CANADA
DEPARTMENT OF MINES
HON. T. A. CRERAR, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

BUREAU OF ECONOMIC GEOLOGY
GEOLOGICAL SURVEY

MEMOIR 187

Rae to Great Bear Lake, Mackenzie District, N.W.T.

BY

D. F. Kidd

OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1936

Price, 25 cents No. 2410

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INTRODUCTION

Field work in Great Bear Lake area was carried on by the writer in 1931 and 1932. During 1934 reconnaissance mapping of the geology was extended south from Camsell river—where work was stopped in 1932—to Rae on Great Slave lake. The mapping was done mainly along the canoe route between Rae and Great Bear lake. F. Jolliffe acted as sub-chief and took charge of a large part of the areal mapping. J. Y. Smith and S. E. Malouf acted as assistants and performed their duties in a satisfactory manner. The work was done mainly by examining most of the shore-lines of all the lakes adjacent to the canoe route. Some time was spent at recently found pitchblende deposits at Beaverlodge lake. The writer spent a month in Echo Bay and Camsell River districts at Great Bear lake.

CLIMATE

The general character of the climate has been described in a previous report [1]. Data for 1934 on limits of seasons are as follows:

First aircraft on floats to Great Bear lake[2]	—First week of June
First boat to arrive at Rae	—June 26
First boat to arrive at the east side of Great Bear lake[3]	—Last week of August
Last aircraft on floats to leave Great Bear lake, expected to be	—Fourth week in September
Last aircraft on floats to leave Rae	—First week of October

TRANSPORTATION

At Great Bear lake there was, for the first time, serious competition in the transportation business both by air and water. Water transportation rates were lowered. New boats for use on Great Bear lake and Bear river were built by both major operators, the Mackenzie River Transport and the Northern Transportation Company. Owing to low water-levels trouble was experienced getting some of these boats up Bear River rapids. The tonnage of freight brought to Great Bear lake in 1934 is estimated at 1,200 to 1,500 tons. Seventy-five tons of pitchblende-silver concentrates were shipped by boat from the Eldorado mine.

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[1] Geol. Surv., Canada, Sum. Rept. 1931, pt. C.

[2] The aircraft landed in a small area of open water at the head of a shallow bay; ice in the lake was still solid.

[3] Boats could have reached the east side of Great Bear lake somewhat earlier.

Up to September freight to the pitchblende deposits at Beaverlodge lake was shipped by air from Rae, to which point it was brought by boat. In September freight was delivered via Great Bear lake. The freight was brought by boat to White Eagle on Camsell river, flown 10 miles to Clut lake, loaded onto a scow and delivered without further transhipment at Beaverlodge lake. The 10-mile flight avoided four portages on Camsell river. Shipping by this roundabout route to any place south of lake Malfait is not advisable.

GAME, FUR, AND FISH

Large game was scarce along the canoe route from Rae to Great Bear lake in the summer of 1934. It seems probable that caribou may have been abundant in the winter, in at least the northern part of the area, as Indian winter camps were numerous. Otter, mink, and muskrat were seen. All of the area is in the Yellowknife game preserve and is closed to white trappers.

Lake trout are abundant in all the larger lakes. Jackfish, whitefish, and in some lakes pickerel, are plentiful.

TIMBER AND WATERPOWER

All of the area is south of the limit of trees and except for the highest rocky ridges is timbered. Black spruce, birch, and in the southern part jackpine, were noted. Good stands of timber are present in sheltered places. At Beaverlodge lake a stock of straight spruce logs 30 feet long with 8-inch tops was seen.

With the exception of White Eagle falls on Camsell river no large potential waterpower sites were seen. The writer was personally informed that measurement of the flow of Camsell river at White Eagle falls indicates there is an ultimate possible power development there of 22,000 horsepower, with very favourable conditions for power development and water storage. Comparatively small sites could possibly be developed at the outlet of lake Margaret or at some of the falls on Emile river.

ACCESS AND CANOE ROUTES

The area is best reached from the south by way of Rae at the head of the north arm of Great Slave lake. Rae can be reached by boat towards the latter part of June or by air about June 1. The northern part of the area is accessible by canoe from Great Bear lake. Most places in the area are best reached by canoe or aircraft.

Data for canoe routes from Rae to Great Bear lake are summarized in Table I. There is a choice of routes at several points. According to the way chosen it is between 285 and 320 miles from Rae to the White Eagle property, near the mouth of Camsell river. Northbound there are forty-three or more portages depending on conditions and outfit. Southbound not over thirty-eight portages may be necessary. From Rae to the height of land at lake Sarah there is no choice of route. Between lakes Sarah and Faber either of two portages may be used; except at low water that by Camsell river is the better. Between lakes Faber and

Hardisty there are four possible routes, as indicated in the table. The shortest, by lakes Rae, Ste. Croix, Tuchetu, and Seguin, involves one long portage. The westernmost route, which follows Camsell river from lakes Faber to Rae, portaging from the west arm of lake Rae into Takatu lake, and thence down Camsell river to lake Seguin, has not been much used. The portage at the outlet of lake Faber avoids very shallow rapids and may not always be necessary; the writer did not make it. The route followed by white men in recent years has been the central route by way of Rae, Ste. Croix, and Takatu lakes, Camsell river, and lake Seguin; lake Faber is left at its most northerly point. Between Hardisty and Hottah lakes the route by lakes Malfait and Beaverlodge is much the better. From lake Grouard to Great Bear lake the Indian route is by Fishtrap lake, entirely avoiding Camsell river. It is not used by white men.

TABLE I

—	Miles	Number of portages	Total portage distance (chains)
From Rae to head of Marian lake	18	0	—
" head of Marian lake to head of Hislop lake	55	16	44
" head of Hislop lake to head of Sarah lake	24	13	105
" head of Sarah lake to head of Hardisty lake—			
(a) East route by Tuchetu lake	62	9	186
(b) Central route by Camsell river	79	10	109
(c) Central route by small lakes	68	9	142
(d) West route by west shore Faber and Rae lakes and Camsell river	67	6	130
" head of Hardisty lake to Stairs bay, Hottah lake—			
(a) By lakes Malfait and Beaverlodge	50	3	57
(b) By lake Isabella	65	2	120
" Stairs bay, Hottah lake, to foot of lake Grouard—	63	0	—
(a) Foot of Grouard lake to White Eagle mine	16	3	43
White Eagle mine to Cameron bay	44	0	—
(b) Foot of Grouard lake to Gunbarrel inlet	35	5?	65?
Gunbarrel inlet to Cameron bay	40	0	—

DRAINAGE

The area is an elongated strip 300 miles long and up to 40 miles wide, along which is a chain of lakes of various sizes up to 50 miles in length. Drainage in the northern part is north to Great Bear lake and in the southern part south to Great Slave lake. The height of land lies between lakes Sarah and Mazenod 70 miles north-northwest of Rae. The area lies along a broad depression, as streams drain to it from both east and west. The master stream flowing north is Camsell river, which rises in lake Sarah and drains to Great Bear lake through lakes Faber, Rae, Ste. Croix, Takatu, Seguin, Hardisty, Isabella, Hottah, Grouard, Clut, and Rainy. At White Eagle falls near its mouth the summer flow in 1934 was reported by personal communication to average 5,000 cubic feet a second. From the west its largest tributary drains Malfait and Beaverlodge lakes and flows into Stairs bay, Hottah lake. From the east a large tributary, here named Calder river, flows into the northeast arm of Clut lake. Two other large tributaries flow into a bay at the head of Grouard lake and Margaret lake, respectively. The latter is probably larger than the main stream above lake Ste. Croix.

The master stream south of the height of land is Marian river. It enters Mazenod lake from the east close to the outlet of the lake and flows south through Hislop lake to its mouth in Marian lake. It has two large tributaries, La Martre river which enters from the west 20 miles above the mouth and Emile river which joins it from the northeast 4 miles farther upstream. Marian river just above the junction with Emile river, Emile river, and La Martre river all appear about equal in size. La Martre river drains an unknown area to the west. About 25 miles up it is lac la Martre, a large unmapped body of water. Emile river flows slightly west of south for the last 25 miles to its mouth. In this distance it has several falls and rapids.

PHYSICAL FEATURES

The area lies along the west edge of the Canadian Shield and is on the boundary between two contrasting types of topography.

West of the canoe route the underlying rocks are little disturbed sediments, in part at least of Palæozoic age. The topography is subdued and rolling; the hills have even slopes, and very few outcrops of bedrock occur. Although relief is generally low, broad, dome-shaped elevations occur and may rise 1,000 feet or more above the surrounding country. Looking west from elevations along the canoe route the skyline indicates at most places a rolling upland. Occasional small scarps mark the outcropping edges of nearly flat-lying sediments. Streams flowing from the west usually have mature valleys up to several hundred feet deep; examples are the two streams flowing from the west into the south end of lake Malfait.

This type of topography is bounded on the east by the eastern margin of the flat-lying sediments, which rest unconformably on the Precambrian. South of lake Faber this boundary is at many places marked by an east-facing scarp 50 to 150 feet high. The scarp may be seen on the canoe route at the portages at the north and south ends of lake Sarah, and on the west shores of Mazenod lake and the north part of Hislop lake. North of lake Faber the physiographic boundary is not usually so sharp and there may be a belt of low country several miles wide, largely drift covered, between the last outcrops of Precambrian and the rolling slopes presumed to be underlain by little disturbed sediments. Similar conditions prevail between Hardisty and Hottah lakes.

The eastern physiographic unit is underlain by granitic rocks in which are elongated belts of older rocks. A large proportion of bedrock is exposed. Glaciation has scoured bedrock and left many shallow depressions which are now occupied by irregular lakes with numerous rocky islands. Drainage is mainly typical of many other parts of the Canadian Shield. Streams with rapids and falls over bedrock connect rock basin lakes. On Marian river below Hislop lake a veneer of post-glacial silts has filled many of the hollows that lie between the rock ridges and has somewhat subdued the topography. Marian river in this part of its course flows in a valley usually less than 50 feet deep and has a steady current and relatively few lakes and falls.

The maximum relief is about 800 feet in the parts of the area underlain by rocks of the Canadian Shield. The highest hills are ridges coincident with belts of feldspar porphyries or sedimentary rocks. Areas underlain by granite as a rule have low relief, and conversely nearly all areas of low relief and even skyline are underlain by granite. This fact should be of considerable help to prospectors. Occasional isolated hills in low, granite country are usually underlain by remnants of older rocks or by granite intruded by a very large quartz vein.

The present topography in the Precambrian area was in part developed in Precambrian time, for to the west flat-lying Palæozoic conglomerates lie on the flanks of present-day hills of Precambrian rocks. The best example noted is at Beaverlodge lake, between the north and south parts of which there is a prominent northeast-trending ridge 600 feet high. On the flanks and at the base of this ridge on the west side of the lake are remnants of flat-lying sediments, a relation that clearly indicates that the hill stood as such when the sediments were deposited. The hill remained buried through all later time, and has only recently been exhumed by erosion of its mantle of sediments. Finally the rocks of the hill were polished by glaciation. Similar evidence of marked Precambrian relief has been found elsewhere.

GENERAL GEOLOGY

Because of the great area explored in a single season the classification of the rocks is necessarily largely lithological. For description they may be divided as follows:

Table of Formations

Cenozoic	
Pleistocene and Recent	Morainal material, gravel, silt.
Palæozoic	
Silurian?	Grey dolomite, sandy dolomite, buff dolomitic sandstone. All very little disturbed.
Disconformity	
Early Palæozoic or Late Proterozoic	Conglomerate, quartzite, sandstone with interbedded dolomite. Very little disturbed.
Unconformity	
Archæan or Proterozoic	Basic dykes and intrusive sheets. Some dykes, not separated in mapping, are younger than the Early Palæozoic or Proterozoic sediments.
Intrusive contact	
Archæan	Granite, granite-gneiss, granodiorite, and related rocks.
Intrusive contact (in part)	
	Feldspar and feldspar-quartz porphyries.
Intrusive contact	
	Andesite and other lavas, agglomerate, tuff, quartzite, argillite, conglomerate, limestone, and their metamorphosed equivalents.

Some rocks whose stratigraphic position is obscure have been omitted from the above table. These include sediments resting unconformably on granite 2 miles below White Eagle falls, and others on Marian lake, and a gabbro cut by granite at Hottah lake. The sediments are described on pages 7 and 11 and the gabbro on page 13.

ANCIENT LAVAS, SEDIMENTS, AND PORPHYRIES

Rocks of the basement complex and feldspar and feldspar-quartz porphyries occur together in belts up to 30 miles long and several miles wide. Both are intruded and altered by the granites in their vicinities.

The porphyry group includes all the porphyries with very fine-grained groundmass, except those that show amygdaloidal or fragmental structures indicating an extrusive origin, and those that occur with, and cannot be differentiated from, volcanic rocks.

Lithologically the porphyries show a broad similarity under the microscope, though they differ markedly in the hand specimen. In general they have phenocrysts of orthoclase, sodic plagioclase, or quartz, in a fine-grained to cryptocrystalline groundmass, which is probably largely feldspathic. The large grains are usually euhedral, but in a few sections appear like fragments, thereby suggesting a clastic origin for the rock. The quartz grains are usually corroded. Accurate determination by the microscope is impossible because of the character of the groundmass. Judging by the composition of the large crystals the rocks appear to be rhyolite and andesite with quartz latite most common.

Similar porphyries in the Great Bear lake area to the north have been described by the writer. The following opinion on their origin in that area was expressed.

"In some cases volcanic structures can be seen in them at intervals or they contain bands of recognizably sedimentary rocks and so may be part of a volcanic-sedimentary group, but over large areas, however, these criteria of volcanic origin have not been found, and the rocks are classified only as belonging to a group older than the granite in their vicinity. Some of these bodies of feldspar porphyry may be intrusive and if so may be related either to the volcanics of the Old Complex or to the granites, though they are intruded by them. Regional metamorphism by the granite may possibly have caused the formation of secondary feldspar crystals in some rocks. Which of these three possible origins should be assigned to any individual body of porphyry, or if more than one origin, which is most important, can only be told after detailed field work."[1]

This also applies to the porphyries in the present area. No metamorphic porphyries have been recognized.

At many places the porphyries are intruded or altered by granite. At several places they cut sediments or volcanics. Their common occurrence at the contacts of granites with sediments and the presence of sediments in the central parts of porphyry belts indicate that for the most part they have a closer relationship with the granites than with the sediments and volcanics of the basement complex.

The rocks of the basement complex and the porphyries will be described together by areas as follows.

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[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 7.

CAMSELL RIVER AREA

A belt of sediments, volcanics, and some minor intrusives trends west-northwest along Camsell river near its mouth and also on the islands in Conjuror bay. The belt is divided into two parts by a tongue of granite which trends parallel to it and lies approximately along its middle. To the northwest in Conjuror bay it is cut off abruptly by the Dowdell Point granite batholith. It is not clear whether the belt extends southeast from White Eagle falls any considerable distance; sediments and porphyries on Clut lake may be its southeast extension.

Two rock groups are represented. One group may be correlated on lithological grounds with the Cameron Bay group[1] in the Echo Bay district. Rocks belonging to this group outcrop on the islands in Conjuror bay, adjacent to the mouth of Camsell river, and for 3 miles up Camsell river to the point where the river turns east. The rocks comprise unbedded, brown, cobble conglomerate, red to brown felsitic tuff, rhyolite and rhyolite tuff, brown arkose and quartzite, argillite and impure limestone. The conglomerate has well-rounded but poorly graded pebbles and boulders commonly up to 8 inches but occasionally up to 2 feet in diameter, in a matrix of finer fragments. The pebbles comprise various felsitic porphyries, feldspar and feldspar-quartz porphyries, banded arkose, vein quartz, jasper, and rhyolite.

Rocks of the second group in Camsell River area have some similarities to those of the Echo Bay group at Echo bay. Insufficient work has been done to determine the relationships of the two groups in Camsell River area, but it seems probable that the group first described is the younger.

Rocks of the second group in general order of abundance are as follows: andesitic tuff and breccia, often bedded; andesitic flows; feldspar porphyry with purplish grey groundmass and nearly white phenocrysts; and argillite. Amygdaloidal and vesicular bands in the purple porphyry indicate that it is in part at least volcanic. At the White Eagle mine there is a small area of basic porphyry in volcanics of this group (*See* page 30). The bedded rocks of the group trend rather uniformly slightly south of northwest. Except near granite contacts dips are usually less than 45 degrees.

Rocks of this group adjacent to the granite tongue in the middle of the area are extensively metamorphosed and contain chlorite, pyrite, and in places actinolite and magnetite.

Sediments rest unconformably on granite on the west side of the outlet of Balachey lake, the eastern of two northerly bays of Camsell river, 2 miles below White Eagle falls. The granite is a part of the mass forming the central tongue of Camsell River area. The sediments consist of 20 feet of breccia, composed at the base of closely packed, angular fragments, up to 2 feet across, of the underlying rock. The breccia grades upwards into a normal conglomerate with rounded cobbles of basic granite, andesite, felsite, and various feldspar porphyries. Overlying these rocks is light brown, pebbly sandstone. Structurally conformable to the sand-

1 Geol. Surv., Canada, Sum. Rept. 1932, pt. C, pp. 1-37.

stone and outcropping one-quarter mile north a bedded greywacke occurs and is succeeded upwards by agglomerate, interbedded chert, recrystallized white limestone, and chocolate-coloured argillite. All these rocks are gently dipping and the total thickness of the sediments above the granite is about 300 feet. These rocks resemble some of those of the Cameron Bay group at the mouth of Camsell river, and, therefore, that group also may be younger than this granite. A quartz vein several feet wide cuts both granite and overlying breccia.

FISHTRAP LAKE AREA

Argillites and impure quartzites outcrop on islands in Fishtrap lake and the lake immediately north. They form a belt known to be 11 miles long and up to 1 mile wide. The belt is not known to reach either Conjuror bay or Hottah lake. The adjacent granites intrude the sediments and near the edges of the belt have altered them to phyllite, mica schist, or sedimentary gneiss.

HOTTAH LAKE AREA

Andesitic lavas, quartzites, and argillites outcrop east of Bell island in Hottah lake. They strike northwest and appear to form a belt 6 miles wide. Extensive outcrops of gabbro, which forms a gently dipping intrusive sheet or sheets, occur on islands in the lake and interrupt this part of the volcanic, sedimentary belt. To the southeast the belt appears to be interrupted by granites that lie east of the south end of Bell island. Sediments outcrop south of the outlet stream flowing west from Zebulon lake. Red and reddish brown feldspar porphyries outcrop in the northern section of the belt on the mainland east of Bell island, but their relationships to the sediments are not known.

BEAVERLODGE LAKE AREA

A belt up to one mile wide, of sediments, volcanics, and quartz and feldspar porphyries trends northeast along the ridge that lies between the north and south parts of Beaverlodge lake. Granite borders these rocks on the south; on the north outcrops are almost absent but those seen were granite. Four miles northeast of the narrows in Beaverlodge lake the rocks of the belt finger into granite. To the southwest the belt of folded rocks has not been traced beyond the west end of the south part of the lake. West of here the ridge in which they outcrop disappears, outcrops are scarce, and a few miles farther west the topography indicates that the little disturbed sediments overlie any extension of the belt in that direction.

The rocks of the Beaverlodge Lake area comprise green, brown, and black argillites, phyllites and schists, grey or pink quartzite, types intermediate between all these, rhyolite, and carbonate-chlorite schist that is possibly also a volcanic rock. Porphyries intrude the sediments at places but are themselves schistose in many places. They are pink to light greenish or purplish grey and have a fine-grained groundmass in which euhedral feldspars or quartz grains occur as phenocrysts. The porphyries form probably one-half the rocks of the belt, but whether they occur as a continuous body or as a series of small bosses is not known.

Argillite, quartzite, and some brown feldspar porphyry outcrop over an area of about 2 square miles near the east side of Beaverlodge lake south of the east arm. The sediments strike northwest.

Isolated hills rising out of low country west of lake Malfait are composed of reddish brown feldspar porphyry.

ISABELLA LAKE AREA

Feldspar porphyry having a fine-grained groundmass, reddish brown or dark grey in colour, outcrops north of the northeast arm of lake Isabella. It is known to extend 8 miles northwest and to be at least 2 miles wide. Prospectors say there is a belt 8 miles wide largely composed of porphyries.

MARGARET LAKE AREA

Feldspar porphyries and sediments outcrop in the south and southeast parts of lake Margaret. The porphyries commonly have fine-grained matrices, reddish brown or chocolate coloured, with light-coloured feldspar phenocrysts up to three-eighths inch long and, occasionally, smaller quartz grains. At a few places traces of finely banded structures are visible on the weathered surfaces and the rock may be a recrystallized sedimentary rock with more or less admixed porphyry. The more typical porphyry has phenocrysts of plagioclase (albite-oligoclase) and orthoclase in a microcrystalline groundmass in which are bunches of chlorite probably of metamorphic origin.

How far these rocks extend to the southeast and north is not known. To the south they may join with porphyries and sediments on lakes Ste. Croix and Rae.

STE. CROIX LAKE-FABER LAKE AREA

A belt of rocks in the granite, consisting mainly of feldspar porphyries, extends from the east end of lake Ste. Croix to the northeast part of lake Faber where it is abruptly cut off. It may be the southern extension of the porphyry belt in the Lake Margaret area. Feldspathized argillitic sediments in areas only rarely large enough to map were found in the porphyries at a few places near the central part of the belt.

The porphyries have a groundmass of reddish brown, chocolate, or grey colour, and a fine texture except near the bordering granites where the groundmass is usually visibly crystalline although still fine grained. It is feldspathic. Phenocrysts are euhedral, light-coloured orthoclase and sodic plagioclase, up to one-quarter inch long. Less commonly quartz phenocrysts are present as well.

WEST SIDE FABER LAKE AREA

Brown feldspar porphyries occupy the north-pointing peninsula on the west side of lake Faber. A high, conical island near the middle of the lake is in part feldspar porphyry.

AREA EAST OF THE SOUTH END OF FABER LAKE

The west edge only of this area is known. The topography indicates that the east edge of this area of rocks older than the granites is probably not far east of the limit of the map. The rocks are dominantly feldspar porphyries, in general similar to those of the Lake Ste. Croix-Lake Faber area, except that varieties in which the groundmass is visibly crystalline are more common. Feldspar phenocrysts too are larger, up to one-half inch long. More sediments were found in this belt than in the adjoining belt on the north, but this may be fortuitous. The sediments are grey argillites commonly calcareous but in places siliceous.

SARAH LAKE-MARIAN RIVER AREA

This area of rocks older than the granites forms a band extending from lake Sarah across Mazenod lake and Marian river to a point east of the river 10 miles north of its junction with Emile river, a total distance of 30 miles. Where known the width is up to 4 miles. South of Mazenod lake sediments are abundantly present in this belt of rocks and feldspar porphyries are less in amount. Here, too, the porphyries are more coarsely crystalline, especially in the groundmass, and in character approach granite porphyry. For mapping they are not readily distinguishable from granite and may in some places have been mapped as such. At its northern end the belt disappears under lake Sarah. The belt at its south end, here composed of sediments, bends to the east and appears to be offset an unknown distance in that direction at a large northeasterly trending quartz vein.

The feldspar porphyries between lakes Sarah and Mazenod are similar generally to those of the Lake Ste. Croix-Lake Faber area. Two selected rocks proved to have about the composition of latite porphyry and to contain plagioclase (albite-oligoclase) and orthoclase phenocrysts in a microcrystalline groundmass.

Thin-bedded, dark argillites, the most northerly sediments found in the belt, outcrop along Marian river for a mile below the outlet of Mazenod lake. Three miles above Hislop lake, where the belt crosses Marian river, a considerable part of it also is thin-bedded argillite with minor agglomerate, interbanded on a large scale with reddish brown, massive, finely crystalline rocks that in places contain feldspar phenocrysts.

The same belt of rocks was traversed from a point on Marian river 3 miles below the outlet of Hislop lake. At the west edge there is a band, a mile wide, of fine-grained granite porphyry. Interbanded sediments and intrusive, reddish brown feldspar porphyry occur for the next 2 miles to the end of the traverse. The sediments of the belt here comprise green and purple argillite with a few bands of fine, squeezed, pebble conglomerate, dark grey quartzite and arkose, reddish brown, impure chert, and a band at least 500 feet thick of dark grey phyllite (an altered, sandy argillite) on the weathered surface of which are closely spaced, lighter weathering, rounded, raised dots averaging one-half inch across. They are the ends of irregular, cylindrical structures that do not have the tiny clastic quartz grains of the rest of the rock. Their origin is not known.

Another traverse of the belt was made 4 miles farther south, from a point on Marian river 2 miles above Tumi lake. Here a series of sediments, at least one mile wide, strikes with the belt and dips 45 degrees east; the eastern edge was not reached. The sediments are mainly limestone, impure limestone, and argillite.

At the south end of the belt, 4 miles farther south, a series of metamorphosed sediments dip steeply east and are exposed for 1½ miles across their strike. They are bounded on each side by granite or granite porphyry. They belong to the same series that was found east of Tumi lake, but are more metamorphosed. Biotite schist and ripple-marked quartzite are present, in addition to sediments similar to those in the more northerly areas.

EMILE RIVER AREA

Biotite schists, chlorite and sericite schists, and sedimentary gneisses, outcrop at intervals along Emile river from a point 12 miles above its junction with Marian river to a lake 10 miles farther upstream. Beyond this lake they were not explored. As the rocks strike parallel to the river, the belt may be only a mile or two wide; aerial photographs suggest this.

AREA SOUTHWEST OF MOUTH OF LA MARTRE RIVER

Sediments in a belt ¼ to ¾ mile wide outcrop in hills close to Marian river just below its junction with La Martre river. The belt was traced 6 miles in a south-southeast direction. The sediments are quartzite, greywacke, and fine-grained feldspathic gneiss.

MARIAN LAKE AREA

Two belts of sediments separated by one-half mile of granite are exposed on the west shore and islands of Marian lake. The western belt, slightly more than 1 mile wide, outcrops in and strikes parallel to the ridge between Marian and James lakes. To the south it disappears in low, muskeg country; to the north it was not followed beyond the end of Marian lake. The rocks dip steeply to vertically and strike with the belt. They are fine-grained, feldspathic gneisses, which represent recrystallized greywacke and argillite, and squeezed conglomerate. The pebbles of the conglomerate are fine grained and feldspathic, or were derived from sedimentary rocks.

Rocks of the eastern belt outcrop: (1) on the west shore of Bedford point; (2) on the end of a T-shaped point 3½ miles to the north of Bedford point; and (3) on the two most westerly of a group of islets 1½ miles east of the second locality. The rocks are argillite, siliceous argillite, dolomite with odd structures like inverted stacks of bowls, dolomitic grit, buff to green, fine-grained sandstone, and siliceous dolomite with quartzite lenses. The structures in the dolomite apparently closely resemble those in dolomite in the lower part of the Great Slave group on Great Slave lake on the north side of Pethei peninsula, south of Mountain river. These were described by Stockwell [1] who ascribed to them an algal origin. The

[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 56.

sediments of the group strike slightly west of north except in the northernmost exposures where they swing to the west. They dip at angles up to 45 degrees.

The relationship of the rocks of the eastern belt to those of the western belt is unknown. As they are less altered than those of the western belt, they may be much younger. They are so much more folded, however, and occupy such a small area that they have not been separated in mapping from the older sediments.

GRANITE, GRANITE-GNEISS, GRANODIORITE, AND RELATED ROCKS

Granite, granite-gneiss, and granodiorite are the most abundant rocks in the area. The commonest type is a coarse-grained, porphyritic, pink, biotite-chlorite granite with phenocrysts of pink to reddish brown orthoclase, up to 2 inches long and occasionally even larger, in a matrix of orthoclase, sodic plagioclase, quartz, and biotite. Chlorite commonly replaces biotite in part. Apatite and titanite are the usual accessories. Sodic plagioclase is abundant enough in some specimens to place the rock in the quartz monzonite class. A gneissic structure, due to alinement of the large feldspar crystals, is common in the southern part of the area, but is ordinarily only faintly visible in the northern granites.

Pegmatites are numerous for 50 miles north of Rae. North of Hislop lake they are uncommon and at Great Bear lake they are rare. Near Rae they have abundant quartz, some pink feldspar, and very often tourmaline, either black or brown, in crystals up to one-half inch wide. In places a pale mauve muscovite, which gave a negative test for lithia, is found. Allanite occurs at Great Bear lake in one of the very rare pegmatitic segregations in the Dowdell Point batholith. The occurrence is at the lake shore on a small point three-fourths mile north of survey monument No. 9.

Other and varied types of granitic rocks occur adjacent to belts of porphyries or sediments. There are granitic types that have little or no apparent quartz and approach quartz diorite or diorite in composition. In these chlorite and biotite are abundant and hornblende occurs irregularly. South of lake Faber it becomes increasingly difficult to distinguish between the feldspar porphyries and border phases of the granites. The groundmass of the porphyries becomes coarser until it is visibly crystalline, and pink and red types with the mineralogical composition of granite are numerous. Where these granite porphyries are not known to be intruded by the granites they are included with them for mapping. An example of one of them is the rock between Marian river at Tumi lake and the belt of sediments lying to the east. Microscopic evidence such as sutured textures indicates that there has been considerable recrystallization in these rocks.

BASIC DYKES AND INTRUSIVE SHEETS

Minor basic intrusives of several ages occur in the area. The majority are younger than adjacent granite, though at one place one was found older than the granite. Some are older than the large quartz veins; some are younger than the primary filling of the veins, but older than the final stages of quartz introduction; some are only known to be younger than the granite. In this section of the report all except those cutting quartz veins will be described.

A gently dipping diabase sheet, 300 feet thick, outcrops in an isolated hill at the head of Gunbarrel inlet on Great Bear lake. Its extent is unknown. A thin section shows euhedral plagioclase (andesine), a colourless, partly uralitized pyroxene, interstitial micrographic quartz and orthoclase, brown biotite, and an iron oxide. It shows no sign of alteration by nearby granite, so is probably younger.

At Hottah lake two rocks, altered gabbro and diabase, outcrop over an extensive area on a group of islands and points east of Bell island. They were not separated for mapping purposes although readily distinguishable because of difference in metamorphism, the altered gabbro being the older. Both appear to be gently dipping, intrusive sheets. Similar sheets cutting granite have been found at intervals for 20 miles northeast of this locality or to the head of Grouard lake, and for this distance they may occur as one or more continuous bodies.

The altered gabbro was definitely recognized only on small islands east of the isthmus on Bell island and on the elongated, southwesterly trending peninsula north of them. It is a massive, medium-grained, dark green, uralitized rock commonly containing a little disseminated pyrrhotite. In thin sections it shows ophitic to sub-ophitic texture. Altered plagioclase laths occur which prove to be andesine-labradorite where determinable. There is abundant uralite either as shreds or as masses after an unidentified pyroxene. Iron oxides, a carbonate, and shreds of white mica are present. In some sections actinolite and epidote are common. At the base of the peninsula the altered gabbro is cut by granite dykes, several feet wide.

Diabase at Hottah lake cuts the older altered gabbro. It is a brown, crumbly-weathering, moderately fresh, medium-grained rock. Two thin sections examined were quartz diabase, with the pyroxene partly altered to chlorite.

Several bands of altered gabbro, trending northeast and up to several hundred feet wide, occur in granite between the east bay of Beaverlodge lake and Stairs bay, Hottah lake. Although general evidence suggests they are dykes cutting the granite some details give rise to doubt. The altered gabbro is cut by large quartz veins.

Between Seguin and Ste. Croix lakes a northeasterly-trending diabase band may be followed for 12 miles. The freshness of this diabase indicates that it is younger than the nearby granite; jointing suggests that it is a gently dipping dyke. It is a medium-grained, somewhat porphyritic, brown-weathering, greenish grey diabase containing biotite and a yellow sulphide, possibly pyrrhotite.

East of lake Faber there is an area of rather fine-grained gabbro. Here, also, lack of alteration indicates that the gabbro is younger than nearby granite. It is gabbro rather than diabase because at only a few places has it an ophitic texture.

EARLY PALÆOZOIC OR LATE PROTEROZOIC SANDSTONE, QUARTZITE, CONGLOMERATE, AND DOLOMITE

The presence of these rocks is largely inferred from the topography as few outcrops were seen. Areas underlain by these rocks and by those of a younger sedimentary group have a comparatively subdued topography and outcrops are rare. For reconnaissance mapping these areas with subdued topography were presumed to be underlain either by the sediments of this group, or by the sediments of the younger group, and a map unit comprising both was employed. On account of the very few outcrops of these rocks it was possible to indicate by symbols on the map the character of the rocks in the outcrops seen.

Rocks of the older group were found in small outcrops on the north shore of Hottah lake and on the west sides of Beaverlodge, Rae, Faber, and Marian lakes. At most places they appear to be the basal beds of nearly flat-lying sediments, and to rest unconformably on the granite or on quartz veins. They are correlated on structural and lithological grounds with the Hornby Bay series at Great Bear lake.

On the north shore of Hottah lake fine-grained, purple, buff, and white sandstones outcrop. They are nearly flat-lying and overlie nearby granite; the actual contact, however, is concealed.

At Beaverlodge lake flat-lying, white and red, coarse, well-sorted sandstone outcrops in a low cliff along the north shore of the west bay that lies south of the narrows in the lake. A mile to the north, half-way up the south slope of a 600-foot ridge, an outcrop of conglomerate occurs and contains boulders up to 5 feet across. The boulders, as well as the interstitial pebbly grit material, are composed exclusively of vein quartz obviously derived from a not far distant quartz vein or veins. The matrix is calcareous. The rock is clearly a remnant of a hill-slope deposit and the materials probably were derived largely from the large quartz vein that outcrops at the crest of the hill some 200 feet higher.

Arkose rests unconformably on weathered granite on the north shore of the west arm of Rae lake. It appears to be flat-lying. A section, only 1 foot thick, is exposed.

On the west side of lake Faber at the base of the north-trending peninsula flat-lying boulder conglomerate rests unconformably on granite. The boulders are up to 2 feet across and are of vein quartz and jasper. Abundant blocks of sandstone occur on an elliptical island 2 miles long, which lies 3 miles east of the outlet of lake Faber; the island is evidently underlain by similar rock.

Sandstone also outcrops on Marian lake, on the point immediately west of Rae and on the next point 4 miles north. It is light buff to light mauve in colour, moderately fine-grained and crossbedded. Only a few feet are exposed in low outcrops on the shore.

LATER DIABASE DYKES

Diabase dykes that cut an early generation of quartz in large quartz veins that will be described under Economic Geology were found at several places. Dykes at Beaverlodge lake, which cut the early quartz, are themselves cut by a later quartz. In the map-area they have not been found cutting the rocks correlated with the Hornby Bay series. Diabase dykes cut rocks of the Hornby Bay series on Great Bear lake. In the present area the correct age of the later diabase dykes is not known, but they are tentatively placed above the Early Palæozoic or Late Proterozoic sandstone and conglomerate because of the relationships prevailing on Great Bear lake.

Other places where diabase dykes cut the early quartz of the large veins may be mentioned. On the east part of Workman island in Great Bear lake a quartz diabase dyke cuts a quartz vein. Between Beaverlodge lake and Stairs bay, Hottah lake, numerous diabase dykes cut quartz veins. A mile east of Tuchetu lake a medium-grained diabase dyke cuts a large quartz vein that outcrops prominently in a ridge. These dykes are lithologically similar to a flat-lying basic dyke in Great Bear Lake area[1].

PALÆOZOIC DOLOMITE AND DOLOMITIC SANDSTONE

For mapping purposes the rocks of this group, as already stated, have been included with those of the Early Palæozoic or Late Proterozoic sedimentary group. Their distribution is largely inferred because outcrops are scarce. The rocks are considered younger than those correlated with the Hornby Bay series because they definitely lie above them or are inferred to do so for structural reasons. Correlation of the various exposures is based solely on lithological and structural grounds. Fossils found at two localities were too poorly preserved to be of much value for determination of age.

Conglomerate, 15 feet thick, with a limy cement and overlain by dolomite, outcrops on a double-headed point northwest of Bell island. The conglomerate rests upon granite and has pebbles of quartz and granite.

Nearly flat-lying dolomite outcrops at several places on, or near, the west shore of Hottah lake. It is brownish grey, grey, or buff, visibly crystalline, and at places sandy. Buff dolomite with salt-crystal casts outcrops in a scarp 5 miles west of the foot of Stairs bay and 1 mile north of the river that there enters Hottah lake. The crystal casts are skeletal and up to an inch on a side.

Dolomite occurs on the north end of lake Sarah just west of the longer portage to lake Faber. Fifty feet of flat-lying, uniform, dark brownish grey, very sandy dolomite, in beds 1 to 8 inches thick, is exposed at the crest of a southeasterly facing scarp, 165 feet high. Ten feet of similar sandy dolomite and some dolomitic sandstone outcrop at the top of a scarp on the west side of Mazenod lake. Fossil-like markings (unidentified although possibly fucoids)[2] were found in grey dolomite float which strews the lake shore and must have come from nearby.

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[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 15.

[2] Communication from Palæontological Division, Geol. Surv., Canada.

On the west side of Marian lake, at a few miles from the shore, a distinct scarp is visible in the gently rising, drift-covered country. It was examined at a point 2½ miles south of James lake and 3 miles west of Marian lake, where there is a section of 15 feet of flat-lying dolomite in beds averaging 2 inches in thickness. The rock is buff and light brown dolomite. At the base is a browner fossiliferous bed. The fossils are reported on as follows: [1]

1. Indistinct markings which show no structure.
2. Fragment—unidentifiable.
3. Crinoid disks, and several crinoid roots.

The material is too poorly preserved to indicate the age of the rocks. The crinoid disks do not belong to the earliest known crinoids, but no further conclusion is possible.

In the Norman range 250 miles west-northwest of Marian lake, Silurian strata include very sandy limestone and in places an indurated unfossiliferous sandstone. [2] Hume [3] found Silurian and supposedly Silurian rocks at intervals from the west shore of the north arm of Great Slave lake to Marian lake. At the farthest north locality the top strata are grey dolomites which outcrop on the crest of an east-facing scarp. Underlying these beds and some concealed beds, are unfossiliferous, yellow, purple, and greenish sandstones. At Redrock point farther south, sandstone is overlain by shale and the latter by red, arenaceous dolomite. It seems probable that the exposures near Marian lake examined by the writer are on the northern extension of the scarp found by Hume and are likewise of Silurian age. So, too, the sandstone at Rae and to the north may be correlated with that described by Hume. Its age is unknown. Arid climatic conditions indicated by the salt-crystal casts in the dolomite at Hottah lake suggest that the dolomite may be of Silurian age, for such conditions prevailed in the Mackenzie region at times during the Silurian period.

PLEISTOCENE AND RECENT

The region was glaciated and the general direction of ice movement was from east to west. In places the striæ vary considerably in direction, but when a mean is calculated for different localities it is clear that the centre of glacial radiation was far to the east of Hottah lake. Average directions of striæ observed are as follows:

Place	Number of striæ measured	Average bearing (ast.)
Clut lake	1	S. 94° W.
Hottah lake	8	S. 93° W.
Beaverlodge and Isabella lakes	9	S. 79° W.
Hardisty lake	5	S. 72° W.
Rae Faber, and Sarah lakes	14	S. 69° W.
Marian river	5	S. 65° W.
Marian lake	7	S. 59° W.

[1] Palæontological Division, Geol. Surv., Canada.
[2] Geol. Surv., Canada, Sum. Rept. 1932, pt. B, p. 54.
[3] Geol. Surv., Canada, Sum. Rept. 1932, pt. B, p. 33.

Though there is only a poor intersection of these bearings a centre of accumulation near the headwaters of Backs river is suggested.

Pleistocene deposits are not widespread except in areas presumed to be underlain by the Palæozoic and (or) late Proterozoic strata. Such areas have bedrock nearly completely mantled by morainal material. Elsewhere glacial drift occurs mainly in hollows and a large proportion of bedrock is exposed. Where the underlying rock is granite, it has been so shattered and heaved at a few places by frost action that there is little or no rock undisturbed. Such broken surfaces occur over parts of the large peninsula in the south part of Hardisty lake.

Large eskers were seen at the outlet of Fishtrap lake, on Hardisty lake, where they form the isthmus of a peninsula, and at the north end of lake Malfait.

Post-glacial lake or stream silts are common along most of the larger streams. They form a mantle probably never more than 100 feet thick and in most places much less, for knobs of bedrock protrude through them. They were not deposited by the present streams, but lie above them and have level upper surfaces. Moreover they cover areas measured in square miles. They have their greatest area along Marian river from Hislop lake to the mouth; the known width here is up to 10 miles. These silts are rock flour deposited by streams flowing from the east, and perhaps also from the west; the streams from the west may have come from local ice caps.

Small, raised, gravel and cobble beaches are numerous in the map-area, and occur at various elevations. The highest seen are 300 $\pm$ 15 feet above lake Faber, the elevation of which is given as 753 feet on the Rae sheet, National Topographic Series. Lake Faber is not more than 25 feet lower than the height of land between Camsell and Marian rivers. It is evident, therefore, that a large waterway existed between the basins of Great Bear and Great Slave lakes for some time after the ice retreated from that vicinity. The lack of reliable determinations of elevation, however, made it impossible to investigate this question as it deserved. The Rae and Camsell River sheets, National Topographic Series, show elevations according to which Great Bear lake would be 308 feet below Hardisty lake, but this is considerably too large, as the difference can hardly exceed 150 feet. Without reliable elevations it is impossible to correlate the beaches in the area.

No fossils have been found in the raised beaches or elsewhere in the Quaternary deposits of the map-area. This may indicate a fresh or brackish water body rather than a direct arm of the ocean. The area of the water body must have been very great.

STRUCTURAL GEOLOGY

Throughout the area the regional trend of the rocks older than the granites is mostly north to northwest. In the south part of the area it is about north; farther north it is more westerly until at Camsell river it is west-northwest. This direction approximately parallels the trend of the much younger folding in the Rocky mountains to the west. The belt of sediments at the narrows in Beaverlodge lake is an exception because it trends northeast. The reason for this is not clear.

Numerous large faults occur. The majority of these trend about northeast. In most cases giant quartz veins occupy the fault zones. The quartz of these veins is of different ages and there has been repeated fracturing and recementation at different times. The age of the faults is known only within wide limits. Faulting began later than the intrusion of at least some of the granites and later than the folding of the basement complex because these rocks and structures are themselves displaced. Some of the northeasterly trending faulting continued after deposition of rocks of the Hornby Bay series[1]. There may have been faulting in Palæozoic or later time, for at Pine point on the south shore of Great Slave lake where lead-zinc replacement deposits in Middle Devonian limestone occur, the rock is considerably fractured and the deposits are somewhat elongated in a northeasterly direction. Eighty miles to the northeast of these deposits, Stockwell[2] mapped a system of very large faults, 125 miles long, cutting Precambrian rocks on the south side of the northeast arm of Great Slave lake. It is quite possible that these faults extend to the west under the Palæozoic cover there, and that the last movements on them took place in Devonian or later time. Movements of the same ages may have taken place along similar faults in the Rae to Great Bear Lake map-area.

Viewed broadly this great system of northeasterly trending faults known to be present in a region from the Arctic ocean to Great Slave lake is a structural feature of the first magnitude. The writer suggests that it is but the surface expression of a major zone of weakness that trends somewhat west of north from Great Slave to Great Bear lakes and beyond. May not the northeast, right-hand tension faults be caused by a movement of the west side of the main structure northward relative to the east side?

ECONOMIC GEOLOGY

GIANT QUARTZ VEINS

Very large quartz veins occur in various places throughout the region under discussion. They have been found at intervals from near the mouth of Coppermine river northeast of Great Bear lake, to Rae on Great Slave lake, some 350 miles. Stockwell[3] has described one at Odjick lake 125 miles east of Hottah lake, and an apparently similar vein is reported from Bathurst inlet on the Arctic coast 250 miles east of Great Bear lake. In the map-area seventeen were found with average widths exceeding 100 feet and lengths up to 10 miles. There probably are others with this order of magnitude and there certainly are many somewhat smaller.

The veins are usually similar to those on the east side of Great Bear lake described in an earlier report[4]. As in that area, most of them strike about northeast. Some are known to be along large faults and probably

[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 18.
[2] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, map, p. 58.
[3] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 63.
[4] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 15.

most of them are of this character. The uniformity of strike and the great length and size of the veins show clearly that they are along major fractures.

The veins are composite stockworks. Replacement by quartz of walls and included rock fragments has been extensive. In places replacement has been complete, leaving bodies of solid quartz hundreds of feet wide. Elsewhere all stages of replacement are represented, and may be most clearly seen where veins cut granite. Adjacent to the veins the granite usually contains more than the average amount of chlorite and quartz and the latter is milky. A few veinlets of white quartz cut the granite at a distance from the centre of the vein, and, nearer, increase in number to form a stockwork in which the feldspars of the included granite blocks are increasingly altered to secondary micas, though the outlines of the fragments remain. Finally there is a gradation to massive quartz which fails to show even ghosts of fragments. Where veins cut sediments the walls are usually not readily definable on account of the silicification. The main vein at Beaverlodge lake (described on page 26) illustrates this.

In most of the veins there is evidence of at least two stages of quartz deposition. In others the quartz was deposited at more than two stages. Usually the primary vein filling is later than any known granites in the region and also than some of the basic intrusives. However, a younger group of diabase dykes cuts the quartz of this primary stage. Sediments of the Hornby Bay series at several places rest unconformably on quartz veins. Yet at Hornby bay and the bay southwest of Richardson island, northeasterly trending stockworks of quartz stringers cut the Hornby Bay rocks. Also, at Beaverlodge lake, quartz veinlets cut diabase dykes which cut the primary veins. Evidence, therefore, indicates that a long time interval separated two stages of quartz deposition in these veins.

The quartz of the earlier stage of deposition is white and massive with occasional small vugs with glassy quartz crystals and rosettes of specular hematite. Chalcopyrite and other copper minerals are present at a few places. In the southern part of the map-area pyrite may be present.

The younger quartz very commonly has crystals facing open cavities. These crystals show alternate bands of milky and glassy quartz parallel to their faces. At a few places pitchblende occurs with the quartz. Specular hematite is very commonly present on quartz crystal faces.

SUMMARY DESCRIPTION OF MINERAL DEPOSITS

Pitchblende deposits at Beaverlodge lake and silver deposits near the mouth of Camsell river were the only ones seen in the map-area. Gold is reported to occur near the mouth of Camsell river, and pitchblende at Hardisty lake.

However, as additional field and laboratory work has been done on some of the Great Bear Lake deposits since the last report on them, this description will be extended to embrace the new features as well as the deposits within the map-area.

Mineral deposits in the general area from Great Slave lake to Coppermine river comprise deposits of copper, pitchblende, silver, and gold. These may be classified as follows:

A. High temperature deposits containing chlorite, pyrite, magnetite, biotite, actinolite, arsenopyrite, and possibly hematite.
B. Disseminated native copper occurrences in the Coppermine River lavas.
C. Vein deposits in fracture and fault zones, which commonly have a northeast trend:
   (1) Quartz-bornite-chalcopyrite deposits.
   (2) Quartz-calcite-chalcocite deposits.
   (3) Quartz-hematite-pitchblende deposits, which contain in places some of the following: cobalt-nickel minerals, chalcopyrite, pyrite, galena, bismuth minerals, dolomite.
   (4) Deposits with carbonates (usually manganiferous), silver minerals, and some of the following: chalcedonic or amethystine quartz, copper sulphides, galena, sphalerite, cobalt, nickel or bismuth minerals.

It is possible that deposits of types 3 and 4 under Group C are really one type and represent two stages of deposition. At some places either the pitchblende or the silver stage is missing.

Deposits belonging to Group A occur most prominently in the Echo Bay district at Great Bear lake, close to the margins of elongated granodiorite stocks. The pyrite in them gave rise to the conspicuous gossans in this area. Near the mouth of Camsell river similar mineralization occurs adjacent to a granite tongue that lies in the central part of rocks belonging to the basement complex.

The deposits of Group B, disseminated native copper in the Coppermine River lavas, have not been studied. They are limited by the area of the lavas to a region northeast of Great Bear lake.

Deposits of Group C include all those of known economic importance.

Type 1, quartz-bornite-chalcopyrite deposits, occurs in the giant quartz veins. At Hunter bay, on Great Bear lake 35 miles north of Echo bay, the deposits are sufficiently large to be economically important. A deposit of bornite and chalcopyrite in a quartz vein north of Dismal lake and cutting lavas of the Coppermine River series is placed in this group. All these deposits have been described. [1]

Type 2 deposits, quartz, calcite, chalcocite veins, are known only in the area underlain by the Coppermine River lavas. One of these has been described. [2]

Quartz-hematite-pitchblende deposits of type 3 occur in Echo Bay district, at Workman island 15 miles to the north, and at Beaverlodge lake in the map-area. One is also reported at Hardisty lake. In Echo Bay district deposits of type 4 may occur in the same veins as those of type 3. This is the case at the Eldorado mine, at the Echo Bay Group property of the Consolidated Mining and Smelting Company of Canada, Limited, and at M Group of Bear Exploration and Radium, Limited. At these three properties silver deposition took place in the same channels as the pitchblende, and may have followed deposition of the pitchblende. In all type 3 deposits pitchblende, quartz, hematite, and chalcopyrite occur.

[1] Geol. Surv., Canada, Sum. Rept. 1931, pt. C, pp. 55-59.
[2] Ibid., p. 60.

Pitchblende has colloform and other structures indicating its deposition from a gel state; hematite is both contemporaneous and later and is commonly specular; chalcopyrite and galena are still later. At Workman island and Beaverlodge lake the deposits belong to the last stage of infilling of giant quartz veins. At Echo bay they are in smaller quartz veins. At the Eldorado mine the quartz closely resembles that of the very large veins.

Type 4, silver-bearing deposits, occurs in Echo Bay and Camsell River districts, at Great Bear lake. In the former district, as mentioned above, the deposits may occur in the same zone as the earlier pitchblende. Only at the Eldorado mine has a detailed study been made, and in this deposit there was a break between the quartz-pitchblende mineralization and that of carbonates, sulphides, and silver minerals. Detailed evidence indicates the break may not have been a major one. The elements common in both types, and their occurrence in the same zones suggest two stages in one sequence of mineralization rather than two sources. At Camsell river the silver occurs in quartz and the later carbonate is manganiferous like the silver-bearing carbonates at Echo bay. Banding and some crustification are common. Sphalerite, galena, and several copper sulphides occur in the manganiferous carbonates. In the quartz, in addition to native silver, there are silver sulphides and copper-silver sulphides and the silver telluride, hessite. Argentite is more abundant than native silver in the Echo Bay group. Where native silver and niccolite occur together the silver replaces the argentite in preference to the other minerals. Chloritic fragments of wall-rock in veins were favourable for silver deposition. Practically all the native silver is primary and where determinable it is the latest formed silver mineral.

The mineralogy of the four types of deposits listed in Group C is complex. It is summarized in Table II.

TABLE II

Abundant = A Widespread or abundant in places = a Identified = i Occurs in wall-rocks = W	Coppermine veins	Hunter bay	Bud group	Eldorado	Consol. Mining and Smelting	B. E. A. R.	Bonanza	El-Bonanza	Thompson	White Eagle	Elite group	How group	Beaverlodge lake (Tatee claim)	Beaverlodge lake (Bee claim)	Beaverlodge Watt-Kerr
Pitchblende				A	i	i			i				A	A	A
Magnetite				AW	AW	i W	AW								
Hematite		i	a	A		a	AW		i	i	i		A	A	A
Pyrite		i ?	a	AW	AW	a			i	AW	i W	iW	i	i	
Pyrrhotite			a												
Marcasite					i								i		
Arsenopyrite				i	a	a				i		i			
Smaltite-chloanthite				a	a									(Supergene Co-Ni minerals noted)	
Safflorite				a	a	i				a	i				
Rammelsbergite						i ?					i ?				
Skutterudite				a											
Nickel skutterudite				i ?											
Cobaltite				a		i									
Gersdorffite				i						i ?	i				
Glaucodot				a		i									
Löllingite				i											
Nickeliferous löllingite															
Niccolite				i	a	i				a					
Polydymite				i											
Molybdenite				i											
Native bismuth		i ?		a	i	a				a	i	A		i	
Bismuthinite										i		a			
Unknown Bi, Pb, Cu mineral											i				
Unknown Bi, Pb, Ag mineral													i		
Bornite	A	A		a	A	a		a	A						
Chalcopyrite	a	A	A	A	A	a	i		A	A	a	a	a	a	
Chalmersite				i											
Tetrahedrite				a	i ?	i		i							
Freibergite				i											

Chalcocite	A	a	...	a	a	a	...	...	i	...	...	...	...	...	...
Famatinite	...	a	...	...	...	...	...	...	...	...	...	...	...	...	...
Covellite (supergene)	a	...	...	a	a	a	...	i	a	...	i	...	i	...	...
Sphalerite	...	...	...	a	A	...	...	a	a	a	i	i	...	...	...
Galena	...	...	...	a	A	...	...	...	...	A	i	A	i	...	...
Native silver	...	...	i	A	a	A	A	A	...	A	a	a	...	...	...
Argentite	...	...	...	a	A	i	...	...	...	a	i	...	...	...	...
Jalpaite	...	...	...	i	...	...	...	...	...	...	...	...	...	...	...
Stromeyerite	...	...	...	a	a	i	...	...	...	...	...	...	...	...	...
Polybasite	...	...	...	...	...	i ?	...	...	...	...	...	...	...	...	...
Hessite	...	...	...	a	...	i	...	...	...	...	...	...	...	...	...
Native gold	...	...	i	...	...	...	...	...	...	...	...	...	...	...	...
Massive white quartz	...	A	A	A	a	a	...	a	A	...	a	a	A	A	A
Massive red quartz	...	i	...	a	...	a	...	...	...	...	...	...	...	...	...
Comb and crust quartz	A	a	...	a	...	a	...	...	...	A	a	...	i	i	...
Dolomite	...	...	...	a	...	...	...	...	...	A (mang.)	...	A (mang.)	...	...	...
Calcite	A	...	...	...	i (mang.)	a (mang.)	a (mang.)	A	...	...	...	...	...	...	...
Rhodochrosite	...	...	...	(ferrug.) A	(ferrug.) A	(ferrug.) A	...	...	...	...	...	...	...	...	...
Carbonates (undifferentiated)	...	a	a	...	...	...	...	...	...	...	a	...	...	...	...
Barite	...	...	...	i	...	...	...	...	...	...	...	...	...	...	...

The properties listed from left to right in the table are arranged in order of occurrence from north to south. Where minerals of Group A occur in deposits of Group C they are indicated. There are thirty-eight identified hypogene primary metallic minerals and several others that have so far defied identification, and may be new minerals. There are a number of supergene secondary minerals that have not been much studied. The gangues are quartz and carbonates, there being several varieties of each. Only the ores of the Eldorado mine have had a thorough study. Some of the minerals listed from that place only may also be present in small amounts in some of the other deposits.

The mineralogy and vein structures of the deposits summarized here and given in more detail in the descriptions of properties, indicate fairly well the relative conditions at the time of formation of the deposits. In Group A, the presence of magnetite, biotite, and in places garnet and tourmaline, indicates the relatively high temperatures prevailing when they were formed. In Group C3, colloform and other structures in the earliest formed mineral pitchblende show that the latter solidified from a colloidal gel. The presence in it, at the Eldorado deposit, of later molybdenite, a mineral usually considered to form at fairly high temperatures, suggests that the pitchblende originated near the upper end of the temperature range of formation of colloids. Hematite is considered unreliable as a temperature indicator because of the wide range of conditions under which it may form. The remaining minerals suggest by comparison with deposits elsewhere a temperature of formation, declining from intermediate to low. The presence at the Eldorado property of high temperature mineral chalmersite in this association is inexplicable unless it be a relict mineral.

The mineral deposits of Group C are considered to have originated in a single widespread source, though perhaps not exactly contemporaneously; they may be termed consanguineous. Table II shows that several elements, some of them rare, are common to the majority of the deposits. Uranium, silver, bismuth, cobalt, nickel, copper, and iron in hematite are such elements. The descriptions of the deposits show that many structural and physical features are also similar.

Igneous rocks younger than the mineralization are, with one possible exception at the Elite property, unknown. The relationship of the deposits with the little disturbed sediments is also not known. Stockworks of quartz veinlets similar to some of those containing mineral deposits cut the rocks of the Hornby Bay series. The stratigraphic evidence leaves the age of the deposits uncertain.

Direct determinations of the age of the pitchblende at the Eldorado mine have been made by using the lead-uranium ratio method. Lane[1] reports an age of 1,277 million years. According to the geological timetable based on this method the time of formation of the pitchblende was early in the Precambrian. The lead-uranium ratio of the deposits at Beaverlodge lake indicates a much younger age for the pitchblende. From several analyses of high-grade pitchblende ore, made by the Department of Mines at Ottawa, the calculated proportions of lead and uranium are:

[1] National Research Council U.S.A. "Report of the Committee on the Measurement of Geologic Time" (1934).

350,000,000

TABLE III

—	I	II	III	IV	V	VI	VII
U....................	40·96	32·50	44·35	18·70	34·78	11·59	11·38
Pb....................	2·18	1·57	2·35	1·05	1·90	0·68	0·52
Pb/U................	0·0533	0·0483	0·0530	0·0561	0·0462	0·0578	0·0457

Nos. I to V are analyses of pitchblende ore from the Tatee claim at Beaverlodge lake and are based on a 1½-ton shipment to the Mines Branch, Department of Mines, Ottawa.

Nos. VI and VII are from claims WLO 12 and WLO 9, respectively, both 3 miles northeast of the Tatee claim.

The average Pb/U ratio for I to V is 0·0514, and for VI and VII is 0·0507. This gives the pitchblende an age, in round numbers, of 350 million years, using the formula

$$\text{Age } 6{\cdot}75 \times 10^9 \times \frac{\text{Radium G}^1}{\text{Uranium}}$$

According to this, the pitchblende from Beaverlodge lake was formed in Silurian time[2]. A very small amount of galena was present in one specimen, so that the Pb/U ratio, and, therefore, the calculated age, is probably somewhat too great.

The age estimates indicate a difference of 900 million years between the ages of the Eldorado and Beaverlodge pitchblendes. There is nothing in the field evidence to indicate any such difference; on the contrary the chemical, physical, and structural similarities suggest that the age is about the same. The writer thinks that there may be some unsuspected factor in the Eldorado age determination. Galena is so widely distributed in this ore compared with that at Beaverlodge lake, that though Piggott[3] has determined the lead in the Eldorado pitchblende to have mostly the isotopic composition of uranium lead, it is questionable whether uranium lead was not introduced into this deposit by solutions rather than that it all formed by decomposition, in place, of uranium. Until more conclusive evidence is produced the pitchblende deposits are tentatively considered approximately contemporaneous.

SOURCE OF THE MINERALIZATION

The mineral deposits of Group C are believed to have formed during the later stages of formation of the large quartz veins. In earlier reports the writer considered the granite magmas as the most obvious source of the pitchblende and silver mineralization. This opinion was based partly on the areal distribution of the then known deposits adjacent to the Dowdell Point granite or its equivalent at Labine point, and partly on the mineral association that is typical of deposits in other regions believed to be related to granites. However, at two new localities, Workman island and Beaverlodge lake, large quartz veins cut granite and were later reopened and mineralized with pitchblende and younger quartz. Thus the

[1]Radium G is the name given to the lead produced as the final disintegration product of radium and uranium. In practice it is often difficult to determine whether all the lead present was formed by disintegration of radium or introduced in other ways. If other lead is present and cannot be distinguished, the age as determined by this method will be too great.

[2] National Research Council, U.S.A. "Report of the Committee on the Measurement of Geologic Time," p. 2 (1934).

[3] Jour. Geol., vol. XLII, pp. 641-645 (1934).

pitchblende mineralization is younger than the bulk of the vein filling, though the age difference may not have been great; and is, therefore, certainly younger than all the rocks cut by the veins, including the granites.

It is possible that the pitchblende-silver mineralization and the Dowdell Point granite, though perhaps of different ages, may have had a common source in a parent magma. This hypothesis receives some support from the occurrence of a little fluorite both in the eastern Bonanza and Eldorado deposits at Echo bay and in the Dowdell Point granite. Fluorite was found in two out of seven thin sections of this granite taken from various localities. Although forty-nine thin sections were made from other intrusive rocks, mostly granitic in texture, all failed to show any fluorite. Moreover, no radioactive minerals were found in any granite except that at Dowdell point. Allanite occurs in a pegmatitic segregation 10 miles south of Dowdell point. The distribution of these minerals does, therefore, suggest a consanguinity of the deposits with the granite.

DETAILED DESCRIPTIONS OF PROPERTIES

Beaverlodge Lake District

TATEE AND BEE CLAIMS

These claims are on the north side of the east arm of Beaverlodge lake. In the autumn of 1933 Indians found pitchblende in a large quartz vein on the ridge east of the narrows between the north and south parts of the lake. D'Arcy Arden and E. H. Hargreaves staked claims in January 1934, and at various times later. Development was undertaken by Hottah Lake Mines, Limited, a company organized for that purpose.

Two and one-half miles northeast of the narrows in the lake an intrusive sheet of gabbro probably dipping gently south cuts sediments and porphyries. Sediments, porphyries, granite, and gabbro are cut by quartz veins, up to several hundred feet wide, that strike northeast and dip usually steeply. They are cut by diabase dykes (*See* page 15). Later veinlets containing quartz and some pitchblende occur in the main veins and cut the dykes.

The Tatee claim (No. 32024) is on the large quartz vein that crosses the narrows of the lake, about 1½ miles northeast of the narrows. The "vein" is 175 to 250 feet wide, and on the western part of the claim it lies in finely banded, fine-grained, quartzose sediments. The latter are cut by a network of quartz veinlets and have been silicified to a hard, white, or pale green quartzite. The sediments also form a considerable part of the "vein." They are still recognizable as sediments by joints that follow original bedding planes, and by occasional ripple-marks. At some places in the "vein" there are lenses up to several feet wide of less completely silicified sediments. At other places replacement has completely recrystallized the rock and obliterated original structures or else true vein quartz has been deposited. Taken as a whole the proportion of vein quartz to siliceous sediments in the "vein" was not determined. It is, however, considerable and for practical purposes the whole will be referred to in this report as a vein. Farther east where it cuts granite it is a true vein. Near the workings the southeast margin of the vein is sharp, presumably because the sediments there give place to a band of feldspar porphyry. The porphyry is fine grained and is blotchy green and yellow. It is largely composed of chlorite and carbonates, probably in part ferruginous. In places the weathered surface shows relicts of feldspar crystals up to one-eighth inch long. Alteration makes it impossible to determine whether the rock is a volcanic interbedded with the sediments or a phase of the porphyry elsewhere intruding them. The northwest boundary of the vein in this locality is also sharp. The wall-rock is sedimentary schist more argillaceous than the sediments silicified by the vein. Lenses of sedimentary rock included in the vein may owe their preservation to an original argillaceous content greater than that of the rock entirely replaced.

Several sets of joints cross the vein and pass into the wall-rocks. In order of prominence these are: (1) bedding joints, relict from replaced sediments; (2) diagonal joints in two sets N-S and E-W; (3) northwest joints at right angles to vein walls and dipping steeply northeast; (4) low dipping joints parallel in strike to walls. The size of the vein system indicates a major zone of structural movement. The diagonal joints probably represent small adjustments subsequent to consolidation of the quartz. Faulting, with horizontal displacement up to 50 feet, took place along some of the joints.

Pitchblende has been found in the vein at two places, and deep pits have been sunk to explore the deposits. The original find is 50 feet from the southeast edge of the vein. The rock is pale greenish, silicified, ripple-marked quartzite, cut by bedding joints, cross joints, and east-west diagonal joints. Pitchblende with hematite formed three lenses a few feet long, one above the other, which had been largely mined out at the time of examination. However, numerous uranium and iron stains and some pitchblende indicated where the lenses had been. The lenses were found in a lens 8 feet long of twisted and intensely sheared chlorite schist. In the second pit, 50 feet south of the first and 15 feet from the edge of the vein, pitchblende and hematite were found. Both the rock and joints are similar to those in the first pit. The pitchblende occurs along joints in short, wide lenses of a few cubic feet each. Work was discontinued when these lenses were mined out. The ore from the pits was cobbed and 1½ tons of the best shipped to the Department of Mines at Ottawa. This was divided into five lots which assayed in U_3O_8 as follows: 48·4 per cent, 38·4 per cent, 52·4 per cent, 22·1 per cent, 41·1 per cent. [1]

The mineralogy of the deposits is simple. Hematite and colloform pitchblende intimately mixed and in a quartz gangue are the principal minerals. Pyrite and chalcopyrite in very small amounts are common. Galena and an unknown bismuth-lead-silver mineral were seen in one specimen. F. Jolliffe reports the presence of a little marcasite. Its relations to the other minerals are unknown. The pitchblende has within it structures similar to those noted in pitchblende from Great Bear lake. Hematite particles in the pitchblende grade down in size to the limits of microscopic visibility (approx. $\frac{1}{250,000}$ inch). Hematite deposition

[1] Assay results supplied by the Ore Dressing Division, Mines Branch, Department of Mines, Ottawa.

continued after that of pitchblende, or was renewed, for later veinlets of coarser specular hematite cut the mixture. Hematite has replaced quartz, particularly in the presence of pitchblende. Pyrite occurs in cubes. It and chalcopyrite followed pitchblende in order of deposition. Galena and the unknown mineral mentioned above are also later than pitchblende and hematite. The unknown mineral contains bismuth and lead, according to microchemical tests. [1]

The location of the pitchblende was determined by the joints and small faults. It was deposited after the consolidation and jointing of the main bulk of quartz. The uraniferous solutions came up joint cracks and deposition took place at junctions of joints where fracturing was unusually intense. In pit 1 the chlorite schist may have influenced deposition. As the pitchblende occurs along short, discontinuous joints, the prospects for lateral extension are poor. However, if junctions of joints occur at greater depths, as may be expected, other pitchblende lenses of similar size may occur below. The tonnage in such lenses is not great and exploration by underground mining would probably be unprofitable. Pitchblende may also occur in suitably fractured parts of the vein now covered by drift. One such place may exist 250 feet southwest of the present workings. Trenching in search of such places would be difficult, expensive, and perhaps fruitless. Geophysical prospecting with some form of gamma ray detector would be the most effective way of exploration.

On the Bee No. 3 claim (32031) pitchblende was found in 1934. The locality is 1⅛ miles northeast of the Tatee claim and ½ mile from the east arm of Beaverlodge lake. It is 700 feet southeast of the quartz vein that outcrops at the crest of the ridge north of the east arm of Beaverlodge lake. The pitchblende lies in a quartz vein, 300 feet wide. Eight hundred feet southwest the vein narrows to 40 feet and disappears under drift. At a point the same distance northeast it is faulted, and its extension was not found. To the northwest beyond a shallow depression a gently dipping sheet of gabbro occurs and to the southeast, gabbro, sediments, and quartz porphyry. The vein holds lenses of altered sediments and quartz porphyry. East-west right-hand faults displace it with throws up to 30 feet. Some movement on the faults must have taken place before the final filling of the vein, because a dyke of fine-grained porphyritic diabase that lies along one fault cuts the vein and is cut by later comb-quartz veinlets carrying specular hematite.

The pitchblende occurs near the middle of the vein 100 feet northeast of the dyke. Limy argillite and quartz porphyry occur here in the vein as a lens up to 40 feet wide and 150 feet long. The porphyry intrudes the argillite and both are cut by a network of quartz veinlets. The porphyry is altered to a waxy, pale yellow-green aggregate, partly serpentine, in which are numerous glassy quartz grains. The pitchblende occurs at several places in a distance of 100 feet, appearing as seams a fraction of an inch wide, and is associated with comb quartz similar to that cutting the dyke. The greatest amount at any one place is a lens 5 feet long by 3 inches wide, estimated to contain 10 per cent pitchblende. The lens is partly along the contact of sediments and porphyry and partly

[1] F. Joliffe, personal communication, states that it contains silver as well.

along a shear plane that branches from the contact. It is thus localized apparently because the inclusion of country rock has been more intensely fractured than the quartz of the vein.

The mineralogy is similar to that at the Tatee deposit except for the presence of small amounts of native bismuth and the apparent absence of galena and the unidentified mineral. At one place there are distinct stains of cobalt and nickel bloom.

Though excellent in quality the pitchblende so far visible is quite insufficient in amount to be of much value. The large inclusion of country rock, with which the pitchblende is associated, does not extend to the southwest, but may continue beneath the drift to the northeast. Nothing was found to indicate whether other lenses of pitchblende might be expected at depth.

WLO AND WK CLAIMS

These WLO and WK claims cover the northeast extension of the quartz veins at Beaverlodge lake. They lie along the quartz vein system 2 miles northeast and 2 miles southwest of the head of Stairs bay, Hottah lake.

The rock on the claims is largely biotite granite in which are small areas of altered, older feldspar porphyry. Altered gabbro in three northeasterly trending bands, up to several hundred feet wide, also occurs in the granite. Quartz veins up to 400 feet wide are traceable across the claims. They cut both granite and gabbro and at many places form large stockworks. Fine-grained diabase dykes cut the veins and in places lie within them about parallel to the edges. They are probably the same age as the diabase dyke that occurs on Bee No. 3 claim. Quartz veinlets carrying hematite and pitchblende cut these dykes.

Pitchblende was seen in seven widely separated places on the claims and in some at more than one point. The only metallic mineral accompanying it in important amounts is hematite, with which it is as intimately associated as on the Tatee and Bee No. 3 claims. The greatest amount of pitchblende seen at any one place was on the northwest part of claim WLO 12, where a quartz vein, up to 4 inches wide, striking east and dipping 30 to 50 degrees north, is exposed in a shallow pit. The vein could be traced 50 feet west and 100 feet east of the pit. It lies in gabbro, which is crossed by a network of other quartz veins. In addition to the quartz vein the pit for a distance of 25 feet shows at intervals a band of material, up to 3 inches wide, containing thin seams, up to ½ inch, of pitchblende-hematite mixture. A sample from this claim, probably from this locality, sent to the Mines Branch at Ottawa for testing purposes, assayed 13·70 per cent U_3O_8[1]. Other occurrences grade down in size from that described to a single $\frac{1}{16}$-inch pitchblende seam that borders a veinlet of comb quartz for a few inches. In most places the pitchblende is in veinlets that cut the diabase dykes or the older gabbro. These are undoubtedly the most favourable rocks for its occurrence. Veinlets of quartz cutting granite usually contain hematite only. An exception,

[1] Communication from the Ore Dressing Division, Dept. of Mines, Mines Branch, Ottawa.

pitchblende in granite, on claim WLO 4, may be explained by the fact that the granite over a width of several inches is altered to chlorite schist along a small shear and is thus in places similar in composition to the basic rocks.

The deposits so far discovered are not in themselves of economic importance. In places they might be profitably worked by selective mining for a few feet from the surface, but they are too small for profitable underground mining. The main hope for profitable mining depends on the discovery of more continuous pitchblende-bearing fracture zones in the gabbro. The widespread distribution of pitchblende on these claims suggests that somewhere a larger deposit may have formed. Any larger zone would need to have a northeasterly strike in order to have appreciable length in the favourable rock. In the survey, indications of such zones were noted at one place, though there may be others. This is near the western edge of claim WLO 12, where a pit sunk on a hematitic zone beside a basic dyke in a quartz vein shows a broader zone of fracturing.

Camsell River District

WHITE EAGLE SILVER MINE (OTTER GROUP CLAIMS)

A brief description of this property has been given in an earlier report[1]. The discovery is on a sloping rock ledge on the north bank of Camsell river, 9 miles above its mouth.

The rocks along this part of Camsell river are volcanics of the basement complex cut by porphyry dykes and small bosses of intrusive rocks of several kinds and ages. Along both banks of the river east and west of the mine are outcrops of andesitic volcanics, largely tuffs and agglomerates. At the entrance of the main adit, and for 100 feet west along the shore and at least several hundred feet inland, a massive, dark greenish grey, fine-grained diabase outcrops. At the shore 100 feet west of the adit this rock is in contact with tuff. The contact is rather faint and irregular although sharp. The diabase on account of its form and character is thought to be an intrusive cutting the volcanics, though perhaps nearly contemporaneous with them. In thin section it has a porphyritic trachitic texture, and sodic plagioclase phenocrysts in a fine-grained groundmass of smaller plagioclase laths form a felt with uralite and an iron-oxide mineral. Pyrite is widely disseminated and there are a few relict grains of olivine.

The vein lies in the diabase and is a fracture zone that strikes north 40 to 45 degrees west and dips 70 to 75 degrees northeast. Development work consists of an adit that, starting at the river bank, crosscuts 40 feet to intersect the zone, which is then followed northwest for 300 feet. At 175 feet from the mouth of the adit there is a second crosscut which runs northeast for 110 feet. In this latter crosscut there is a vertical winze 100 feet deep and at its foot another crosscut runs back southwest to the fracture zone. Drifting on the zone at this bottom level has been done since the property was visited.

[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 29.

The fracture zone exposed in these workings and on the surface varies in width from 1 inch to 3 or 4 feet. A fault, presumably of no great magnitude, appears to have broken the rock, in places along two or more closely spaced planes, and caused some shattering of the walls and included blocks. Near the mouth of the upper drift chlorite is abundant along the plane of shear. Solutions entered along the channels thus produced, and formed veins in the main planes of fracture and a swarm of veinlets in the jointed and shattered walls. In the western part of the adit there are in places three such veins up to 15 inches wide, which with the intervening breccia occupy the full width of the drift. At 240 feet from the adit mouth a sharp, right-angled twist in the vein and a second twist back to its former course indicate a pre-vein cross fault with a few feet displacement.

Silver is the economically important mineral at the White Eagle mine. Native silver was found abundantly in one surface trench, and also on the adit level 60 feet below the surface occurrence, where the length and width of the shoot were much greater than on the surface. Drifting on the level at the foot of the winze had not been done at the time of the writer's visit, but has since been completed without, it is said, finding the downward extension of the ore shoot. Further operations have been suspended.

The vein mineralogy is complex. The gangue minerals are quartz of at least two generations, and manganiferous dolomite, pale pink in colour, very coarsely crystalline in places, with cleavage surfaces up to 3 inches long. The dolomite was analysed with the following results[1]:

	Per cent
Insoluble	17·52
Metals	—
Fe_2O_3	0·69
Al_2O_3	0·12
FeO	1·16
MnO	2·12
CaO	24·93
MgO	14·96
CO_2	38·08
	99·58
This is equivalent to:	
$FeCO_3$	1·87
$MnCO_3$	3·44
$CaCO_3$	44·52
$MgCO_3$	31·42

The following primary metallic minerals are present: pyrite, arsenopyrite, chalcopyrite, sphalerite, galena, native bismuth, bismuthinite, safflorite-rammelsbergite, hematite, native silver, and argentite.

The vein at many places exhibits banding and crustification. The vein section where complete has an outermost band of manganiferous dolomite against the wall-rock and this band commonly holds many fragments of the latter. Adjoining this band and often having an indefinite contact with it is a fine-grained, white to pale pink, opaque quartz band of variable width. Its inner edge has a selvage of tiny crystals of glassy quartz and there are strips of clear quartz within it paralleling the walls.

[1] Analysis by Division of Chemistry, Mines Branch, Dept. of Mines, Ottawa.

Wall-rock fragments are also embedded in this band. Pink dolomite is the most abundant central filling, but in some places a white, coarsely crystalline carbonate occupies this position, and in others quartz of a later generation occurs. Vugs, wherever present, are lined with quartz crystals, some of which are amethystine.

Pyrite, chalcopyrite, sphalerite, and galena are disseminated through the wall-rocks of the vein and rock fragments within it. The same association of minerals is likewise found in the contact aureole of the granite stock a mile to the northeast, and both are, therefore, inferred to have the same origin. Arsenopyrite was found at one place in carbonate and at another was noted along with chalcopyrite in the early quartz. Its place in the mineral sequence is not clear. In one specimen native bismuth surrounded by bismuthinite was seen in a veinlet of pink dolomite. Chalcopyrite and galena as coarsely crystalline masses, up to several feet long, occur between quartz walls in the centre of the vein as well as in wall-rock. Zoned grains and rosettes of safflorite-rammelsbergite, often with niccolite nuclei, occur in the pink dolomite of the central filling. Another cobalt-nickel mineral, unidentified, though possibly glaucodot, occurs in the early quartz. Hematite forms a film on quartz crystals of the second generation. Native silver occurs mainly in quartz of the earlier, fine-grained, banded variety. It is distributed evenly in the quartz as tiny wires, which polished sections show have replaced the quartz along cracks. It is especially abundant where a country-rock fragment is embedded in the quartz. Some chloritic fragments of country rock were particularly favourable for deposition for they are now largely silver. Silver is also present at some places associated with niccolite, which it has replaced in marked preference to other cobalt and nickel minerals. Where niccolite and silver occur in carbonate the silver is always closely associated with the niccolite. Argentite, like hematite, is present on second generation quartz crystals, occurring as thin, iridescent, readily flexed films. It is present also as crystals, up to $\frac{1}{8}$ inch long. In one thin section it was seen as a replacement of the unidentified cobalt-nickel mineral noted above.

The silver is localized in a shoot in the vein. Abundant silver at the sharp twist 240 feet from the mouth of the adit, and in places where wall-rock fragments are embedded in the early quartz, indicate the conditions favourable for deposition. The upward narrowing of the fracture zone, shown by the narrowing of the vein, may have formed a natural trap for ascending metalliferous solutions. The more intensely fractured conditions where the silver shoot occurs may have determined a route of most active circulation of mineral solutions, but this channel in whole or in part may have been blocked above, perhaps by deposition, and the silver remaining in solution deposited in the vein below the obstruction. If this tentative interpretation is correct, then the places to search for more silver are those where pre-mineral disturbance was especially intense and particularly where such places lie below constrictions in the fracture zone.

HOW GROUP CLAIMS

A brief description of the mineral occurrences on these claims was given in an earlier report.[1] This group lies east of the Otter group in which is the White Eagle mine. The workings are on claims How 4 and 5. The country rocks were considered to be probably volcanics, and the discovery of tuff and agglomerate beds now confirms this. Further work has been done on a vein in which silver was found in 1932. A shaft has been sunk by hand steel for 60 feet on a zone of fracturing and some shearing. This zone, 6 inches to 3 feet wide, strikes north 75 degrees east and dips 80 to 85 degrees north. The vein lies along the fracture zone and comprises a network of carbonate veinlets, individually up to 8 inches wide. The principal gangue mineral is manganiferous dolomite similar to that at the White Eagle mine. An analysis[2] of this gave:

	Per cent
Insoluble	2·74
Metals	—
Fe_2O_3	0·97
Al_2O_3	1·06
FeO	1·06
MnO	2·89
CaO	29·87
MgO	16·88
CO_2	44·48
	99·08
This is equivalent to:	
$FeCO_3$	1·71
$MnCO_3$	4·68
$CaCO_3$	53·34
$MgCO_3$	35·45

Residuals of an earlier quartz gangue are seen under the microscope. The metallic minerals are pyrite, chalcopyrite, sphalerite, galena, native bismuth, argentiferous bismuthinite, and native silver. Pyrite, sphalerite, and some chalcopyrite and galena are disseminated in the chloritic wall-rocks of the vein and, like the same minerals at the White Eagle mine, may be associated with the granite here one-quarter mile northeast, and be unrelated to the subsequent mineralization. Chalcopyrite has relict pyrite grains; sphalerite occurs as veinlets in chalcopyrite. Native bismuth, argentiferous bismuthinite, and galena occur intimately associated in masses within the carbonate. They are evidently somewhat later than the carbonate, for they occur along cleavage planes. The bismuth usually exhibits striated crystal faces. The bismuthinite is an unusual variety that carries considerable silver. Microchemical tests show definitely bismuth and silver, probably lead, and possibly antimony. Assays from material rich in bismuth and bismuthinite and without visible silver gave over 1,000 ounces of silver to the ton,[3] thus tending to confirm the presence of a bismuth-silver mineral. Galena in places fills the interstices of a mesh of fine bismuthinite needles and without etching is indistinguishable from them. Bismuthinite surrounds native bismuth. Native silver is present in tiny leaves in joints in country rock near the vein. In 1932 it was found alongside the vein at the crest of a hill in an area then

[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 30.
[2] Chemical Division, Mines Branch, Dept. of Mines, Ottawa.
[3] Communication from C. Riley.

described. In 1934 it was found in a similar position 100 feet west of the first locality and at the base of the hill. Its relations to the other minerals are not clear. Its localization may be due to north-striking cross fractures near these two positions. One such fracture was noted just east of the eastern occurrence, another is inferred to lie 10 to 20 feet west of the second locality, where there is a covering of post-glacial silts. As at the White Eagle deposit the more open channelling at the intersections of the main fracture with cross fractures may have directed the silver-bearing solutions, and the chloritized wall-rock may have acted as a precipitant.

ELITE GROUP CLAIMS

These claims are on the south bank of Camsell river opposite the White Eagle mine. Native silver was found late in 1932 on the Elite No. 2 claim and was explored in 1933 by trenching. The locality is one mile south of the White Eagle mine adit.

The rocks in this area are mapped as volcanics and sediments. At the silver locality, however, the rock is a feldspar-quartz porphyry in a band, 500 feet wide, outcropping in a low, rocky ridge that trends southeast. At the north base of the ridge and paralleling it, bedded greywacke of the basement complex dips 30 degrees south. On the south side andesitic greenstone of the same group is cut by dykes of the porphyry. The porphyry is pink to grey and contains well-formed orthoclase phenocrysts up to one-half inch long, and smaller quartz grains in a microcrystalline groundmass. As far as determinable, it is mineralogically a quartz latite. This porphyry is younger than several other intrusive porphyries that occur as small masses in the district and have not generally been mapped. Pyrite is sparsely disseminated in all these rocks. As at the White Eagle and How properties the granite to the east is considered to be the source of the pyrite. Younger than all these rocks is a 6-foot porphyritic diabase dyke that lies on the south slope of the porphyry ridge.

Five fractures trending east to east-southeast cross the porphyry mass. The longest can be followed 400 feet east and 150 feet west of the later diabase dyke; the others can be traced 20 to 200 feet east of the same dyke, but run beneath drift to the west. One of the latter lies 90 feet north, and the other three within 200 feet south, of the longest fracture. The long fracture was formed before the dyke because it is displaced 6 feet horizontally by the dyke and the dyke itself is unfractured.

These fractures are filled by veins, ½ to 12 inches wide, which likewise are not found in the dyke. The gangue minerals are crystalline quartz and a pale buff-coloured carbonate that partly replaces it. Chlorite occurs in the wall-rocks. The metallic minerals, other than the pyrite of the wall-rock, are chalcopyrite, safflorite-rammelsbergite, gersdorffite (?), galena, native silver, argentite, covellite, and a mineral previously tentatively named boulargerite, but which on further work cannot be identified. This mineral is dark grey and has a prismatic habit like stibnite. Bismuth is the major constituent and lead and copper are essential.

The chlorite in the walls was formed by the vein-depositing solutions either before or along with the vein materials themselves.

The cobalt-nickel minerals occur in quartz, and commonly have their usual concentric shell structure. They are veined by chalcopyrite, native bismuth, and the unidentified bismuth mineral. Native silver is present in wires interstitial to tiny quartz crystals, which it replaces. Galena, chalcopyrite, and argentite occur in carbonate gangue, which replaces quartz and the cobalt nickel minerals. Covellite probably is a result of surface alteration.

Silver is the only metal of economic importance. It was seen in three of the veins, including the longest, and is reported to occur in a fourth. It is present in quartz as patches of abundant wires and these masses have lengths up to 12 feet, and widths from a fraction of an inch to a rare maximum of several inches. Greater amounts of high-grade silver will have to be found for mining to be profitable.

All the silver is close to the north side of the diabase dyke, which suggests that the dyke influenced its deposition. Yet this apparent relation may be misleading and the silver may have been present in the fractures before the dyke came in. Although the dyke certainly post-dates the fractures it is not necessarily later than the vein-filling, but the absence of mineral occurrences within it rather suggests that it is.

Echo Bay District

In the following section dealing with this district only those properties are mentioned about which there is geological information additional to that in the 1932 report.

THE ELDORADO MINE (COBALT GROUP CLAIMS)

Two previous reports[1] contain information on this property. Since 1932 underground development has been done, a mill built, and production of concentrates started.

The property is at Labine point, the northwest cape of Echo bay. The oldest rocks on the point are much altered, fine-grained sediments and volcanics of the Echo Bay group, the oldest known group in the district. They have been extensively altered by feldspathization and introduction of pyrite, chlorite, magnetite, biotite, and other minerals characteristically developed near granodiorite stocks. The granodiorite which caused the alteration at Labine point outcrops in an area scarcely 100 feet in diameter on the east side of Labine bay. Granite occurs on the west side of the point and aplite dykes cut the older rocks. A still younger intrusive, a diabase sheet, outcrops on an island off the end of the point.

Several fracture and shear zones converging to the east-northeast cross the rocks of the Echo Bay group on the point. They contain quartz, carbonates, and at places metallic minerals. Adjacent to the No. 2 zone on the point the high-temperature suite of minerals is more abundantly developed than in more distant rocks, so that the zone must have started to form before their introduction. Movements in the zone did not stop

[1] Geol. Surv., Canada, Sum. Rept. 1931, pt. C, p. 61; ibid., 1932, pt. C, pt. 19.

at least until after the aplite dykes from the west side of the point had formed, for the zones cross the dykes.

The mineralogy of the deposit is complex. Thirty primary metallic minerals are recognized and several others have so far remained unidentified. The principal gangue minerals are quartz, dolomite, and ferruginous rhodochrosite. The following are partial analyses of the two carbonates.

—	I	II
	Per cent	Per cent
MgO	18·53	5·00
CaO	28·53	0·97
MnO	....	38·74
Mn	0·52	
CO_2	44·50	38·3
Fe	3·12	9·13
BaO	0·01	
Cu	0·28	

I. Dolomite.
II. Ferruginous rhodochrosite.

The quartz is of several kinds. The earliest is massive white quartz with occasional hematite rosettes. This is cut by red hematitic quartz veinlets. A third variety occurs as crystals of alternately banded milky and glassy quartz. Mineralization took place in stages as follows[1]:

(1) High-temperature rock alteration, with introduction of feldspar, pyrite, magnetite, biotite, etc.
(2) Quartz, pitchblende, hematite, molybdenite, and minor cobalt-nickel minerals (glaucodot, polydymite, and gersdorffite).
(3) Comb quartz in veinlets with smaltite-chloanthite and skutterudite in large zoned crystals, cut by later cobaltite. Dolomite with native bismuth and chalcopyrite fills the vein centres. This type is not quantitatively important.
(4) Dolomite followed and replaced by ferruginous rhodochrosite, and together accompanied by a wide variety of metallic minerals as follows: niccolite, sphalerite, galena, tetrahedrite, freibergite, bornite, chalcopyrite, chalmersite, chalcocite, stromeyerite (Ag_2S Cu_2S), jalpaite (3 Ag_2S Cu_2S), argentite, hessite (Ag_2Te), and native silver. Small amounts of barite, witherite, and fluorite are present.
(5) Weathering at the surface formed many additional minerals, among which are covellite, azurite, malachite; manganese, uranium, and uranium-copper minerals; carbonate crusts, and a very little native silver.

Mineralization of stages 2 and 3 is represented in the three main shear zones at Labine point. That of stage 4 is known only in the No. 2 zone, mainly in the northeast part. Here there is a break in the depositional sequence between the quartz and pitchblende and the later dolomite and still later rhodochrosite.

Mining development at the property has been principally on the No. 2 zone. A crosscut 415 feet long was driven to intersect the northeast part of No. 2 zone at a depth of 90 feet. The zone was then followed 360 feet northeast and approximately 800 feet southwest, reaching the surface

[1] Abstracted and modified from "Mineragraphy of the Ores of Great Bear Lake", by D. F. Kidd and M. H. Haycock, Bull. Geol. Soc. Am. 46, pp. 879-960 (1935).

again on the south slope of the point. A vertical winze was started in 1934 and at the year's end it was reported that stations had been cut at 125 and 250 feet and drifting started on these levels. A 50-ton concentrator was started in December 1933, drawing ore from dumps and from a stope on the adit level. In 1934 it was enlarged to 75 tons. Production from December 1933 to the close of boat navigation 1934 was approximately 75 tons of pitchblende-silver concentrates, which were shipped to the company refinery at Port Hope, Ontario.

ECHO BAY GROUP CLAIMS

These claims adjoin on the northeast the Cobalt group, on which is the Eldorado mine. They were staked in 1930 for Consolidated Mining and Smelting Company. The mineral deposits on them and their development have been described in previous reports.[1]

The rocks are tuff, dacite, feldspar porphyry, and fine-grained, banded sediments, all belonging to the Echo Bay group. Like those at the Eldorado mine they all show extensive alteration of the same high-temperature type.

Six shear and fracture zones, five of which trend northeast, have been found in an area 2,000 feet long and 600 feet wide that extends across the crest of a prominent hill. The deposits occur in these zones as veins or stockworks. Some movement has occurred after mineral deposition as there are gouge seams beside the veins and in places the metallic minerals are crushed. Movement has been small, however.

The mineralogy is complex and similar to that at the Eldorado mine. The minerals may be grouped as follows:

(1) Feldspathization of country rock and extensive development of chlorite, pyrite, magnetite, biotite, garnet, actinolite, probably arsenopyrite, and locally sphalerite, chalcopyrite, and galena.

(2) Quartz, pitchblende, probably safflorite-rammelsbergite and chalcopyrite, and possibly marcasite.

(3) Manganiferous carbonate and sphalerite, galena, niccolite, tetrahedrite, chalcopyrite, bornite, smaltite-chloanthite or skutterudite, stromeyerite, argentite, and native silver.

(4) Supergene managanese, copper, and uranium minerals.

The carbonate of Group 3 has largely attacked and replaced the quartz of Group 2. It is the most abundant vein filling. A quartz vein several feet wide with chalcopyrite and bornite, in the 300 zone[2] is of uncertain position in the mineralization sequence.

Argentite and other silver minerals are the most economically important in the deposit. Pitchblende also occurs in the northeasternmost zone (500 zone), but the amount is not large; about one ton has been hand-cobbed and sacked. Until 1934 development was by trenching and short-hole diamond drilling. In 1934 a crosscut tunnel was commenced on the north slope of the hill, which it was expected would cut a northeast extension of the 400 zone (*See* Map, 1932) at a depth of 85 to 100 feet below the outcrop.

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[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 22. *See* Map.

[2] Geol. Surv., Canada, Sum. Rept. 1931, pt. C, p. 66; ibid., 1932, pt. C, p. 21.

M. GROUP CLAIMS (BEAR EXPLORATION AND RADIUM COMPANY, LIMITED), CONTACT LAKE

These claims are on the north shore of Contact lake, 5 miles southeast of Cameron Bay settlement in Echo bay. The deposit on them was previously described.[1]

At the workings the rock is a massive, medium-grained granodiorite or quartz-diorite that forms part of an elongated stock extending northwest for several miles. Massive, medium-grained, pink granite outcrops a few hundred feet south beyond a swamp. It is stated that the granite intrudes the granodiorite.[2] A zone of fracturing up to 3 feet wide cuts the granodiorite, and strikes north 75 degrees east up the face of a rocky hill. The dip at the surface is steeply south, but in the underground workings in places is reversed. It has been traced 350 feet on the surface and its probable extension located for several hundred feet farther. The zone has been explored underground throughout a length of 480 feet by an adit from the base of the hill. On a second level below, several hundred feet of drifting has been done.

The zone of shearing and fracturing is cemented by a vein 12 to 20 inches wide underground and somewhat narrower at the surface. The wall-rocks are highly chloritized granodiorite with some magnetite, biotite, and pyrite, and in places chalcopyrite. The veins are banded in places parallel to the walls, and crustification is evident in the final filling.

The mineralogy is complex. The principal gangue minerals are quartz of at least two ages and two kinds of manganiferous carbonate. White, massive quartz with specular hematite and wall-rock fragments forms the edge of the vein. The principal vein filling is a manganiferous, pink carbonate or possibly two carbonates. This has invaded and replaced the quartz. An analysis of it gave:

	Per cent
Insoluble	10·76
Metals	—
Fe_2O_3	3·80
Al_2O_3	1·15
FeO	10·86
MnO	27·06
CaO	6·40
MgO	5·24
CO_2	34·22
	99·49

This is equivalent to:

$FeCO_3$	17·52
$MnCO_3$	43·84
$CaCO_3$	11·42
$MgCO_3$	11·00

As the material was not examined microscopically, it is possible that it includes two carbonates, such as dolomite and ferruginous rhodochrosite replacing dolomite, as at the Eldorado mine. Irregular masses of red

[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 24.

[2] Personal communication from G. M. Furnival, mine geolo...

to pale grey, cherty quartz occur in this pink carbonate. They have rude, sinuous, band-like forms, making complete rings in some places. Some of the bands are faulted and recemented by pink carbonate so the quartz may be of the earlier generation. Where the pink carbonate does not fill the vein, late quartz crystals up to an inch long line the remaining cavity. At their bases is a narrow, red, hematitic (?) band. On these quartz crystals in turn a white, coarsely crystalline, manganiferous calcite occurs. An analysis of this carbonate gave:

	Per cent
Insoluble	0·94
Metals	—
Fe_2O_3	1·92
Al_2O_3	1·39
FeO	5·73
MnO	11·53
CaO	27·17
MgO	9·91
CO_2	42·91
	101·50

This is equivalent to:

$FeCO_3$	9·24
$MnCO_3$	18·68
$CaCO_3$	48·52
$MgCO_3$	20·81

The following metallic minerals have been found in the vein and wall-rocks; pyrite, magnetite, hematite, arsenopyrite, pitchblende, safflorite-rammelsbergite, skutterudite (?), cobaltite (?), glaucodot, niccolite, native bismuth, chalcopyrite, tetrahedrite, bornite, chalcocite, covellite, argentite, stromeyerite, hessite, native silver, and polybasite (?). Surface alteration products comprise malachite, azurite, supergene manganese minerals, and cobalt and uranium bloom. The early quartz gangue contains pyrite, arsenopyrite, hematite, safflorite-rammelsbergite, skutterudite (?), cobaltite (?), glaucodot (?), and pitchblende. Native bismuth occurs in cracks in it but may be later. The pink carbonate contains chalcopyrite, bornite, and the silver minerals in the form of scattered blebs. Of the silver minerals, native silver is the latest and most abundant. It is especially so in chloritic spots, which are remains of wall-rock inclusions. Some occurs in the chloritic wall-rocks of the vein as small leaves. Tetrahedrite and niccolite were only seen in single specimens, but they probably belong to the pink carbonate stage.

Silver is the economically important mineral at this property. Pitchblende has been found only in one small lens at the surface. Development has aimed at a thorough search of the zone for sufficient minable shoots of silver ore to warrant a mining operation. Some have been found.

BONANZA GROUP CLAIMS

These claims are at Dowdell point. There are two deposits one-half mile apart. In 1934 development of the eastern one was undertaken by the El-Bonanza Mining Company. The only information obtained since

1932[1] is the analysis of carbonates that occur with the native silver at each place. The analyses are as follows:

—	I	II
	Per cent	Per cent
Insoluble	10·96	17·34
Metals	1·14	—
Fe_2O_3	3·06	0·36
Al_2O_3	2·76	0·06
FeO	0·29	—
MnO	3·18	0·13
CaO	41·50	45·90
MgO	0·56	0·07
CO_2	35·38	36·05
	98·83	99·91
Equivalent to:		
$FeCO_3$	0·61	—
$MnCO_3$	5·15	0·21
$CaCO_3$	74·11	81·96
$MgCO_3$	1·18	0·15

I. White carbonate with silver from the western Bonanza deposit.
II. Nearly white carbonate from a fluorite and silver-bearing vein at the eastern Bonanza (El-Bonanza) deposit.

The carbonate from the El-Bonanza deposit is unique among all the carbonates associated with silver in the region in not being manganiferous.

BUD GROUP CLAIMS

These claims are 6 miles northeast of Labine point and are on the east side of a lake locally known as Sparkplug lake. The showings are on the northeast corner of Bud No. 5 claim, approximately one-quarter mile southeast of the east bay of Sparkplug lake. A series of pits and drill holes have been placed to explore a mineralized zone of fracturing reported to be auriferous.

The country rocks are brown argillite and fine-grained, impure quartzite. Near the fracture zone they contain chlorite and some serpentine. The zone is cemented by quartz veinlets and they as well as the wall-rock contain pyrite, chalcopyrite, pyrrhotite, and hematite. Native gold as a single, minute speck in pyrite was seen under high magnification. Some white carbonate occurs with the quartz. The zone has been found at intervals for 250 feet and is up to several feet wide; it is irregularly, but on the whole sparsely, mineralized. Erratic, at places high, values in gold are reported. The occurrence is of interest on this account and because of the presence of the mineral pyrrhotite which is not known to the writer to occur elsewhere in this district. The deposit may be associated with the granodiorite and unrelated to the silver deposits, but at present this is only speculation.

WORKMAN ISLAND DEPOSIT

The pitchblende deposit exposed at Workman island is of no economic importance, but its genesis is of significance. The occurrence, which is on Maple No. 1 claim, is in a giant quartz vein on the east side of

[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 26.

Workman island just south of the narrows in McAlpine channel. The vein cuts granite which it has altered extensively to chlorite. Including stockworks it is 300 feet wide, of which 120 feet is solid quartz. It is cut by a 15-foot diabase dyke. Some distance south of the dyke a little pitchblende was found in a stockwork of the vein at the junction of two chloritic shear zones, 1 to 6 inches wide. In 1934 only a few yellow uranium and green copper stains were to be seen in the bottom of a pit, a foot deep. Quartz of the second generation associated with a little hematite occurs where the stockwork is sheared.

HINTS TO PROSPECTORS

Sediments and volcanics of the oldest group are without doubt the most favourable places to prospect for silver and pitchblende, as the deposits so far found are mainly in these rocks, and associated minor intrusives. Some small pitchblende deposits and one minor silver occurrence are in fractures in basic dykes. Economically important deposits of this type have not been found in other rocks in the region. The feldspar and feldspar-quartz porphyries are but little more favourable for prospecting than the granites to which they are chemically rather similar. Hematite-bearing quartz veins, large and small, are nearly as common in granites and porphyries as in the older rocks, but even small deposits have rarely been found in them.

At Beaverlodge lake quartz veinlets that cross alternating bands of diabase and granite were found to carry pitchblende in the diabase, but only hematite in the granite. From this observation a tentative generalization was made that basic or chloritic wall-rocks are specially favourable for the deposition of pitchblende and silver. This was tested on the other known deposits and is apparently valid. The Eldorado, Consolidated Mining and Smelting Company (Echo Bay group), Bonanza, Bear Exploration and Radium (M group), and White Eagle deposits are in fracture and shear zones in which the wall-rocks are much more altered to chlorite than the rocks away from the zones. This alteration is considered to be earlier, and from a different source, than the deposition of pitchblende and silver. In detail, too, the silver in many places is most abundant in chloritic spots in the vein. The hypothesis also well explains the mode of occurrence of a pitchblende deposit on the Thompson claims at Echo bay[1] where the mineral lies in a fracture in a basic dyke that cuts granite.

Pitchblende is not always characterized by prominent yellow stains as is sometimes assumed. The stains may be leached away at the surface and throughout a foot in depth. The surface material if mixed with hematite may closely resemble hematite, though the streak will be brown rather than red.

South of the previously known areas of sediments and volcanics at Great Bear lake is an area at Hottah lake and a small one at Beaverlodge lake. The present survey has shown no other considerable area of these rocks along the canoe route as far south as Mazenod lake. The older

[1] Geol. Surv., Canada, Sum. Rept. 1932, pt. C, p. 26.

rocks extending from Mazenod lake south nearly to Emile river are mainly porphyries in the north and sediments in the south. Another area of sediments lies along Emile river. Sediments on the west shore of Marian lake are largely quartzose and in places altered to gneiss, and thus appear relatively unfavourable for mineral occurrences. In these areas the more chloritic sediments and any volcanics, or in general any green or dark greenish grey, moderately soft, rocks, are well worth examining for quartz veins carrying pitchblende.

Southward from Camsell river to Rae the temperature of formation of the large quartz veins becomes higher; the low temperature, rhythmically banded comb quartz, becomes scant and finally is no longer present. With its disappearance goes the likelihood of the occurrence of the rather low temperature type of silver deposits found at Great Bear lake. The older rocks south of Mazenod lake are, therefore, considered relatively unfavourable for silver deposits of this type.

Considerable values in gold have been reported in assays from Great Bear lake. In the reported occurrences examined the veins were massive quartz with chalcopyrite, bornite, or pyrrhotite. From the appearance of the quartz the veins reported auriferous at Great Bear lake were formed at relatively high temperatures. Farther south in the map-area conditions of regional metamorphism progressively become more intense. Hornblende as an altered product becomes more common than chlorite; pegmatites become common in the granites; lit-par-lit gneisses and schists appear along granite contacts; the porphyries are coarser grained. These higher temperature conditions may at one time have favoured the formation of gold deposits.

The abundance of brown tourmaline in pegmatites in granite for 50 miles north of Rae, and the occurrence of muscovite-bearing, nearly feldspar-free pegmatite suggest that prospectors watch for the tin mineral cassiterite. This is sometimes difficult to distinguish casually from brown tourmaline.

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