole 15 to 20 per cent, biotite 5 to 10 per cent, and minor amounts of calcite, hematite, epidote, and apatite. They are massive rocks in part laminated and seamed by irregular streaks of amphibole. Apart from the superficial resemblance to volcanic rocks, the alteration they have undergone has obliterated any direct evidence regarding their original character. In mineral composition, texture, and even in appearance they resemble rocks elsewhere definitely determined to be sediments. Henderson in 1932 considered that the Sickie series consisted of a lower group of sediments and an upper group of acid volcanics with interbedded sediments. The writer has not visited many of the areas that were examined by Henderson in 1932 and at present cannot confirm the presence of volcanic rocks in this series.

An unconformable contact of the Sickie conglomerate with older rocks was observed only on the east side of the long, narrow lake locally called Black Trout Lake which lies a short distance east of the south end of Sickie Lake. At this contact the conglomerate strikes north and south and is overturned to the west. The pre-Sickie rocks consist of basic, chloritic schist, schistose amphibolite, and a little sericite schist studded with garnet, and strike 80 degrees and dip steeply north. The schists are highly contorted and are sharply truncated by the overlying conglomerate. These relations indicate a definite structural unconformity between the Sickie and the older rocks and a period of erosion prior to the deposition of the Sickie series.

The contact of the conglomerate with the greenstone is usually abrupt, but on the east side of Hughes Lake the Sickie conglomerate apparently grades without a perceptible break into a volcanic agglomerate that forms part of the pre-Sickie greenstone group. It is possible that the chlorite and amphibole schist at Black Trout Lake are members of a series of rocks older than the greenstone group at Hughes Lake, but it is more likely that both assemblages are parts of one group, particularly as the massive greenstone often grades into schistose and highly metamorphic types.

The larger structural relations of the Sickie and pre-Sickie groups of rock confirm the presence of a structural break between them. North of Chicken Lake the Sickie rocks are folded into a tightly compressed synclinal structure which has for the most part a north-south strike. Although the exact structure of the pre-Sickie rocks is not known, their general strike is more or less in an east-west direction. This east-west strike may be considerably diverted by intrusive granite, but it is in the main nearly at right angles to the strike of the Sickie rocks.

Southward from Ghost Lake the Sickie sediments are transformed into biotite and biotite-hornblende gneiss and schist cut by pegmatite and aplite. These rocks probably include a small proportion of rocks derived from the older pre-Sickie group and also from intrusive rocks younger than the Sickie series. The gneiss is on the average medium grained, but

near intrusive granite or where pegmatite is abundant, the grain coarsens and the colour changes from dark or light grey to light pinkish grey. The rocks are in part banded, but are partly massive and homogeneous, so that they are largely granulites rather than true gneiss. The banding is due to the segregation of biotite and hornblende, but the platy minerals are usually evenly distributed with a parallel orientation throughout an interlocking feldspar-quartz mosaic.

The gneiss and granulite are for the most part feldspar to quartz-rich rocks with a mica content—biotite and usually minor muscovite—of up to 20 per cent. Occasionally a small percentage of hornblende is also present. The feldspars are oligoclase and microcline with some orthoclase in about equal proportions, but the oligoclase is usually predominant.

A band of basic, green hornblende gneiss follows the south shore of Granville Lake. Well-preserved pillow structures are present in this band and it is clearly derived from a basic lava. It is in part banded and in part massive, and is composed of hornblende, andesine, and biotite. Occasional pyroxene-rich bands with titanite are present. Its lithology suggests that it is an upfolded or up-faulted band of pre-Sickle rocks, but definite proof that it belongs to this group is lacking.

A short distance to the south of this basic band the quartzo-feldspathic gneisses contain bands of biotite gneiss derived from a fragmental rock. The fragments are lighter coloured than the matrix, but apart from containing less biotite are of similar composition. The fragments are oval in cross-section with average diameters of 2 and 5 inches. Quartz is present as stringers and as oval-shaped masses which are similar in shape and size to the fragments, but may have been introduced by the stringers. It is possible that these fragmental bands represent the highly metamorphosed equivalent of the Sickle conglomerate. South of Lasthope Lake and to the west of this lake, the Sickle conglomerate is altered for a narrow width at the contact with granite, to a biotite-rich gneiss. The conglomerate here contains a variety of pebbles including red to grey felsite and quartz porphyry, granite, vein quartz, and grey chert. But as the altered zone at contact is approached the various types of pebbles gradually lose their distinctive characters and are transformed into nearly uniform, light to dark grey, feldspathic, biotite gneiss and lie in a dark grey matrix of biotite-rich gneiss and schist. The loss of identity of the constituent pebbles where the conglomerate is highly altered supports the suggested equivalence of the fragmental bands in the gneiss and the conglomerate.

Locally interbedded with the gneiss at Granville Lake are dark, biotite-rich gneisses and schists which may be the altered equivalents of diorite and gabbro intrusions that cut the Sickle sediments north of Granville Lake.

The gneiss is cut by light red pegmatite and aplite, which are locally very abundant. The pegmatite occurs in tabular bodies, in thin stringers along the banding of the gneiss, and as very irregular masses and pods that are often highly contorted. Where the gneiss is intruded by much pegmatite adjacent to the large intrusive masses, it is converted to a medium to coarse-grained rock which is often difficult to distinguish from a granite-gneiss. Many of the highly altered gneisses contain metacrysts

of a micaceous mineral probably muscovite, which weather out on the surface of the rock and look like almonds. Their presence may be of value in determining the contact of gneiss with granite. At one locality south of the west arm of Granville Lake, feldspathic gneiss studded with white metacrysts is cut by granite. The gneiss here is medium grained and has a granitic aspect, but the contact of the gneiss and granite is well marked by the abundance of metacrysts in the gneiss and their absence in the granite.

DIORITE AND GABBRO

Sills, dykes, and stocks ranging from diorite to gabbro cut the Sickie rocks and also probably the pre-Sickie group, although they have not been definitely identified in the latter group. These intrusions occur for the most part near the base and outer margin of the Sickie series, but one large mass lies on the west side of the north arm of Granville Lake well within the altered equivalent of the Sickie series. Two remarkably persistent sills occur, one 3 miles west, and the other about 2 miles east, of Chicken Lake. The western sill ranges from 200 to 500 feet wide and extends for a known distance of 8 miles, but may well continue much farther. The eastern sill, which is in part 500 feet wide, comes up along the contact of conglomerate and greenstone, south of Black Trout Lake. This sill includes narrow bands of conglomerate which it has split away from the main body to the west. The strike of these narrow, included bands is parallel to that of the main conglomerate member.

The rocks that form these basic intrusive masses are medium and occasionally coarse grained; they have a high ferromagnesian mineral content which gives them a grey to blackish grey colour. They are as a rule sheared and in part have a foliated, but indistinctly gneissic, structure. They resemble the recrystallized basic volcanic rocks and usually have an altered appearance.

Thin sections of two of these rocks were examined, one from the long sill west of Chicken Lake and the other from the intrusive body on the north arm of Granville Lake. The rock forming the sill is a gneissic oligoclase diorite. It has a granulose and rather well-defined, gneissic structure. It is composed, in the following approximate proportions, of: oligoclase 40 per cent, quartz 10 per cent or less, brown, highly pleochroic biotite 30 per cent, with a small amount of green hornblende, titanite, and magnetite, and about 5 per cent apatite in large, irregular grains. The rock forming the intrusive body is massive and medium to coarse grained. It is considered to be an altered gabbro, although its mineral composition is that of a diorite. It is composed of basic andesine 50 per cent, hornblende 25 per cent, biotite 10 per cent, with a small amount of quartz, apatite, and magnetite, and about 5 per cent scapolite. The high chlorine content in both these rocks suggests that they are genetically related. In the oligoclase diorite the presence of sufficient excess silica favoured the formation of feldspar and apatite; in the altered gabbro, which contained a smaller proportion of silica, the chlorine entered into combination with the feldspar molecule to form scapolite.

The altered diorite and gabbro intrusion are clearly younger than the Sickie series which they definitely cut in the form of various types of intrusive bodies. Unfortunately these intrusive bodies lie usually within the Sickie series and their relations to the granitic intrusions are not so apparent. The diorite sill west of Chicken Lake, as well as other masses of these basic intrusives, is cut by pegmatite and aplite dykes. In the sill west of Chicken Lake these dykes are probably closely related in age and in origin to the neighbouring granite to the west, which indicates that the diorite is older than the granite. The regional distribution of the basic, intrusive bodies within the Sickie series and their suspected presence in a highly altered state within the gneisses at Granville Lake suggest that they, also, are older than the granite which definitely intruded the Sickie rocks and has converted the series into gneiss.

POST-SICKIE GRANITE INTRUSIVES

A large part of the area is underlain by granitic intrusives of quartz-rich types grading from quartz diorite to granite and including locally small masses of diorite. Crosscutting relationships between the various individual members of this intrusive group show quite clearly that they constitute a complex of successive invasions rather than a single contemporaneous intrusion. But whether they represent one, or more than one, group of related intrusions cannot be determined from the data at present collected. Some of the granitic intrusions are either incipiently or markedly crushed and deformed; as they also possess other similarities that serve to distinguish them in general from the main massive group they are shown on the map by a separate pattern. It is possible that they may form a distinct intrusive group separated from the main group by a considerable interval of time; but valid reasons for substantiating such a distinction are lacking. Although the question of their relative age is an open one, yet the distinction may prove of value if mineralization has been associated chiefly with the deformed types of granite. There is a more remote possibility that part at least of the deformed granite is older than the Sickie series. Here again definite evidence is lacking, and although the Sickie conglomerate contains granite pebbles, it is by no means certain from what source these pebbles were derived.

The granite and related igneous rocks, which have been classed as massive, have a fresh, unaltered appearance. Although they are in part well foliated they show as a general rule no indication of crushing or granulation. They are medium to coarse grained, occasionally porphyritic, and prevailing grey in colour, but pinkish red types are common. No attempt was made to study in detail the various rock types or to delimit their boundaries. From the thin sections examined the two most prevailing rock types seem to be quartz-oligoclase diorite and microcline granite. The quartz-oligoclase diorite contains about 60 per cent oligoclase ($\text{Ab}_{70}\text{An}_{30}$), 20 per cent quartz, 10 per cent biotite, 5 per cent microcline, 5 per cent hornblende and accessory titanite, apatite, and magnetite. Locally where inclusions of biotite and hornblende gneisses and schists are numerous the rock is a quartz diorite with andesine in place of oligoclase and a high

proportion of hornblende with little biotite. The microcline granite, in part at least, cuts the quartz-oligoclase diorite, and is usually more massive and less foliated. It is composed of about 45 per cent oligoclase ($\text{Ab}_{80}\text{An}_{20}$), 20 to 30 per cent microcline, 20 per cent quartz, and 10 per cent biotite with accessory titanite, apatite, and magnetite.

Massive, uncrushed diorite is not a common rock type. It occurs on the east side of Keewatin River 3 miles north of Sickie Lake. Large, irregular crystals of hornblende, partly altered to chlorite and calcite, give the diorite here a ragged appearance. Along the west side of Keewatin River this diorite intrudes, with a sharply defined contact, highly crushed diorite and quartz diorite or granodiorite, which are mapped as part of the crushed intrusives.

Pink to white pegmatite and red aplite are common associates of the massive, ungranulated granite which occurs on either side of the Sickie Lake syncline and its continuation to the south and southeast. Pegmatite intrusive into gneiss is particularly abundant in the region about Granville Lake. It forms an oval-shaped aureole with numerous inclusions of gneiss about the small granite mass that lies immediately east of the north arm. The aureole is wider on the northwest and southeast sides of this intrusion which forms a domal structure in the gneiss. The pegmatite is composed of microcline, quartz, biotite, and muscovite, with occasional crystals of tourmaline; pyrite, chalcopyrite, and magnetite may also be sparingly present. Small, red aplite intrusions are common on the west arm of Granville Lake. They occur mostly as small, homogeneous masses, more rarely they occur as selvage borders to small dykes with a central filling of pegmatite.

The crushed granitic rocks occur in the northern part of the area and are intrusive into greenstone. They are small bodies when compared with the large mass of granitic rocks that lie east of the Sickie Lake syncline. Mineralogically the crushed rock types cannot be distinguished from the massive, ungranulated intrusives. Microcline granite either grey or pink in colour is a common type among the crushed rocks. It is composed of about 40 per cent oligoclase ($\text{Ab}_{83-80}\text{An}_{17-20}$), 30 per cent quartz, 20 per cent microcline, and 10 per cent or less biotite with abundant accessory titanite and a little apatite and magnetite. Crushed quartz diorite with andesine or quartz-oligoclase diorite occur also, and in many cases form border zones about the microcline granite, as on Barrington Lake. The granite cuts the quartz diorite both at Barrington Lake and in the area to the northwest of this lake.

The crushing these rocks has undergone varies from place to place. On the southeast and northwest sides of Barrington Lake the crushing is excessive. There the individual minerals of the rock are broken down to a fine size. In part the minerals are sheared out into thin, discontinuous bands and the rock is highly schistose granite. Weathering emphasizes the shearing by bringing out in relief narrow ridges of quartz. In part, the broken down grains are not sheared out and the granite has a massive, chert-like appearance. The ferromagnesian content of these crushed rocks is largely converted to chlorite, which is banded in the sheared types.

In the central part of Barrington Lake and on Hughes River east of Hughes Lake the granite shows only incipient crushing which is expressed by a granulation of the quartz into small grains, but otherwise without much deformation. The feldspars of these rocks have usually a waxy appearance and the ferromagnesian minerals are partly converted to chlorite or have shattered borders. A gradation from incipiently crushed granite to highly sheared granite occurs on the western side of the granite mass extending westward from the northwest side of Barrington Lake.

Associated with the crushed granite are medium to fine-grained, light to dark grey, quartz-feldspar porphyry dykes. The phenocrysts are quartz and oligoclase with or without included microcline; the groundmass is a microcrystalline aggregate of quartz and feldspar with small shreds of biotite and hornblende. The fine-grained type in many cases contains pyrite scattered throughout the rock.

Pegmatite occurs only rarely in association with the main part of the granite mapped as crushed. At Barrington Lake only one small pegmatite dyke cutting granite was observed. This dyke contained small garnets, which are also present in some of the highly sheared granite. Pegmatite, however, occurs abundantly in association with the granite mass on Gold-sand Lake. This granite may be incorrectly included with the crushed granites, although it is apparently continuous with the very highly sheared granite that occurs to the west of Hughes River at the northern limit of the sheet. This very highly sheared granite is lithologically similar to the highly sheared granite at the southeast corner of Barrington Lake and is associated with similar, fine-grained, grey, quartz-porphyry dykes which also contain pyrite.

Two small areas of sheared granite were not differentiated from the massive granite east of Sickie Lake, due to lack of information. They occur in contact with the greenstone and lie 5 miles south of Hughes Lake and 5 miles southeast of Chicken Lake, respectively.

At the southeast side of Barrington Lake crushed, cherty granite is cut by a green, porphyritic, andesite dyke. The dyke is 8 feet wide and was traced for 1,000 feet. It is composed of small, white phenocrysts of andesine in a green groundmass of microcrystalline feldspar and amphibole. Similar dykes occur cutting a band of grey rhyolite in the greenstone on the east side of the outlet of the lake.

The contacts of the crushed granitic rocks with greenstone are for the most part sharp with little alteration of the greenstone even at the contact. Exceptions to this type of contact, however, occur at Cockeram Lake where the greenstone is recrystallized to amphibolite in a broad zone bordering the granite, and on the west side of Hughes River above Hughes Lake where the greenstone is punctuated by a small granite intrusion and is converted to amphibolite over a wide region. At the contacts where the greenstone is highly altered the granite probably dips gently under the greenstone, but where the granite contact dips steeply the alteration may be negligible.

At the contact of the ungranulated intrusives with greenstone and sediments, the invaded rocks are usually converted to gneisses of various types: these contacts are not well defined but can usually be located within

a short distance. The ungranulated granites are usually rich in pegmatite, and apparently the pegmatite plays an important part in the alteration of the invaded rocks.

The large bodies of granitic rocks lying on either side of the Sickie Lake syncline and its continuation to the south definitely cut the Sickie rocks and are younger than this series. In the northern part of the area the crushed granitic rocks cut the greenstone, but were not observed in contact with the Sickie series. Two facts are difficult to explain if the crushed granites are older than the Sickie series: (1) amphibolite derived from greenstone near granitic intrusions is not found as pebbles in the conglomerate, which would be expected if amphibolite had been formed prior to the deposition of the conglomerate; (2) the percentage of granite pebbles in the conglomerate is small and their occurrence is local only, which is in contrast with the probability that granite pebbles would form an important part of the conglomerate, had such large areas of granite as are now present in the greenstone occurred in pre-Sickie time. Granite pebbles in the conglomerate indicate the presence somewhere of granite undergoing erosion, although not necessarily in the immediate neighbourhood of the conglomerate. It was mentioned in connexion with the acid volcanic members in the greenstone, that the granite intrusive phases of the acid volcanic rocks may have been the source from which the granite pebbles in the conglomerate were derived. Until definite evidence to the contrary is forthcoming it is preferable to believe that the crushed granitic rocks are closely related to the massive, ungranulated types and that they represent the earliest phases of a protracted series of granitic invasions.

GLACIAL DEPOSITS

A variety of glacial deposits occur in the district. The islands and shores of Granville Lake are blanketed by varved lake clays which extend to an elevation of about 30 feet above the average level of the lake. Stratified sands with seams of magnetite and occasional boulders are interbedded with the varved clays on the west arm of Granville Lake. It is believed that the deposition of these varved clays occurred in a northern part of Glacial Lake Agassiz. Above the level of the clay, hummocky boulder clay occurs interspersed with rock ridges polished and scoured by the ice. Sheets of outwash sand, gravel, and boulders conceal the boulder clay locally and are particularly extensive in the northern part of the area.

A few boulder ridges and irregular boulder trains with a definite northeasterly alinement occur, and probably represent recessional stages on the retreat of the ice-sheet. One very marked ridge about 70 feet high and 200 feet wide, composed mainly of boulders with a maximum size of about 6 feet, crosses Churchill River immediately east of the Granville map-area. The river pours through a narrow gap in the ridge as an impressive rapid. Two other boulder trains were observed, one east of Barrington Lake and the other south of the junction of the rivers draining Eden and Barrington Lakes. The boulder trains are not well-defined features but consist of an assortment of scattered boulders with a maximum size of about 8 feet concentrated along a definite northeasterly direction.

Eskers and esker-like ridges of sand and gravel occur here and there throughout the northern part of the area, and have a definite northwesterly alinement. One esker 50 to 70 feet high and 200 feet wide was traced for 7 miles along the river draining Barrington Lake to the south. The majority of these ridges, however, appear to be short, and gradational types from true ridges to irregular outwash deposits occur. The ridges consist of sand in the centre with narrow fringes of gravel and rounded boulders 6 inches or less in size on either side.

The northeasterly trend of the boulder deposits and the northwesterly alinement of the eskers and ridges suggest that the Keewatin ice-sheet here retreated in a northwesterly direction; the glacial striae indicate that it advanced in a southerly to south-southeasterly direction.

MINERAL POSSIBILITIES

Some prospecting has been done in Granville Lake district prior to the issue of the present topographical and geological maps. It is probable, therefore, that the main water routes and the larger lakes have been fairly well examined and the chances of making mineral discoveries will depend on intensive search back from the main water routes. The area has promising features, but is not superior in possibilities to many other districts closer to railway transportation. The geological formations present in the area are similar in many respects to those of the northern Manitoba mineral district described by Wright (3) of which it should be considered a part. Anyone familiar with the district between Amisk and Kississing Lakes should be perfectly at home at Granville Lake.

The types of mineralization so far known are: pyrrhotite replacements; shear zones with disseminated pyrrhotite; pyrite, chalcopyrite, and sphalerite; quartz veins and pyrrhotite; chalcopyrite; pyrite carrying a little gold according to report.

No large pyrrhotite replacement bodies were observed. Small and spotty pyrrhotite replacement occurs in the basic gneiss band along the south side of Granville Lake and particularly in the west arm of the lake. Another larger replacement of this type is reported to occur on the north side of the lake that flows into Granville Lake immediately south of Pickerel Narrows.

The shear zone type of mineralization was observed only at one locality which lies on the southeast shore of Barrington Lake about 1 mile north of the outlet on the south side of a large bay leading into the east. The showings here were staked as the Caribou mineral claim by Adolfson in 1930. The main rock at the claim strikes 105 degrees to 115 degrees and dips 80 degrees north. It is a massive greenstone of the agglomerate type, with fragments and matrix of a similar composition. A volcanic (?) conglomerate band about 100 feet wide, with squeezed pebbles of grey chert in a green schistose matrix, is interbedded with the greenstone. This band is locally silicified and impregnated with pyrite which on weathering stains the rock brown. At the lake shore the conglomerate has been trenched for a distance of 20 feet and to a depth of 5 feet. The trench

was filled with water, but exposes a shear zone in the conglomerate about 4 feet wide impregnated by small, irregular stringers of pyrrhotite, pyrite, chalcopyrite, and sphalerite. This shear zone is also exposed at one other point 100 feet distant from the shore. But the entire conglomerate band is apparently cut off sharply by sheared granite 1,000 feet from the lake. The massive greenstone immediately west of the conglomerate and on the promontory extending northwestwards into the lake is intersected by narrow, silicified joints impregnated by pyrite, and is cut by occasional, small quartz veins containing scattered pyrite and a little sphalerite.

Quartz veins with reported assay values in gold occur in the district, but none so far has been proved of commercial importance. Only one quartz vein mineralized with pyrrhotite, chalcopyrite, and pyrite along narrow cracks and containing low values in gold was seen by the writer. This vein is several feet wide and is persistent for several hundred feet at least. It occurs near the greenstone in one of the altered diorite sills that cut the Sickie sediments and definitely shows that gold mineralization in part at least is younger than the Sickie series. The presence of this quartz vein in the diorite sill does not signify that gold mineralization is associated with intrusions of diorite sills. The relationship is only a structural one, and is, therefore, quite fortuitous. It is more likely that the gold mineralization is associated with the granitic intrusions.

White, barren-looking quartz veins without sulphide mineralization are abundant in the bedded sedimentary rocks and gneisses between Sickie and Granville Lakes. Many of these quartz veins contain feldspar and are akin to pegmatites.

The greenstone belts seem to present greater possibilities for the discovery of mineral deposits than other parts of the area. The mineralization described in the southeast side of Barrington Lake shows definitely that mineralization has occurred to some extent at least in the greenstone. Unfortunately in the northern part of the district where the greenstone belts are best developed the country is low and the rocks are concealed over large areas by sand and gravel deposits, or by widely prevalent muskeg. The shores of the larger lakes are, however, usually burned, and rocky ridges in the country surrounding the lakes are visible.

Quartz veins carrying sulphides, although too small to merit much attention, occur in the greenstone at a number of places, particularly where the greenstone is not highly altered. Indications of mineralization such as these were observed in the following localities: in the greenstone along the southern shores of Barrington Lake; in the greenstone—here very highly sheared as is also the neighbouring granite to the north—that lies on the south side of the promontory extending eastward into Barrington Lake west of Jim Brooks cabin; in the greenstone north of the large, irregular lake that drains south into Cockeram Lake and lies 1 mile west of Hughes River; and in the greenstone west of Anson Lake. Considering the very small part of the area actually observed and traversed this list is suggestive only, as many other localities probably present similar features. At each of these localities the greenstone is cut by sheared granite and by dykes of a grey, cherty rock or of grey, quartz-feldspar porphyry, which are impregnated by occasional sulphides.

The southern end of the greenstone belt that lies about 6 miles northeast of the north arm of Granville Lake is worth mentioning on account of the structure here developed. It is best reached by ascending the river, locally known as the Lynx River, which empties into the north arm of Granville Lake opposite Manitou Island, as far as the first large lake. A closely folded anticline that plunges to the south borders the eastern side of the lake and brings up a narrow wedge of greenstone and sheared quartz porphyry. The porphyry is in part intrusive and in part apparently a volcanic flow rock interbedded in the greenstone. A narrow syncline of sediments and conglomerate cut by diorite sills lies on the east side of the anticline. These structures are worth examining to find out whether they have provided a structural control capable of localizing mineralization. A narrow band of iron formation extends northwestward along the western border of the greenstone and must not be confused, if weathered, with the capping of an ore deposit. On the other hand, mineralized quartz veins may cut the iron formation so that it should not necessarily be neglected.

To what extent mineralization in this district is associated with particular intrusive rocks or particular rock structure is not known. Indications of mineralization mentioned above occur in many cases in the greenstone where it is cut by sheared granite accompanied by grey, quartz-feldspar porphyry or grey, cherty dykes. On the other hand, the areas underlain by granite, mapped as massive and unsheared, are large; the granite boundaries of these areas with greenstone lie for the most part far from the main water routes and were not often visited. The suggested association of mineralization with the sheared granites rather than the unsheared granites remains to be tested before it can be established. The possibility, although quite hypothetical, that the Sickie conglomerate might act as a protection barrier capable of localizing mineralization is worth mentioning. This conglomerate is a massive, tough rock and has formed a strong, structural unit during the deformation of the rocks. The contact of conglomerate with the older rocks east of Sickie Lake and to the southeast of this lake is a zone of weakness along which sills of diorite and granite have locally ascended. Such zones of weakness, if the rocks are highly sheared as at the Caribou mineral claim at Barrington Lake, may be mineralized. Furthermore, a major fault dislocates the conglomerate south of Sickie Lake and presents a structure worthy of investigation.

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The annual Summary Report of the Geological Survey is issued in parts, referring to particular subjects or districts. This year there are four parts, A, B, C, and D. A review of the work of the Geological Survey for the year forms part of the Annual Report of the Department of Mines.