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GEOLOGY AND MINERAL DEPOSITS
OF THE
BIRD LAKE AREA

Lac du Bonnet Mining Division
Manitoba

by
J. F. DAVIES

WINNIPEG
1955

Province of Manitoba

DEPARTMENT OF MINES AND NATURAL RESOURCES

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TABLE OF CONTENTS

	Page
Introduction	1
Previous investigations	2
References	2
Present study	3
Acknowledgements	3
Topography and drainage	4
General geology	4
Table of formations	6
Rice Lake Group	7
Andesite, basalt, tuff; derived schists	7
Greywacke, tuff, quartz-mica schist	10
Arkose	12
Silicified zones	12
Intrusive rocks	14
Bird River sill	15
Granitic intrusives	17
Age relations of granite	18
Pegmatite	20
Diabase, trap	21
Structural geology	22
Folding	22
Faulting	23
Mineral deposits	25
Base metal deposits	26
Occurrence and distribution	27
Mineralogy	27
Gangue minerals	28
Mineral relationships	28
Grade of deposits	29
Faulting of deposits	30
Origin of sulphide deposits	30
Maskwa Nickel Chrome Mines Limited	32
History of development	32
Chance deposits	34
Martin-Devlin deposits	34
Colossus 1517 Claim	35
Wento Claim	36
Colossus 3 deposit	36
Lucky Boy Claim	37
Petra Chromite Limited	37
Chromite deposits	37
Petra Chromite Limited	38
Maskwa Nickel Chrome Mines Limited	39
Pegmatite mineral deposits	39
Lithium deposits	40
Tin deposits	42
Beryl deposits	43
Economic possibilities of the pegmatites	43

GEOLOGY AND MINERAL DEPOSITS OF THE BIRD LAKE AREA

INTRODUCTION

With the recent widespread search for base metal deposits in Canada and renewed interest in Canadian sources of lithium, the area around and north of the Winnipeg River has again been receiving the attention of prospectors and mining companies. Falconbridge Nickel Mines Limited (through its subsidiaries, Maskwa Nickel Chrome Mines Limited and Sudbury Northrim Exploration Company Limited), Hudson Bay Mining and Smelting Company Limited, Conwest Exploration Company Limited, and God's Lake Gold Mines Limited have all been active in this field.

Surface mapping, geophysical surveying, and diamond drilling have been done on several properties. Present indications are that some of these can be developed into producing mines.

An important factor influencing future production from all types of deposits found in this region will be the economical treatment of the ores. Beneficiation of the chromite ore will be necessary in order to raise the chrome-iron ratio. The intimate intergrowth of quartz and spodumene in the lithium-bearing pegmatites presents an extraction problem. Incomplete investigations on the copper-nickel ore from the property of Maskwa Nickel Chrome Mines Limited indicate that extraction of the metals by the pyro-metallurgical methods used in the Sudbury area would not be economical. The company reports, however, that studies of other metallurgical processes offer hope for economic treatment of this ore.

As an aid to the development of this region the Manitoba Mines Branch plans to map, on a scale of 1,000 feet to the inch, an area along and north of the Winnipeg River, bounded by longitude 95° 30' W and the Manitoba-Ontario boundary, and latitudes 50° 20' N and 50° 30' N. The present report, dealing with the first of four contiguous map areas, covers the northwest quarter of the larger region just outlined.

The area under study is situated about 35 miles northeast of Lac du Bonnet, and may be reached from there by road to Bird River and thence by canoe up the river. It may also be reached by aircraft based at Lac du Bonnet.

PREVIOUS INVESTIGATIONS

Geological investigations in southeastern Manitoba have been made intermittently since 1912, when E. S. Moore made a reconnaissance survey of the main water routes. Following the discovery of base metal sulphides near Bird Lake in 1920, H. C. Cooke examined and mapped a small area in the vicinity of the deposits. Between 1922 and 1929, a large part of southeastern Manitoba was investigated by J. F. Wright. Deposits of tin, lithium, and beryllium were discovered during this time.

In 1942 chromite deposits were discovered north of Bird River and at Euclid Lake. J. D. Bateman and G. M. Brownell investigated these occurrences. Drilling at the west end of Bird Lake by Petra Chromite Limited in 1944 revealed large deposits of chromite.

In 1948 and 1949 G. D. Springer mapped a large area between Maskwa Lake and the Winnipeg River. The writer, in 1951, mapped the area to the west of that done by Springer. The mapping of both Springer and the writer was done for the Manitoba Mines Branch.

Maps of the area published by the Geological Survey of Canada were on a scale of 4 miles to the inch (Moore) and one mile to the inch (Cooke, Wright) and those by the Manitoba Mines Branch, one-half mile to the inch.

Besides the main projects mentioned above, and listed below, numerous articles referring to specific minerals and mineral locations, have been published.

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Moore, E. S. : Region East of the South end of Lake Winnipeg; Geol. Surv., Canada, Sum. Rept. 1912, pp. 226-270.

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Wright, J. F. : Geology and Mineral Resources of Oiseau River Area, Manitoba; Geol. Surv., Canada, Sum. Rept. 1924, pt. B.

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Bateman, J. D.: Bird River Chromite Deposits, Manitoba; Trans. Can. Inst. Min. and Met., Vol. 46, pp. 154-183, 1943.
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PRESENT STUDY

As mentioned previously, this report is concerned with the first of four adjacent map areas in the Bird Lake-Winnipeg River region. The field mapping was conducted in conjunction with C. M. Allen, seasonal geologist with the Manitoba Mines Branch and lecturer in Geology at Mount Allison University, Sackville, New Brunswick.

Mapping was done on aerial photographs enlarged to 1,000 feet to the inch. Traverses were run at 400-foot intervals; outcrops and geology were plotted directly on the photographs. Considerable time was spent on examination of the various mineral deposits in the area.

The base map, on to which the geology was transferred from the aerial photographs, was prepared from township surveys, claim surveys, the survey of the interprovincial boundary, and the aerial photographs. Further control, useful both in the field mapping and compilation of the base map, was obtained from chained picket lines cut by Sudbury Northrim Exploration Company Limited, in the west part of the area, north of Bird River.

ACKNOWLEDGMENTS

The writer wishes to express his gratitude to the officials of Maskwa Nickel Chrome Mines Limited for the use of the buildings on their property. Helpful information about the Chance-Devlin sulphide deposit was obtained from this company. Through the courtesy of Petra Chromite Limited, the writer was provided with the results of drilling along the chromite zone at the west end of Bird Lake. Mr. H. Tageson and

Mr. H. Johnson of Bird River P. O. offered many courtesies which are greatly appreciated.

Besides C. M. Allen, whose collaboration has already been mentioned, capable and efficient assistance in the field was rendered by W. R. Purdy and F. de Forest, students at the University of Manitoba, and C. H. Riddell and D. Russell.

TOPOGRAPHY AND DRAINAGE

The topography of the area is characterized by low outcrops, few with relief of more than 50 feet, separated by stretches covered by swamp, muskeg, and glacial drift. Through most of the area, outcrops are fairly numerous and generally well exposed. South of Bird Lake there are fewer outcrops than elsewhere in the map area.

Bird River, which is navigable by canoe during the entire summer season, drains westward into Lac du Bonnet. The few portages along the river are well cut and frequently used by tourists and campers travelling to Bird Lake.

Tree growth consists largely of spruce, jack pine, balsam fir, poplar, and birch. There are several stands of large timber in the area. During June, 1954 a violent windstorm felled a great number of trees in many places; this made land travel difficult.

Deer are particularly numerous throughout the area. Several moose were seen during the summer. Migratory waterfowl are abundant along the streams and on Bird Lake. Fish, mainly pike and pickerel, are plentiful in the lakes. Other species include perch, tullibee, and common sucker.

GENERAL GEOLOGY

Intermediate to basic volcanic, and clastic sedimentary, rocks of the Rice Lake group underlie the greater portion of the area mapped. These are intruded by sill-like bodies of gabbro and peridotite. The Rice Lake group and basic intrusives have been invaded by large bodies of granitic rock.

The Rice Lake group appears to have been folded into a syncline whose axis lies within the sedimentary rocks of the group. Consequently, the sedimentary rocks overlie the lavas, an interpretation contrary to that of Springer (1949, p. 5).

Some of the rocks of the Rice Lake group have been replaced by granitic material, especially near the large bodies of granite. Numerous dykes and sills of pegmatite intrude the Rice Lake group in the southeastern part of the area.

Faulting has affected all the rocks of the region. Several east-west strike faults have been recognized, and probably others are present. Transverse faults, striking north - northwest, are abundant in the area north of Bird Lake.

Deposits of base metal sulphides are closely associated with the peridotite and gabbro, and occur almost exclusively along the contacts of these rocks with the granite. Chromite occurs near the top of the peridotite portion of the Bird River basic complex.

Interesting occurrences of cassiterite, beryl, and lithium-bearing minerals are found in the pegmatite dykes.

The accompanying table of formations indicates the classification of rocks within the area. In accordance with a previous interpretation for the area to the west (Davies, 1952, p. 6) all the rocks in the present area are considered Archaean in age. This is in contrast to the custom of the Geological Survey of Canada, which considers that the intrusive rocks might be Proterozoic.

TABLE OF FORMATIONS

<table>
<tr><td colspan="2">Recent
and
Pleistocene</td><td>Glacial clay and sand</td></tr>
<tr><td colspan="3">Great Unconformity</td></tr>
<tr><td rowspan="5">A
R
C
H
A
E
A
N</td><td rowspan="3">Intrusive

Rocks</td><td>Trap, diabase
Pegmatite dykes and sills
Granite, granodiorite,
quartz diorite</td></tr>
<tr><td>Intrusive Contact</td></tr>
<tr><td>Hornblende gabbro
Peridotite, pyroxenite,
hornblendite</td></tr>
<tr><td></td><td>Intrusive Contact</td></tr>
<tr><td>Rice
Lake
Group</td><td>Silicified rocks
Arkose
Greywacke, tuff, quartz-mica
schist
Andesite, basalt, derived
schists</td></tr>
</table>

RICE LAKE GROUP

Rocks of the Rice Lake group occupy a belt three to four miles wide along Bird River and are flanked on both sides by granitic intrusives.

The lavas, andesite and basalt, and derived schists occur on the north and south sides of the belt; the central band consists of clastic sedimentary rocks -- arkose, greywacke, tuff, and quartzose schists.

There does not appear to be any definite interbanding of the volcanic and sedimentary rocks of the Rice Lake group. Generally the contacts are well marked, frequently by zones of shearing. A band of sedimentary rock occurs within the lavas at Rush Lake. This may represent interbanding but it is equally possible that the relationship between the volcanic and sedimentary rocks may be due to folding.

Besides the normal volcanic and sedimentary rocks there are irregular, sometimes long, bands of light- to dark-coloured, fine-grained siliceous rocks which are thought to represent silicified sediments in some places, silicified lavas in other places. Considerable pyrrhotite occurs in parts of some silicified zones.

Andesite, basalt, tuff; derived schists (1)[1]

Narrow bands of massive andesite occur north of Bird River. Some of these represent remnants in gabbro, peridotite, and granite. A few pillows occur in these flows. In general, the lavas north of Bird River are less altered than those in the south part of the area.

The volcanic rocks south of the belt of sedimentary rocks show varying degrees of recrystallization and alteration. Schistosity is much more prevalent in these rocks than in those to the north. In places, the volcanic schists have been granitized to some extent. Pillow structures which are common in these recrystallized lavas and schists, are preserved, in places, in the granitized lavas.

Some beds of tuff are interbedded with the volcanic schist south of Bird River. These are only a few feet wide and

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1 Numbers in parenthesis refer to rock units on accompanying map.

frequently are difficult to distinguish from schistose andesite.

The massive, fresh-looking, andesite, such as occurs north of Bird River, is a fine- to medium-grained, dark green to dark grey rock which outcrops in hummocky outcrops up to 50 feet high. Some of the medium-grained varieties resemble fine-grained gabbro but flow features, normally pillow structures and flow contacts, can usually be found in the andesite. No porphyritic, amygdaloidal, or fragmental volcanic rocks are known to occur in the massive andesite.

Under the microscope the andesite is seen to consist essentially of plagioclase and hornblende with minor disseminated magnetite. The plagioclase, andesine, occurs as laths, rods and tablets with random orientation. The hornblende may occur as pale green flakes interstitial to the plagioclase, or else, where very abundant, as intergrown ragged grains. In the sections examined both the hornblende and plagioclase were fresh in appearance.

Although the altered volcanic rocks south of the sedimentary ones do not greatly resemble the lavas north of Bird River in appearance, the two are correlated on the basis of composition and stratigraphic position.

The altered lavas are recrystallized to hornblende-plagioclase schists, in places exhibiting a streaky foliation and an ill-defined lineation. A thick, crude banding is present in some of these rocks. Generally, the schists are lighter in colour than the massive andesite; a grey cast to the usual green colour is present in the schists and lacking in the massive lavas.

In places, the streaky nature of the hornblende-plagioclase schists is well-defined. Elsewhere, though present, it is obscure. This streakiness is caused by long, narrow lenses of light- and dark-coloured rock. The light lenses contain a higher proportion of feldspar than normal, the dark bands, more hornblende. These streaks measure an inch or so wide by several inches or feet long. Thin ribbon-like bands, clots, and lenses of quartz, sometimes mixed with feldspar, also commonly occur in the schists, parallel to the foliation. They have the appearance of injections. Usually, fine hornblende is concentrated along the edges of the quartz lenses. This forms the dark streaks in the schist. The boundaries between the light- and dark-coloured lenses generally are gradational. The streaked effect is apparently due to metamorphic segregation, in which the quartz ribbons and lenses have been a factor in effecting the diffusion of elements to form hornblende.

In the area between the east end of Bernic Lake and Osis Lake the volcanic rocks are strongly foliated and granitized to varying degrees. In one place highly granitized pillow lavas retain the outlines of elongated pillows. The whole outcrop is essentially granitoid in texture and composition, except for the pillow selvages which are dark green to black and consist largely of hornblende. The centres of the pillows are composed of a medium-grained mosaic of quartz and albite-oligoclase, together comprising 80 per cent of the rock, with patches and flakes of hornblende and biotite. Accessory minerals include apatite, sphene, carbonate, and magnetite.

Most of the granitized lavas are fine-grained, light grey rocks often remarkably similar to a sedimentary rock in texture and banding. They do not, however, resemble any of the sedimentary rocks found in the area mapped, and occur largely in the southeastern part of the area where pegmatite dykes and granite stringers are numerous. They grade along strike into less-altered and thence into non-granitized lavas.

These fine-grained granitized lavas consist largely of quartz, plagioclase, and biotite. The quartz and feldspar form a granular aggregate; the biotite occurs as minute brown flakes showing rough parallelism. Small patches and veinlets of coarse-grained quartz occur throughout the rock. Chlorite, epidote, garnet, tourmaline, and magnetite occur in some specimens.

North of the east part of Bernic Lake there is a zone of indefinite outline in which fine grey rocks contain abundant small white grains of feldspar, as in a fine-grained porphyry. This rock extends westwards from the place where the granitized pillow lavas occur. Fine granular quartz and feldspar, with numerous tablets of oligoclase and abundant aligned flakes of biotite make up the bulk of the rock. Small amounts of epidote, muscovite, carbonate, and magnetite are present. This rock may be a fine-grained intrusive porphyry or a porphyritic lava flow. On account of its irregular distribution, and patches of andesite which it encloses, the porphyry is probably intrusive.

South of Bernic Lake the hornblende plagioclase schist is in fairly sharp contact with the granite. The only effects noticed were thorough recrystallization, some bleaching, and the production of red garnets near the contact.

Greywacke, tuff, quartz-mica schist (2)

The rocks of this unit constitute the lower members of the sedimentary portion of the Rice Lake group. They are in contact with the southern volcanic belt but do not come into contact with the volcanic rocks north of Bird River. The boundary between these sedimentary rocks and the gabbro, along Bird River, is entirely drift covered. A fault is exposed on the only outcrop where the granite and greywacke can be seen in contact.

Different rock types making up this map unit are: fine-grained, dark brown, thinly laminated schistose greywacke, fine-grained light to dark brown knotted cordierite schist, fine- to medium-grained dark grey to black greywacke and schist, dark green tuff, fine- to medium-grained light to dark brown quartz-mica schist, and a few unusual types discussed later.

These rocks are usually interbedded with one another. However, certain types are more abundant in some parts of the area than in others. Fine schistose greywacke and cordierite schist are common along Bird River in the western part of the area, and, in general, along a belt, up to one-half mile wide, just north of the volcanic rocks. The medium-grained brown and black quartz-mica schist and greywacke are most abundant in the eastern half of the map area, particularly in the northern section of the sedimentary rocks. The tuff and unusual rocks mentioned above are nowhere especially abundant.

The fine-grained dark brown thinly bedded greywacke is also finely schistose. Beds range from a fraction of an inch up to an inch or so wide; the schistose structure is parallel to the bedding. Except for the presence of abundant cordierite knots, most of the cordierite schist is very similar to the schistose greywacke. Normally the cordierite knots are about one-quarter inch in diameter and more or less round in shape.

In the fine-grained schistose greywacke, oligoclase, quartz, and ferromagnesian minerals occur in about equal amounts. The ferromagnesians, biotite and minor hornblende, occur as aligned flakes interstitial to the quartz and feldspar. The cordierite in the cordierite schist contains abundant inclusions of quartz, biotite, and in some specimens opaque grains of unknown composition.

The medium-grained brown quartz-mica schist is more thickly bedded than the fine schistose greywacke. In places bedding is obscure; elsewhere, especially where interbedded with fine greywacke, it is distinct. Fresh and weathered surfaces of this rock show little colour difference, both being grey to dark brown. Schistosity is not nearly as pronounced in the medium-grained schist as in the fine-grained schistose greywacke. Like the fine-grained type, the medium-grained rock consists of about equal quantities of quartz, plagioclase, and aligned biotite. A little muscovite is present in some sections.

Dark grey to black, medium-grained greywacke generally is poorly bedded and displays good to poor schistosity. In other respects it closely resembles the brown quartz-mica schist. The dark colour is due to a high proportion of deep brown biotite and, in some specimens, hornblende. Accessory minerals include carbonate, epidote and sphene. Small red garnets are present in some of the dark greywacke.

The tuff, which is interbedded with the greywacke in places, is a fine-grained, well-bedded, schistose, dark green rock composed of aligned blades of green hornblende with microscopic bands and irregular areas of quartz and acid feldspar. Minor biotite and a few grains of sphene are scattered throughout the rock.

Along the south shore of Bird River close to Bird Lake, a black fragmental-looking rock is exposed at the water's edge. This same rock outcrops in places along the south shore of Bird Lake. It is characterized by egg-shaped masses of cordierite up to 1½ inches long by ½ inch in diameter. These ellipsoids of cordierite contain abundant quartz and biotite inclusions, and are set in a dark grey groundmass of fine quartz and aligned biotite. Several grains of pink garnet occur in the groundmass and a few are embedded in the cordierite. A few grains of magnetite and chlorite are present.

South of the rapids downstream from Bird Lake, outcrops of interbedded tuff, cordierite schist, and light brown, medium-grained greywacke are cut by numerous small stringers of quartz. In these sedimentary rocks, as in some of the hornblende-plagioclase schists described earlier, there is a distinct concentration of amphibole adjacent to these quartz stringers.

Most of the rock types of this map unit contain a few pink garnets in places. Certain beds, associated with the dark medium-grained greywacke along the south shore of Bird Lake are highly garnetiferous. These beds outcrop on a small island 4,000 feet from the east edge of the map-area, and on the lake-shore east of the island. Some beds consist of about 75 per cent garnets in crystals up to 2 inches in diameter. Most of them are a fraction of an inch across. Some bands within the garnet rocks contain disseminated pyrrhotite. The garnet beds alternate with siliceous bands, amphibolite bands, and magnetite-rich bands. Jack Nutt Mines Limited is reported to have obtained, in 1929, assays showing a trace of tin from the garnet-rich rocks.

Arkose (3)

Arkose occupies the central part of the sedimentary section of the Rice Lake group and stratigraphically overlies the greywacke and related rocks. Wide bands and thin beds of arkose are interbedded with some of the greywacke, and, similarly, beds of greywacke commonly are interstratified with the unit mapped as arkose.

Two distinct textural types of arkose are readily distinguished; one is fine- to medium-grained, the other is coarse grained. Gradations between the two types exist. The fine-grained arkose is mostly well-bedded; individual beds measure an inch or so in width. Some greywacke is usually interbedded with the fine-grained arkose. Coarse-grained arkose generally occurs in thick massive beds, and greywacke is never found interbedded with it. In places, the coarse-grained arkose is difficult to distinguish from granite, especially where evidence of bedding is obscure. Large, clear, white or grey, sometimes bluish grey, quartz "eyes" are a prominent feature of much of the coarse-grained arkose.

Both fine and coarse arkose range from light to dark grey in colour. Usually there is a light brownish or orange cast to the weathered surfaces of these rocks.

The arkose consists of 75 per cent or more of quartz and acid feldspar, both showing great variation in shape and size of grains. These minerals are accompanied by sericite, muscovite, and biotite flakes. Small amounts of epidote, magnetite, and tourmaline may be present. Some of the feldspar is microcline, the rest, albite and/or orthoclase. The micas are generally aligned, thus contributing to the schistose structure of the rocks. Nowhere, however, is schistosity very pronounced.

Silicified Zones (4)

Cream-coloured, dark grey, or black, fine-grained siliceous chert-like rocks form several bands within the sedimentary portion of the Rice Lake group. Two bands occur partly or wholly within the volcanic rocks. Some of the siliceous rocks exhibit thin delicate banding, others are entirely massive. Parts of some bands are of coarser grain than normal and have a sugary texture.

In places the siliceous rocks are interbedded with amphibolitic tuff-like bands. It is possible that these bands may represent metamorphic segregations of amphibole similar to those described previously.

Although these fine-grained siliceous rocks, especially the delicately banded ones, greatly resemble sedimentary chert deposits, there is considerable evidence that they actually are silicified greywacke, arkose, and lavas.

Both the structure and texture of the siliceous rocks can be directly related to the rocks with which they are associated. The delicately banded siliceous rocks occur within bands of thinly laminated fine-grained greywacke. The bands within the massive coarse-grained arkose are themselves massive and generally contain small glassy quartz "eyes" like those in the arkose. The chert-like bands within the volcanic rocks are massive and exhibit "ghost-like" areas of darker rock, apparently remnants of incompletely silicified lavas. This correlation of structure and texture is well exemplified by the band, south of Bird River, that follows along the contact between the sedimentary and volcanic rocks. The west part of this band, where it occurs within the thinly laminated greywacke, is delicately banded and very fine grained; the eastern part where it occurs within the volcanic rocks is entirely massive and sugary textured. The inference is that the structure is inherited from the rocks that were silicified.

There is some evidence that these silicified bands cut across the bedding of the sedimentary rocks. The band to which reference was just made cuts across the sedimentary rocks at a small angle. The band just south of the outlet of Bird River from Bird Lake cuts across the arkose and greywacke. Small cross-cutting projections from the main bands can be seen on several outcrops throughout the area. Small inclusions of unsilicified host rock are found within the silicified bands. In addition to the above features, which are indicative of silification, it is common to find small lenses of chert-like rock within the clastic sediments. These always occur in close proximity to the silicified bands and although they resemble elongated pebbles, they are probably dilated injections of fine-grained silica.

The composition and texture of these rocks indicates a non-sedimentary origin. Under the microscope they are seen to be composed of a fine-grained aggregate of quartz and albite, often with small amounts of muscovite and biotite. The quartz and feldspar are in the form of sharply angular mutually penetrating grains. Frequently the texture is characterized by jagged, angular, irregular grains of albite in quartz or quartz in albite -- a fine micrographic texture. It is common to find small tablets of albite, resembling phenocrysts, in the fine quartz-albite aggregate.

Contrary to the opinion of previous workers, the field relationships, composition, and texture of the siliceous rocks indicate that they are not chert, but silicified rocks.

It may be significant that silicified rocks like those just described occur along the contacts of one or two pegmatite dykes in the area. It can be seen, that, for the area as a whole, pegmatite dykes and extensive silicified zones do not occur in the same vicinity. Pegmatites occur in the east, silicified zones in the west, part of the area. One might speculate that the silicification is due to solutions derived from or related to pegmatite or granite at depth in the western part of the area.

Deposits of pyrrhotite are found in parts of some of the silicified zones. Usually some glassy granular vein quartz cuts the fine-grained siliceous rocks in these deposits. Thin bands of graphitic schist are present in some of the pyrrhotite-bearing zones. The pyrrhotite is either massive or disseminated throughout the rocks. Some pyrite and magnetite are commonly associated with the pyrrhotite. Valuable metals such as nickel or copper are not known to occur with the pyrrhotite but there are reports that K. E. Miller, during the early days of tin exploration, found small amounts of stannite in some of the silicified zones of the area.

INTRUSIVE ROCKS

Rocks which intrude the Rice Lake group include gabbro and peridotite of the Bird River sill, and various granitic intrusives; younger diabase dykes intrude the granitic rocks. There has been some controversy over the age relationship between the basic intrusives and granitic rocks. From evidence presented later the writer has concluded that the granite is younger than the peridotite and gabbro.

Within the body of granite north of Bird River there are bands and irregular areas of fine- to coarse-grained dark green rocks. Some of these are undoubtedly diabase or trap, intrusive into the granite. The relationship of others, some of which resemble andesite and some, gabbro, are obscure. They probably represent large inclusions within the granite but since there is some doubt of this interpretation it cannot be used in deciding the age relation of gabbro and andesite on the one hand, and granite on the other.

Bird River Sill (5, 6)

The complex of peridotite, gabbro, and related rocks is a sill-like body, intrusive into the Rice Lake group. Normally the peridotite underlies the gabbro. This has been found to be true of the gabbro-peridotite sill in the area to the west as well as the one presently under discussion. This relationship, however, is complicated in places. On the Saturn 2 claim gabbro lies on both sides of a narrow band of peridotite. East and north of the Wento claim there is a repetition of gabbro and peridotite, in which gabbro lies north of, south of, and in the center of the peridotite band. As in the area to the west it is possible that, in addition to the normal peridotite-gabbro complex, there were separate intrusions of gabbro in the area, which may account for the irregularities found in parts of the sill.

West of the Devlin claim there is a long, wide remnant of andesite within the peridotite. On the Chance claim just south of the granite contact a remnant of andesite is surrounded by the peridotite. East of there the andesite is in direct contact with the granite.

The peridotite is a soft, medium-grained, dark green to black rock in places massive, elsewhere schistose. The weathered surface is dark green or reddish brown in colour. Schistose peridotite is soft and rotten on surface. The minerals are all secondary; no trace of the original constituents was found. In the sections examined, fibrous serpentine and tremolite made up the bulk of the rock. These minerals along with pale amphibole, chlorite,carbonate, and magnetite form a felted aggregate. In places bands of massive hornblende in large green or black crystals up to one inch across occur within the peridotite. Such hornblendite is present near the peridotite-granite contact on the Chance and Devlin claims. Some pyroxenite is found at the top of the peridotite in the southern part of the Colossus 3 claim. At this locality normal peridotite, coarse pyroxenite, and medium-grained pyroxenite form successive bands, to the south of which lies the gabbro. The pyroxenite consists largely of augite with minor intersititial tremolite and a few grains of carbonate.

Though closely delineated on several outcrops, the actual contact between gabbro and peridotite was not observed. It is marked by a narrow drift-filled depression.

The gabbro section of the sill is composed of various phases differing in grain size and proportions of amphibole and plagioclase. The most common phase is a medium- to coarse-grained rock consisting of about equal amounts of labradorite and green hornblende, with accessory magnetite, sphene, epidote, and biotite. For the most part the minerals are fairly fresh.

A second phase, consisting of the same minerals, is very coarse-grained, mottled gabbro in which patches of feldspar, up to an inch or more across, are separated by coarse interstitial hornblende. This mottled gabbro grades into anorthositic gabbro in which feldspar constitutes 70 to 80 per cent of the rock, and into anorthosite containing 95 per cent labradorite. Thin sections of the anorthosite contained a few flakes of pale green amphibole, grains of carbonate, and small patches of perovskite-titanite aggregate. The feldspar, in large plates and tablets,had a composition of $Ab_{40}\ An_{60}$, labradorite.

No regular distribution of the various phases of gabbro were apparent from the field work, but, in general, the mottled and anorthositic phases occur mostly in the south, or top, part of the sill.

The peridotite-gabbro complex is of special interest on account of deposits of chromite and base metal sulphide, which it contains.

On the north shore of Bernic Lake, between the narrows and islands near the center of the lake, there is a narrow band of unusual gabbroic rock not shown on the map. Only a narrow width of this rock is exposed at the water's edge.

The rock is remarkable on account of the occurrence of round spheres of anorthosite set in a gabbroic matrix. Not all the anorthosite is spherical, some is ellipsoidal in shape. The spheres range in diameter from an inch or so up to 4 or 5 inches and form 25 per cent or more of the rock. The anorthosite consists of 85 to 90 per cent labradorite, $Ab_{40}\ An_{60}$, along with a little chlorite, clinozoisite, hornblende, carbonate, and sphene; thus it is very similar to the anorthosite of the sill. The matrix of the rock consists of labradorite and hornblende with minor biotite and magnetite. This matrix is similar to the medium-grained gabbro of the sill. The contact between the anorthosite spheres and gabbro matrix is sharp.

It is difficult to envisage how such a rock would form but the anorthosite spheres probably represent clusters of plagioclase segregated out of a molten gabbroic magma. Why they should assume the unusual shape of almost perfect spheres and ellipsoids is not known.

Granitic Intrusives (7)

The Rice Lake group and basic intrusives are bounded on the north by a large mass of granitic rock. Other granitic bodies invade the volcanic rocks south, southeast, and west of Bernic Lake. The edges of all the granitic intrusives trend parallel to the regional structure; none can be said definitely to cross-cut the older rocks, although stringers of granite do so.

Previous workers in the area have classified the granitic bodies according to various schemes. Cooke (1921, p. 120.) referred to the granite north of Oiseau River as "earlier", as distinguished from a "later" granite in other parts of southeastern Manitoba. His work did not include the Bernic Lake area so no reference is made to the granite there. The "earlier" granite was considered to intrude the Rice Lake rocks and to be intruded by the peridotite-gabbro complex.

Wright (1932) designated the granite north of Bird River as pink and pinkish grey granite, granodiorite, and granite gneiss. Springer (1949) considered this same body to be largely pink microcline granite, but he mentions the heterogeneous nature of the intrusive and notes gradations, over short distances, into other phases, oligoclase granite, quartz diorite, and granodiorite.

The intrusives south and west of Bernic Lake were mapped by Wright, and later by Springer, as partly porphyritic grey granite, quartz diorite, and granodiorite. Wright described the rock as being grey, medium grained, and equigranular to porphyritic. It was said to contain phenocrysts of oligoclase and orthoclase, with some phases being characterized by eye-shaped grains of quartz as well as phenocrysts of microcline.

The writer is unable to agree that there are any essential differences between the three granitic bodies as a whole. Rather, each is composed of various phases common to all. In general, grey and buff granitic rocks are most abundant in all three intrusives.

Only two very different phases can be distinguished readily in the field, one an older-looking, but not necessarily older, grey granite, the other a younger-looking but likewise, not necessarily younger, pink granite. Various intermediate phases, buff and pinkish grey in colour, are more common than these extremes but cannot be separated easily from the strictly grey and pink granites. In all bodies all these phases are equigranular in part and porphyritic in part. In places they are massive, elsewhere somewhat gneissic. However, no extensive areas of granite gneiss are known to occur in the area mapped.

Grey granite is composed essentially of plagioclase and quartz with 10 to 20 per cent ferromagnesian minerals, usually biotite, and in places, hornblende. Those specimens in which the plagioclase is albite are albite granite or, according to Johannsen, sodaclase tonalite. Where the plagioclase is oligoclase the rock is an oligoclase granite, or using Johannsen's classification, tonalite. Rocks having these compositions are not exclusively grey. In many places they are buff, pinkish grey, or pink in colour.

Specimens of microcline granite are pink and massive. In addition to quartz, microcline, and biotite, they may contain small amounts of albite or oligoclase.

Other phases, which range in colour from grey to pink, and can be distinguished only under the microscope, contain varying proportions of microcline and albite or oligoclase. Such rocks are classified as granodiorite and quartz monzonite.

From the descriptions of the granitic rocks it can be seen that types of different composition cannot be distinguished from one another on the basis of colour or texture. In the field no areas of any particular type can be outlined; rather the various phases appear to grade into one another.

Age Relations of Granite

The relationship between the volcanic schist and granite west of Bernic Lake leaves no doubt that this body of granite intrudes the volcanic rocks. There is a contact zone, up to 1500 feet wide, which consists of blocks and bands of schist and irregular intrusions of granite. This contact zone grades into old-looking grey granite and this, in turn, into fresher-looking buff and pink granite. Between the contact zone and normal schist there is a band of fine-grained chert-like rock, the same as that in some of the silicified zones discussed previously.

North of Bird River the relationship between granite and other rocks is less obvious. The contact between the granite and Rice Lake group is not well exposed north of Bird River.

The only information about the granite-andesite contact is obtained from examination of drill core.

Several thin sections revealed that the granite right at the contact with andesite has been crushed and recrystallized. This granite consists of a fine granular aggregate, of quartz and albite, containing large quartz "eyes" composed either of single grains or clusters of grains, and, in places, a few tablets of plagioclase. Other sections are largely coarse grained with small areas of fine material. Considering the fresh nature of the andesite near the granite, and the recrystallized nature of the contact granite, one might suspect that the granite is older than the lavas. However, this granulation is not common to the whole of the granite body but is confined largely to the contact.

The proportions and nature of the ferromagnesian minerals of the granite are significant. The granite in general, including that a few feet north of the contact, normally contains biotite scattered throughout the rock in moderate-sized flakes. In the contact granite, the place of biotite is taken by hornblende, usually in large grains, blades, and flaky clusters, which are cut by the fine-grained granitic material. The amount of hornblende is notably greater than the normal ferromagnesian content of the rock. This would appear to indicate the incorporation of andesitic material by the granite at the contact.

Granite and sedimentary rocks come into contact in only one place and the rocks at the contact are faulted. Pegmatite dykes and pegmatitic granite are intrusive into the sedimentary rocks in the southeastern part of the area.

The settling of the problem of the age relationship between the granite and Bird River sill is important in connection with the origin and deposition of the sulphide deposits in the area.

Cooke (1921) considered that the gabbro and peridotite were intrusive into what he called the "earlier" granite. As already noted the writer is unable to recognize an "earlier" and "later" granite.

Wright (1932) disagreed with Cook's interpretation and stated that the granite, apparently including that north of Bird River, was intrusive into the basic rocks. Springer (1949) concurred with Wright on this matter.

There are several places where the granite is fairly well exposed in contact with gabbro. Along the north boundary of the Bloom 8 claim the granite-gabbro contact is marked by a deep crack about one inch wide. The gabbro at the contact is the very coarse mottled type, so there is obviously no chilling of gabbro against granite at this locality. A few feet south of the contact several fine-grained granite stringers, an inch or so wide, intrude the gabbro. These have essentially the same composition as the normal coarse-grained granite. There are several other granite dykes cutting gabbro along the north shore of Bird Lake, always in close proximity to the large granite mass. Stringers of granite also cut the gabbro at the Wento sulphide deposit.

Granular quartz in the peridotite of the Chance-Devlin mineralized zone, adjacent to the granite contact, is probably related to the granite. Similarly, a felsite dyke in a narrow band of peridotite, not shown on the map, straddling the boundary of the Martin and Devlin claims, and lying between granite and andesite, is best related to the same source.

The abrupt manner in which the gabbro-peridotite sill terminates, at its west end, against the granite, indicates that it is cut off by this rock. It should be emphasized in this regard that there is no faulting along this granite contact.

The available evidence, presented above, clearly indicates that the gabbro and peridotite are older than the granite.

Pegmatite (8)

Pegmatite intrusives are common in the southeastern part of the area. Some of these are dykes that make a small to large angle with the trend of the enclosing rocks, some are sills, and others are irregular bodies. The pegmatite intrudes both the volcanic and sedimentary rocks of the Rice Lake group.

These dykes and sills range from a foot or less up to several hundred feet wide, and from a few tens of feet up to a mile in length. The irregular intrusive north of Osis Lake measures over 1500 feet wide and apparently is part of a large mass of pegmatitic granite to the east. Remnants of country rock, lavas or sediments, commonly occur within the pegmatite bodies.

Most of the pegmatite intrusives strike in a westerly direction. A few, such as the small dykes east of Bernic Lake and others along the north shore of the lake strike in a northerly direction. Dips range from almost vertical to very flat.

The pegmatite is of two types, microcline pegmatite, and albite pegmatite. The age relationship between the two is not known, but since they are associated in distribution they are probably related in origin.

The microcline pegmatite is a coarse-grained, massive, pink rock composed essentially of microcline and quartz. Only small amounts of biotite, muscovite, and albite are present in these rocks. Minerals of economic interest are not known to occur in the microcline pegmatite.

The albite pegmatites are pink, pinkish grey, grey, or white in colour. They are fine grained to coarse grained. Most dykes vary in colour and texture from place to place. Some are distinctly zoned; many have fine grained margins. The zoning of these pegmatites is discussed in greater detail in the section on pegmatite mineral deposits.

The essential constituents are albite, Ab_{95}, quartz, and white to pale yellow-green mica. The albite occurs as large plates and tablets or, in some dykes, as long narrow radiating laths. Quartz is glassy, milky white, clear, or grey in colour. The pale yellowish-green mica occurs in books and flakes closely associated with quartz. Chemical analysis indicates that this mica contains about 0.30 per cent Li_2O.

Besides the essential minerals mentioned above, phases of some of the albite pegmatite contain microcline. In places this mineral occurs only in small amounts, elsewhere it is about as abundant as albite. Black tourmaline, in large or small crystals, is present in nearly all the pegmatites, sometimes in large amounts. In places the tourmaline is a deep olive green translucent variety. Small blue apatite grains and a few red garnets are present in some dykes.

Besides the common silicate minerals, the following rarer minerals are found in many of the albite pegmatites: spodumene, amblygonite, lepidolite, petalite, triphyllite, purpurite, beryl, cassiterite, and tantalite. The occurrence of these minerals is discussed in a later section.

No direct evidence was found indicating the derivation of the pegmatite from any particular granite body in the area.

Diabase, trap (9)

A number of dark green or black fine- to medium-grained diabase and trap dykes, striking in a northwest direction, cut the granite north of Bird River. Besides those which can be more or less positively identified as intrusives there are irregular areas of andesitic and gabbroic rocks in the granite. These are shown as andesite and gabbro on the map but there is little evidence definitely relating them to the gabbro and andesite of the main volcanic belt.

The diabase consists of amphibole and andesine in varying amounts. Some sections contain about equal quantities of amphibole and andesine, in others amphibole may form 75 per cent of the rock. Diabasic texture was seen in some specimens.

STRUCTURAL GEOLOGY

FOLDING

Difficulty in deciphering details of folding arise from the scarcity of features suitable for top determinations. No features of use in this connection were found in the sedimentary rocks. In the volcanic rocks, although pillow lavas are common, they are useful in only a few places.

Despite deficiencies in structural data, there is sufficient information to suggest that the volcanic rocks and the rocks of the Bird River sill, in the north part of the area, dip and face towards the south. This is concluded from a few top determinations and the attitude of the differentiated gabbro-peridotite complex. A similar situation, based on the same type of evidence, was found to exist in the area to the west (Davies, 1952).

Based on a few, but reliable and consistent, determinations of tops of pillow lavas, the volcanic rocks in the south-central part of the area are shown to face north. Consequently, the volcanic rocks form a syncline, the centre of which is occupied by the overlying sedimentary rocks. Owing to lack of detailed structural determinations, the location of the synclinal axis is not known precisely, but it lies within the sedimentary rocks.

The sedimentary rocks all dip steeply southward at angles of 75 to 85 degrees. The south limb of the syncline, then, is overturned. Schistosity in the lavas and sediments is generally parallel to the bedding. Near the south edge of the area, however, there is a reversal of the dip of the foliation in the volcanic schists. South of Osis Lake the dip changes from about 80 degrees south to 80 degrees north across a distance of a few hundred feet. One top determination in this vicinity indicates a south-facing flow, which represents a departure from the regional attitude. It is probable that some minor tight folding occurs at this locality.

Positive evidence of conformity between the volcanic and sedimentary rocks is lacking. The north contact between these rocks is exposed at only one place, near the west edge of the map-area, and there it is faulted. The south contact is in large part occupied by a zone of silicified rocks, thus obscuring the relationship between lavas and sedimentary rocks. Where the south contact is exposed, and not silicified, some shearing appears to be present. However, there is no great angular unconformity between the volcanic and sedimentary rocks, but this does not constitute proof of conformity.

The age relationships between lavas, basic intrusives and acid intrusives has been established; the basic rocks intrude the lavas and both are intruded by granite. The sedimentary rocks are apparently younger than the volcanic rocks. Although pegmatite dykes intrude the sedimentary rocks, the relation of these latter rocks with respect to the pink and grey granite and the gabbro-peridotite sill is unknown. The sedimentary rocks are exposed in contact with the granite in only one place; there, the rocks at the contact are faulted. Gabbro and peridotite are not exposed in contact with the sedimentary rocks.

FAULTING

On the Wento and Colossus 4 claims at the west edge of the map-area the volcanic and sedimentary rocks are heavily sheared along their contact. This shear has been extrapolated to join a fault which displaces the section of the Bird River sill located northwest of there (Davies, 1952), and which exhibits considerable movement. This fault trends southeast and near the boundary of the Wento and Colossus 4 claims curves to a more easterly direction. It is assumed to terminate against a northwest-trending fault. Another northwest fault is thought to lie just southwest of the southwest corner of the Sun fractional claim. The existence of these last two faults appears to be the only satisfactory explanation to account for the abrupt termination of the various map units. East-west shearing seen at the south edge of a small peridotite outcrop between the two northwest faults probably represents the displaced segment of the major curving fault. A third segment of this major fault may occur along the contact of the gabbro and greywacke, and extend along this contact to join the strong east-west shearing on the Rita 1 claim and the south edge of the Perkon claim, near the centre of the map area.

The gabbro-peridotite intrusive in the present area represents a faulted segment of the Bird River sill in the area to the west. However, in the present area, the major northwest fault which caused the displacement does not come into contact with the peridotite and gabbro. The explanation for this is found in the pre-fault intrusion of granite into the basic rocks and post-granite faulting with both horizontal and vertical displacement of considerable magnitude.

A fault is shown on the map, southeast of the Wento claim, although there are no outcrops indicating why the formations are believed to be displaced. Outcrops just outside the area indicate that there is a small displacement of rock units on either side of the fault.

The post-granite nature of faulting is well illustrated by the faults west and north of Bird Lake. A large number of north-northwest faults cut the granite. Most of them are visible as distinct lineaments on aerial photographs, and generally can be seen on outcrops of the granite. Some of these faults dip steeply eastwards, others are essentially vertical. Slickensides on two of the faults near the east border of the area plunge southward at angles of 35 degrees and 40 degrees.

Two of the north-northwest faults, namely that which cuts diagonally across the Perkon claim and the one crossing the Rita 1 and Norah claims, are of particular interest on account of their effect, along with that of the east-trending fault at the south edge of the Perkon claim, on the gabbro, peridotite, and andesite. The movement of the block bounded by these faults is such that the andesite, gabbro, and peridotite have all been cut out, bringing the granite into contact with the sedimentary rocks along the east - west fault surface.

No trace of the north-northwest fault on the west side of the block can be found in the sedimentary rocks south of Bird River, and it is believed that it terminates against the east-west fault. The fault on the east side of the block probably displaces the east-west one. The north-northwest faults belong to the same system, and since one is cut by, and the other displaces, the east-west fault, it is concluded that both east-west and north-northwest faulting are essentially of the same age.

Near the northwest corner of the Wolf claim, east of the fault block just discussed, a small outcrop of granite is intensely sheared in an east-west direction. At the northwest corner of Bird Lake the base of a granite outcrop shows signs of shearing in the same direction. These two outcrops may represent exposures of a fault along the south contact of the granite.

Another east-west fault is shown, on the map, at the south contact of the gabbro near the outlet of Bird River. The east-west shear between granite and greywacke near the south edge of the Perkon claim does not extend into the gabbro to the east of the north-northwest fault, and either terminates against, or is displaced by, this fault. If displaced it possibly follows the gabbro-greywacke contact.

Some of the north-northwest faults in the granite north and west of Bird Lake appear to die out in the gabbro. East of there, however, the gabbro is displaced by these faults, the east sides of the fault blocks being stepped successively north.

It appears significant that none of the north-northwest faults north of Bird Lake are known to occur in the sedimentary rocks south of the lake. This may indicate that the strike fault, assumed to occur along the gabbro-greywacke contact along Bird River, extends eastward and underlies Bird Lake.

There is some evidence of other east-west faults in the area. North of the west half of Bernic Lake the contact between volcanic and sedimentary rocks is marked by a definite lineament. Shearing was seen in the sediments in one place along this contact, adjacent to the silicified band. Some of the other silicified bands are warped and deformed, probably representing silicified shear zones. This is especially apparent along the silicified zone north of Rush Lake.

The contact between the volcanic schists and cordierite schist along the south shore of Rush Lake is somewhat sheared. This same contact is exposed on a point on Osis Lake and there also the rocks are highly schistose. Some pyrrhotite and pyrite occur along this sheared contact.

Since the east-west shearing and faulting trends parallel to the bedding of the sedimentary rocks and the regional structure in general it is possible that there are many other strike faults which either do not outcrop or were not recognized in the course of the field work.

MINERAL DEPOSITS

Mineral deposits of three distinctly different types are found in the area. These are: 1) base metal deposits containing copper and nickel or copper alone, 2) chromite deposits,

3) pegmatite deposits containing concentrations of the lithium minerals, spodumene, amblygonite, triphyllite, and petalite, and of beryl and cassiterite.

Copper and copper-nickel deposits were discovered west of Bird Lake in 1920. Since that time considerable work has been done on some of these occurrences and exploration over the last few years has indicated the economic possibilities of some of them. No new surface discoveries have been made since the 1920's.

Lithium and beryl deposits were first discovered at Bernic Lake in 1925. Tin was found in pegmatites at Bernic and Rush lakes in 1928. Recent exploration and development of lithium-bearing pegmatites in Canada, and locally at Cat Lake, north of the present map area, induce an interest in those at the east end of Bernic Lake.

Possibilities of discovering chromite in the area were first recognized in 1942, following discoveries in the region to the west. Subsequent drilling of potential chromite zones confirmed the presence of large deposits of this mineral at the northwest corner of Bird Lake.

Besides the mineral deposits mentioned above, some of the silicified zones discussed previously contain large amounts of pyrrhotite. Since no minerals of economic importance, except perhaps traces of stannite, are known to occur in these pyrrhotitic silicified zones, no further mention is made of them.

BASE METAL DEPOSITS

Deposits of base metals occur at several places north of Bird River. The mineralized zone outcropping on the Devlin and Chance claims contains both copper and nickel sulphides. Those on the Wento, Colossus 3, Colossus, and Fisher claims contain copper but no nickel. Most of these deposits were discovered more than 30 years ago and some are better known by the former names of the claims on which they are located. The mineralized zone on the Colossus (1517) is known as the Cup Anderson deposit, that on the Colossus 3, as the Diabase deposit.

Recent geophysical work by Maskwa Nickel Chrome Mines Limited has revealed an electrical conductor between two locations, on the Chance claim and the Devlin claim, where sulphide mineralization outcrops.

Occurrence and Distribution

All the deposits, although for the most part not occurring in the granite, are closely associated with it in the sense that they occur at or within a few feet of the contact between the granite and older rocks.

The zone of copper-nickel mineralization lies along the contact between granite and peridotite. Most of the sulphides occur within the peridotite and related hornblendite but some occur in the granite. Although peridotite is not shown on the map at the outcrop straddling the boundary of the Martin and Devlin claims, there is a narrow band of this rock between the granite and andesite.

Most of the deposits containing copper but not nickel occur in andesite or gabbro along, or within, a few feet of the granite contact. That on the Fisher claim at the west end of Bird Lake occurs in peridotite a few hundred feet south of the granite.

The zones of mineralization vary from a few to about 100 feet wide and from a few hundred up to several thousand feet long. The Chance-Devlin zone, although not uniformly well-mineralized, has been traced by geophysical means for about 6,000 feet. Within the mineralized zones the sulphides generally are concentrated in lenticular bodies which on surface measure a few feet wide by a few tens or hundreds of feet long. Besides occurring in lenticular bodies, sulphides are also distributed as disseminated grains throughout the mineralized rock.

Some of the sulphide lenses that have been drilled are of considerably greater widths and lengths at depth than they are on surface, others are much narrower and shorter.

Mineralogy

The most abundant and widespread sulphide found in the copper and copper-nickel deposits is pyrrhotite. The copper-nickel deposits also contain pentlandite, chalcopyrite, and cubanite. The copper deposits contain chalcopyrite and cubanite, but not pentlandite. Some pyrite is found in most of the sulphide deposits. In addition to the sulphides there are variable amounts of magnetite in most of the base metal deposits. On the Wento and Devlin claims small patches and bands of massive granular magnetite are common. Elsewhere this mineral is disseminated throughout the rocks that contain sulphides. Maskwa Nickel Chrome Mines Limited report that several feet of magnetite were intersected in some drill holes along the Chance-Devlin mineralized zone.

At and near the surface the pyrrhotite usually has weathered, leaving a rusty gossan capping over the deposits. In addition, country rock carrying disseminated pyrrhotite is weathered to a soft, rotten, brownish green product. The pentlandite of surface samples exhibits widespread alteration to violarite.

Small lenses of quartz occurring along the shear on the Colossus 4 and Wento claims carry insignificant amounts of sphalerite and galena, as well as some chalcopyrite.

Gangue Minerals

The sulphides occur in peridotite, andesite, and to a small extent, granite. In the Chance-Devlin deposits there are narrow bands of coarse hornblendite that forms the host rock for some of the mineralization. In places other gangue minerals are present. Some of the peridotite is cut by veinlets and clusters of carbonate, and these commonly contain sulphides. At the boundary of the Martin and Devlin claims a narrow band of felsite contains some disseminated sulphides. At this same locality some of the sulphides are enclosed in a sugary quartz gangue. Vein quartz carrying copper sulphides is also common in the old Cup Anderson deposit. A small lens of vein quartz, in which no sulphides were seen, is exposed within the mineralized zone on the Chance claim. On this same claim, however, irregular quartz grains are mixed with carbonate and cut by pyrrhotite and chalcopyrite.

Mineral Relationships

The sulphide minerals were deposited later than the gangue in which they occur. Networks of intersecting pyrrhotite and chalcopyrite stringers are found cutting through the peridotite, hornblendite, andesite, granite, carbonate, and vein quartz. Sulphides also occur as solid massive lenses and as grains and blebs disseminated throughout these rocks and minerals. Not uncommonly, sulphides are found replacing the silicate minerals. Pyrrhotite and pentlandite in the Chance-Devlin deposits replace large hornblende crystals and penetrate between the cleavage planes of the hornblende. A specimen of granite from the north edge of the Devlin-Martin section contains biotite being replaced by sulphides.

The relationships amongst the metallic minerals are fairly simple. Pentlandite occurs as grains intergrown with, and stringer-like areas in, the pyrrhotite. Chalcopyrite is intergrown with pyrrhotite but stringers of chalcopyrite also cut the pyrrhotite. Cubanite is intergrown either as irregular grains or regular laths with the chalcopyrite.

Chalcopyrite was observed cutting grains of magnetite; on the other hand, small stringers of magnetite cut pyrrhotite, pentlandite, and chalcopyrite in some specimens.

Violarite, an alteration of the pentlandite, occurs only with this mineral. Generally, unaltered remnants of pentlandite are present with the violarite. In places, however, the pentlandite of surface samples is completely altered to violarite.

Grade of Deposits

Two ore shoots, on the Chance and Colossus 13 claims, outlined by drilling by Maskwa Nickel Chrome Mines Limited, are reported to average 1.15 per cent nickel and 0.32 per cent copper, and 1.15 per cent nickel and 0.29 per cent copper respectively (Maskwa Nickel Chrome Mines Limited, Annual Report, 1954).

Wright (1932, p. 95) reports that assays of channel samples cut at intervals of 75 feet for a length of 800 feet on the Martin-Devlin section of the Chance-Devlin zone averaged 1.0 per cent copper and 0.5 per cent nickel for a width of about 4½ feet.

Sampling of the old Cup Anderson (Colossus 1517) deposit by the Manitoba Copper Company in 1924 revealed 4.1 per cent copper for a width of 94 feet in one trench, and 3.8 per cent copper for 28.5 feet in another trench nearby. This deposit contains disseminated chalcopyrite, cubanite, and pyrrhotite.

Samples from two small sulphide lenses on the Wento claims averaged 5.2 per cent copper across 17 feet and 14 per cent copper across an average width of seven feet and length of 30 feet.

The sulphide deposit on the old Diabase (now Colossus 3) claim was estimated by Wright to average less than two per cent copper.

Faulting of Deposits

Faults, transverse to the mineralized zones, displace the deposits for a few feet on both the Wento and Cup Anderson (Colossus 1517) claims. No transverse faults are visible in the Chance-Devlin zone but drilling has revealed that the sulphide bodies on the Chance and Colossus 3 claims are displaced horizontally and perhaps vertically as well. The amount of displacement apparently is not great.

It will be recalled that several transverse faults have displaced the granite contact north of Bird River. It is possible that other transverse faults not recognized, displace the mineralized zones. Such faulting conceivably could occur on the Martin claim where peridotite occurs immediately west of the granite-andesite contact. Failure to trace the extension of the Cup Anderson deposit, by drilling, beyond its surface exposure suggests the possiblity of transverse faulting there.

Origin of Sulphide Deposits

Certain features of the copper-nickel and copper deposits suggest the probability that they were not formed by any simple process of magmatic differentiation. Both the copper deposits, and those containing nickel as well as copper are so similar that both types can be considered to be closely related in origin.

The association of copper-nickel deposits with the peridotite is obvious in the Bird River area; furthermore, the association of this type of deposit with ultrabasic and basic rocks is world-wide. Specifically, it appears that, on account of having similar ionic radii and the same valence, nickel and magnesium may substitute for one another in rocks high in magnesium. Apart from the nickel contained in orebodies, the content of nickel in basic and ultrabasic igneous rocks is much greater than in granites. It can be assumed with confidence that the source of nickel for the formation of deposits of this metal is the basic magnesium- and nickel-bearing rock or the magma from which this rock was derived. The mechanics of concentration into a nickel deposit, on the other hand, may have little to do with the process of crystallization of such a magma.

The close association of the sulphide deposits with granite has already been pointed out. This relationship is especially marked in the case of the Chance-Devlin zone, where the sulphides are concentrated in a band lying between peridotite (and andesite) and granite. In this connection two other features are pertinent: 1) that the granite is younger than the peridotite, and 2) that a few sulphides penetrate and replace the granite.

Small amounts of granular vein quartz, throughout which a few sulphides are disseminated, and which, in part, are cut by sulphide veinlets have been mentioned as occurring in the Cup Anderson, Devlin, and Chance deposits.

There is, then, a very definite relationship between the sulphide deposits and the granite, as well as the peridotite in the case of the copper-nickel deposits, and gabbro or andesite in the case of the copper deposits. Any explanation of the origin of the sulphides must take this into account.

Wright (1932, p. 93) has suggested that there were two periods of mineralization, "the first being associated with the intrusion and consolidation of the basic magma, and being characterized by the presence of nickel in addition to copper, and the second following or accompanying the granitic intrusion and being distinguished by the presence of copper without nickel."

Springer (1950, p. 5) makes the statement: "The mineralization was probably connected with the basic rocks of the region but some reworking is indicated as sulphides are present in granite at its contract with the earlier rocks."

Both of these writers imply that the sulphides, in part at least, were concentrated into deposits prior to the intrusion of granite. There is no evidence for this; on the contrary the available evidence suggests the improbability of such an origin. According to Wright's suggestion, no nickel, only copper, should occur in the granite, yet nickel as well as copper sulphides occur in this rock. Springer implies a redistribution, following the intrusion of the granite, of previously concentrated sulphides.

If the sulphide deposits were present prior to the intrusion of the granite it is difficult to understand why the granite should have invaded only to such a position that the edge of the intrusive coincided exactly with the zones of mineralization. On the Chance, Devlin and adjacent claims sulphides occur along the contact for a distance of over a mile. At three other places, on the Wento, Cup Anderson, and Colossus 3 claims the granite contact and sulphide deposits are in coincidence.

It must be admitted, then, that the sulphides, both copper- and nickel-bearing, were emplaced following or accompanying the consolidation of the granite, which had intruded after the crystallization of the basic intrusives. At the same time, the genetic relationship between copper-nickel deposits with magnesium-bearing rocks cannot be ignored.

It is suggested that, on account of reaction between granite magma and the consolidated basic rocks, or assimilation of these rocks by granite, the copper and nickel originally distributed throughout the basic rocks were concentrated into the sulphide deposits as they now occur. It is probable that the copper and nickel were originally bound in the silicates of the peridotite and gabbro. If this is so, the proposed mechanism would require the addition of sulphur from the granite or solutions derived from it.

That the actual process was by diffusion along concentration gradients, dependent on metallic melting points, thermal gradients, and chalcophile nature of copper, nickel, and iron, as suggested by Sullivan for some types of mineral deposits,[1] is a possible explanation of the mechanics of concentration.

This mechanism implies the assimilation of peridotite by granite, or reaction between peridotite and granite, as a result of which the copper and nickel originally distributed throughout the peridotite diffuse towards, or are pushed ahead of the granite into, the unassimilated basic rock. Such a process would be a reflection of the natural partition of copper and nickel between acid and basic rocks, these elements being about ten times as abundant in basic rocks as in granite. It is entirely possible that, originally, the copper and nickel were more abundant in the lower part of the sill, the part assimilated by the granite intrusive, although they were not originally concentrated into sulphide bodies. Some granular quartz and carbonate, which are found in the deposits, and which contain or are cut by sulphides, would be derived from the granite.

Maskwa Nickel Chrome Mines Limited

History of Development

Between 1920, when the copper and copper-nickel deposits of the Bird River area were discovered, and 1923, the

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1 Sullivan, C. J.: Metallic Melting Point and Ore Deposition. Ec. Geol., Vol. 49, no. 6, 1954.

Devlin Mining and Development Company did surface work on the Devlin and Chance deposits. In 1923 the Manitoba Copper Company was organized to explore the Wento and Cup Anderson deposits. This company did surface work at intervals until 1925.

In 1928 Ventures Limited optioned the properties of both the Manitoba Copper Company and the Devlin Mining and Development Company. Ventures conducted a Radiore survey and carried out trenching and diamond drilling. This work was discontinued late in the summer of 1929 and the options were dropped.

By 1930 numerous trenches had been excavated on the Chance, Devlin, Cup Anderson, Wento, and Diabase claims. In addition, shallow prospect shafts were sunk on the Wento and Chance deposits and a few diamond drill holes put down on the Wento, Cup Anderson, Devlin, and Chance deposits.

In 1935 the Great Falls Mining and Smelting Company Limited was incorporated to consolidate the holdings of the Devlin Mining and Smelting Company Limited and the Colossus Syndicate; these holdings consisted of the claims on which the Chance and Devlin deposits were situated.

Great Falls Mining and Smelting Company Limited, in 1936, optioned their property to the Northfield Mining Company who did 5,700 feet of diamond drilling in 21 holes on the Chance deposit.

Following this work, Stanmore Mining and Smelting Company was formed in 1937 to take over the holdings of Northfield Mining Company and Great Falls Mining and Smelting Company Limited.

In 1951 Maskwa Nickel Chrome Mines Limited was organized and acquired the property of Stanmore Mining and Smelting Company, in addition to other claims in the area, including that on which the old Cup Anderson deposit is situated.

Maskwa Nickel Chrome Mines Limited made detailed geological and geophysical surveys of its Bird River property. The results of these geophysical surveys indicated that a conducting anomaly extends from the Devlin claim on the west to the Colossus 15 claim on the east, along what is known as the Chance-Devlin zone.

A program of diamond drilling was commenced and, up to the end of 1953, 22,000 feet had been drilled, mostly on the Chance and Colossus 13 claims. The company, from the drilling combined with the 1935 drilling of the Northfield Mining Company, estimates that 1,350,000 tons of ore grading 1.15 per cent nickel and 0.32 per cent copper are present, on the Chance claim and those to the east, to the vertical drilled depth of 500 feet. The two shoots in which the ore is contained do not bottom at 500 feet, and may be laterally extended for short distances beyond the limits of drilling. The west section of the Chance-Devlin zone, between the Chance and Devlin claims has not yet been thoroughly drilled.

Chance Deposits

Both of the ore shoots mentioned above are exposed on the Chance claim. The eastern shoot outcrops near the east border of the claim. Diamond drilling traced it across the adjacent Colossus 13 claim. On surface the deposit lies along the contact between granite and peridotite and it follows this contact to depth. Most of the sulphides are in peridotite and associated coarse hornblendite. Where its total width can be determined on surface, the deposit measures 10 feet or less wide. The average width of the ore shoot outlined by drilling is 16 feet and it contains 775,000 tons of ore grading 1.15 per cent nickel and 0.34 per cent copper to a minimum vertical depth of 500 feet. A few holes gave true width intersections of 50 feet of well-mineralized peridotite.

The second shoot, containing 575,000 tons of about the same grade as above, outcrops at the west boundary of the Chance claim. On surface there are only a few small lenses of sulphide across a width of 4 to 6 feet. The average true width of the sulphide body outlined by drilling is 20 feet.

Minerals observed in these deposits are pyrrhotite, chalcopyrite, cubanite, pentlandite, pyrite, magnetite, and violarite. Pyrrhotite is the most abundant sulphide. The sulphides are distributed throughout the peridotite as disseminated grains, blebs, solid masses, and networks of narrow intersecting stringers. A few stringers cut the granite.

Martin-Devlin Deposits

The contact between the peridotite and granite, the locus of sulphide mineralization, is not exposed on the Dumbarton claim, separating the Chance from the Devlin deposits. A magnetic and electrical anomaly, however, occurs along this section, and sulphides again outcrop in two places on the Devlin claim.

Sulphides are distributed in a zone, 800 feet long, following the contact between andesite and granite astride the boundary of the Martin and Devlin claims. The mineralized band ranges in width from 20 to 40 feet, but heavily-mineralized sections are only a few feet wide on surface. The sulphides occur in andesite, felsite and a narrow band of peridotite between the andesite and granite. Coarse crystalline hornblendite carries some of the sulphides. A few sulphides are found in the granite. Besides the sulphides, small lenses of granular magnetite occur in the peridotite and hornblendite.

Grains of pyrrhotite, chalcopyrite, and pyrite are disseminated throughout the gangue. A few small lenses of massive solid sulphide can be seen in some of the trenches. The copper content of this deposit is higher than those on the Chance claim; the nickel content is lower. No pentlandite was recognized.

In the eastern half of the Devlin claim disseminated pyrrhotite and chalcopyrite are found in peridotite just south of the granite contact. Some sulphides occur in a granular quartz gangue, others in rusty, rotten peridotite. Apart from small patches well-mineralized with chalcopyrite, sulphides are not abundant on surface.

Colossus (1517) Claim

No recent work has been done on the old Cup Anderson deposit, located on the present Colossus (1517) claim.

Earlier work, including diamond drilling, was unsuccessful in extending the deposit very far beyond the single outcrop where it is exposed. The deposit occurs in andesite immediately south of its contact with granite.

The sulphides, chalcopyrite, cubanite, and pyrrhotite are distributed throughout schistose andesite containing considerable granular quartz. A large proportion of the sulphide occurs in the quartz. Chalcopyrite and cubanite are the abundant sulphides. Only small amounts of pyrrhotite are present. No nickel is known to occur in this deposit but the copper content is higher than in most deposits. As mentioned previously, averages of 4.1 per cent and 3.8 per cent copper were obtained across widths of 94 feet and 28 feet respectively.

The possibility that this deposit has been displaced by faulting was mentioned previously. It is further possible that, on account of the relatively low pyrrhotite content, significant magnetic anomalies may not be obtained over this type of deposit.

Wento Claim

Chalcopyrite and pyrrhotite in gabbro and andesite are distributed in small lenticular masses over an area a few hundred feet long and about 50 feet wide near the west edge of the Wento claim. Granite outcrops just north of the deposit and a few small stringers of granite cut the gabbro and andesite. Masses of titaniferous magnetite are present in the gabbro.

Chalcopyrite, mixed with pyrrhotite, cubanite, and a little pyrite, occurs in small solid masses. Narrow stringers and disseminated grains of sulphide are also present.

Early work on this deposit, by the Manitoba Copper Company, consisted of trenching and some diamond drilling. More recent work, by the Wento Syndicate, and Sudbury Northrim Exploration Company Limited, consisted of a magnetometer survey and a small amount of drilling. This work, confirming the results of earlier investigations, indicated that the sulphide bodies, though of good grade, are small.

The shear zone, lying along the arkose-andesite contact in the south part of the Wento claim carries some granular white quartz and chalcopyrite. On the adjacent Colossus 4 claim, a few small grains of sphalerite and galena were seen in the same shear zone. The mineralization appears to be too scanty to be of much interest.

Colossus 3 Deposit

At the south boundary of the Colossus 3 claim, pyrrhotite and chalcopyrite occur in schistose andesite at the granite contact. The east end of the mineralization lies right at the granite-andesite contact. Westwards the zone strikes into the andesite.

Sulphide mineralization is scattered over a width of up to 50 feet. The average width is about 12 feet, and the length about 300 feet. The deposit dies out along the granite-andesite contact on the east and passes beneath deep overburden on the west.

The pyrrhotite and chalcopyrite are heavily disseminated in lenses throughout the schistose andesite. Pyrrhotite is far more abundant than chalcopyrite. Many magnetite grains are distributed throughout the sulphides. No nickel is known to occur in this deposit. Old reports refer to this as the Diabase deposit.

Lucky Boy Claim

A short, narrow, vertical shear zone in andesite, a few feet north of the granite carries the sulphides on the Lucky Boy 7 claim (unsurveyed and located about 2,000 feet south of the Smelter 8 claim). The mineralized zone is about 150 feet long and 5 feet wide. The east end of the deposit lies at the contact between the granite and andesite.

The main sulphide is pyrrhotite; only minor chalcopyrite is present. Nodules of pyrite or marcasite are common in the weathered pyrrhotite.

Petra Chromite Limited

Copper mineralization is found in peridotite on the Fisher claim at the west end of Bird Lake. The mineralization occurs in rotten schistose peridotite on the north side of the outcrops south of a wide swamp.

Pyrrhotite, chalcopyrite, and pyrite are sparingly disseminated throughout the peridotite for a length of a few hundred feet. Although the sulphide content of the visibly mineralized rock is too low to be of great interest, the location of the mineralized zone in peridotite fairly close to granite, and the probable faulting just north of the zone, indicate that investigation beneath the swamp along the north edge of the deposit might be profitable.

CHROMITE DEPOSITS

Banded chromite deposits outcrop in the area to the west (Davies, 1952) and north of them at Euclid Lake (Springer, 1950). These deposits occur in the peridotite, always near the top of this portion of the Bird River sill.

No chromite was observed outcropping within the present area; the horizon, within the peridotite, at which the chromite should occur is largely drift-covered. However, diamond drilling of the upper (south) part of the peridotite has revealed the presence of chromite just west of Bird Lake and under the northwest part of the lake. Other occurrences are known along the section of peridotite between the Wilfred D claim and the

Queen 3 claim.

Petra Chromite Limited

This company owns the group of claims on which chromite occurs at the northwest corner of Bird Lake. The property was drilled in 1942 and a large tonnage of low-grade chromite is indicated.

The chromite occurs below the top of the peridotite. A few feet of pyroxenite lie between the gabbro and peridotite along this section of the Bird River sill.

The deposit consists of a series of closely-spaced chromite bands alternating with peridotite and chromiferous peridotite. Individual bands of dense and disseminated chromite, rarely measuring over two feet wide, have chromic oxide contents of 10 per cent or less up to 25 per cent. These alternate with bands of peridotite a foot or two wide. In places the peridotite bands are 5 to 10 feet in width.

The entire chromite-bearing section is over 7,000 feet long and averages about 45 feet wide. Drilling has indicated that the chromite zone occurs in several segments separated by transverse faults probably striking north-northwest and having displacements of a few tens of feet up to 300 or 400 feet.

The Bird Lake deposits differ from those in the area to the west, where the chromite occurs largely in a main band 6 to 10 feet wide, and to a lesser degree, in a narrower band about 25 feet below the main one. At Bird Lake the chromite occurs in more or less regularly spaced bands across the entire width of the deposit. Ten or more such bands, up to two feet wide, and grading up to 25 per cent chromic oxide occur within the chromite zone.

In estimating grade and tonnage of this deposit, it seems more practical to consider the entire width of the chromite zone rather than individual bands or groups of closely-spaced bands separated by a few feet of peridotite. On this basis it is estimated that these are close to three million tons of material, grading about seven per cent Cr_2O_3, to a depth of 200 feet, the approximate average depth to which the deposit was drilled. From the type of deposit and its persistence over such great length, it is probably safe to assume continuity to much greater depth.

Maskwa Nickel Chrome Mines Limited

The section of the Bird River sill between the Wilfred D and Queen 3 claims is held by Maskwa Nickel Chrome Mines, Limited. In 1952 this company did 2,356 feet of diamond drilling along the gabbro-peridotite contact. The drilling indicated that the chromite along this entire section is erratic in distribution. Most intersections, although of fairly high-grade chromite, were narrow.

PEGMATITE MINERAL DEPOSITS

The pegmatite dykes of southeastern Manitoba are widely known for the diversity of the less common minerals found in them. Lithium-, tin-, and beryllium-bearing minerals are found in the pegmatites of the area covered by this report. Pegmatite dykes containing lithium were discovered at Bernic Lake in 1925. Beryl was found the same year. Tin was discovered at Bernic and Rush lakes in 1928, a few years after it had been found at Shatford Lake.

In 1929 Jack Nutt Tin Mines Limited sank a shaft, 140 feet deep, on a cassiterite-bearing pegmatite on the north shore of Bernic Lake. Some surface work was also done on a pegmatite containing cassiterite west of Rush Lake. A third dyke, on the former Stannite claim, ½ mile north of the west end of Rush Lake had a small amount of work done on it by K. E. Miller.

In 1930 the Consolidated Tin Mining Company Limited succeeded Jack Nutt Tin Mines Limited. This company apparently did little work on the Bernic Lake tin property. However, they also had control of the lithium deposits at the east end of Bernic Lake and in 1931 mined, by open cut, 200 tons of lithium minerals, which were sorted into bins.

Lithium Corporation of Canada Limited, organized in 1934, did 630 feet of diamond drilling on the dykes at the east end of Bernic Lake, and estimated a content of 20,000 tons of lithium-bearing ore.

In 1940, Northern Tin Mines Limited carried out widespread investigation of several tin-bearing dykes north of Rush Lake. Six hundred feet of drilling were done on one pegmatite, known as the Odd dyke, about one mile north of the lake. Considerable interest in the tin deposits of the region continued till 1943. Cassiterite had been placed on the strategic mineral list, and in 1942 J. D. Bateman examined the tin-bearing dykes of the area for the Department of Mines and Resources, Ottawa. The Department undertook to drill nine more holes, totalling 2,200 feet in length, on the Odd dyke.

The known occurrences of beryl within the region studied are not outstanding. Little work has been done on any of the beryl-bearing dykes except in connection with the investigation of tin or lithium.

Lithium Deposits

The most striking occurrences of lithium minerals are found in a number of dykes on the Buck and adjacent claims at the east end of Bernic Lake. Spodumene, amblygonite, triphyllite, purpurite, petalite, beryl, apatite, and tourmaline, besides the usual quartz, albite, and yellowish micas, are found in these deposits.

The largest and most interesting of these dykes is that near the east side of the Buck claim. This dyke, intruded into recrystallized andesite, strikes west of north and dips 25 to 30 degrees east. The maximum true width as determined by drilling is 22 feet. Several tons of lithium minerals have been taken out of an open cut and the dyke is well exposed for examination.

Several distinct zones with characteristic mineral assemblages and textural differences can be distinguished in this dyke.

The uppermost, or hanging wall, zone is a fine-grained mixture of albite and quartz with minor tourmaline. This chilled margin is about ½-inch thick.

The second zone, 12 to 18 inches thick, consists of about 10 per cent each of feldspar and quartz, the remainder being large black crystals of tourmaline growing normal to the walls of the dyke.

In the third zone, 4 feet thick, large books of yellowish lithium mica accompany quartz and albite. Quartz makes up about 45 per cent, albite 15 per cent, and mica 35 per cent of this zone. The mica books measure about three inches thick and 3 to 5 inches in basal diameter. A few crystals of tourmaline are present. Beryl crystals up to one inch across occur in this zone. They are pale yellowish green in colour and not at all numerous. A few small red garnets are present. The lower, or innermost part of this zone contains some very large pink microcline crystals.

Spodumene is characteristic of the fourth zone. This zone is composed of about 65 per cent quartz, 15 per cent feldspar, and 20 per cent quartz-spodumene masses in which the two minerals are intimately intergrown.

In the fifth zone large crystals of amblygonite up to six inches across are associated with radiating platy albite. A small amount of lepidolite is also present here.

The sixth zone, at the bottom of the open cut, has a minimum exposed thickness of seven feet and consists largely of quartz with numerous crystals of amblygonite up to one foot wide by two feet long. In places, amblygonite makes up 30 per cent of this zone. At the bottom of this zone large masses of grey-green triphyllite up to one foot across occur with the quartz.

This dyke was drilled in 1936 and was found to narrow at depth; 85 feet down dip the pegmatite was only $6\frac{1}{2}$ feet wide. It also appears to pinch out about 250 feet north of the south end of the quarry.

A second dyke, exposed on the east side of a hill near the west edge of the Buck claim, strikes northeast, dips about 20 degrees to the northwest, and can be traced about 125 feet along strike. The base of the dyke is covered by swamp; the exposed thickness is eight feet.

The top of this dyke is composed of white quartz, pale yellow mica, and tourmaline growing normal to the wall. Some of the tourmaline is black and some deep translucent green. Several grains of clear deep blue apatite are also present. The centre of the dyke, about two feet in thickness, consists mainly of pink albite and white quartz. A few spodumene and amblygonite crystals occur in the centre of the dyke but the most striking feature is the presence of considerable deep purple purpurite, partly weathered to a deep brownish colour. The bottom of the exposed section is similar to the hanging wall, and consists of white quartz, tourmaline, and mica. It is probable that this is close to the footwall of the dyke.

The dyke on the Coe claim is remarkable in that in places it consists largely of petalite, an uncommon lithium-aluminum silicate. A mass of this mineral occurs in a zone consisting of numerous small intersecting stringers of quartz, feldspar and petalite. Some pale mica, triphyllite, and blue apatite are also present. The walls of the dyke consist of a fine-grained mixture of quartz, albite, petalite, mica and tourmaline. The dyke is too small to be of economic interest.

Besides the three occurrences mentioned, there are a half dozen other very small dykes, containing much the same minerals, in the area east of Bernic Lake. One particular feature they all possess is the presence of several phosphate minerals: amblygonite, triphyllite, purpurite and apatite.

Lithium minerals, never in very large amounts, occur in a few other dykes examined, usually in association with beryl or cassiterite.

Tin Deposits

Pegmatite dykes which contain cassiterite are found in two localities, one on the north shore of Bernic Lake, the other in an area north and west of Rush Lake.

The property on the north shore of Bernic Lake was formerly held by Jack Nutt Tin Mines Limited, and that company's successor, Consolidated Tin Mining Company Limited. At this locality a number of fairly flat-lying dykes have intruded andesite along fractures trending in various directions. The pegmatites are composed essentially of white to buff albite, quartz, and pale yellow mica. Tourmaline is abundant in several of the dykes and in places occurs as large, black crystals growing normal to the walls. Triphyllite was observed in a few places. The usual maximum width of the pegmatites is 10 to 12 feet; some of the dykes are only a foot or so wide.

Cassiterite occurs in the narrow finer-grained dykes and in places along the fine-grained margins of the wide pegmatites. Jack Nutt Mines Limited sank a shaft on the property and explored several dykes underground. The amount of cassiterite was found to be small.

A large pegmatite dyke a half mile west of Rush Lake was investigated for tin in 1930 by Jack Nutt Mines Limited. This dyke strikes north of east and dips steeply south. It is well exposed and can be traced for a distance of about 1,300 feet; the maximum outcrop width of the pegmatite is 250 feet. There are several large inclusions of andesite within the pegmatite body. Besides the essential components of the albite pegmatite, accessory minerals include tourmaline, beryl, amblygonite, spodumene, triphyllite, sphalerite, arsenopyrite, and cassiterite. Except for tourmaline, which occurs in crystals up to three inches long and one inch in diamater, the remaining accessories are present in only minute amounts.

Another dyke, located 1,000 feet northeast of the area just discussed, is similar to that one.

The pegmatite known as the Stannite deposit, is situated about 2,000 feet north of the west end of Rush Lake. This dyke, in its eastern half, contains a few large crystals of spodumene, in addition to small amounts of beryl, triphyllite, and purpurite. These minerals occur in the normal buff coarse quartz-feldspar-mica assemblage. Near its west end the dyke is rather narrow, and the north side of the dyke, where it is in contact with quartz-mica schist, consists of an aggregate of quartz and pale yellow mica. It is in this coarse quartz-mica mixture that crystals of cassiterite, up to ½ inch across, are abundant. The tin-bearing zone is about one foot wide. It is exposed for a length of only a few feet.

A narrow, fine- to medium-grained grey albitite dyke is exposed on the location of the old Odd claim, about 4,000 feet north of the middle of the north shore of Rush Lake. This dyke consists of white albite, yellowish mica, clear quartz, and small black tourmaline grains. The albitite is most conspicuous in the east half of the dyke, where it is narrow. Westward it widens and becomes coarse pegmatite.

Cassiterite grains are scattered throughout the albitite phase. The east section of the dyke was sampled and drilled by the Department of Mines and Resources, Ottawa. On surface, across a width of 4.7 feet and for a length of 320 feet the dyke averaged 0.35 per cent tin. Drilling revealed narrower width and lower grade at depth. The west end of the dyke where it is pegmatitic contains only occasional large crystals of cassiterite.

Beryl Deposits

Besides the small amounts of beryl found in some of the tin- and lithium-bearing pegmatites, there is one dyke, across the bay from the tin deposits on Bernic Lake, from which considerable beryl was removed. The dyke has been developed by an open cut and some hand-cobbed beryl is piled beside the occurrence. Little beryl can be seen in the dyke at present, but it apparently came from a pod in the centre of the pegmatite. Some triphyllite, and a few crystals of amblygonite, spodumene, purpurite, tantalite, and apatite were observed. This dyke is rather small, measuring about 150 feet long and 10 to 12 feet wide.

Economic Possibilites of the Pegmatites

Of the valuable metals found in the pegmatites of this region lithium appears to offer the most promise of occurring in profitably recoverable amounts. It is probable that beryl could be extracted as a by-product of production of other minerals. The tin occurrences known to date are all too low-grade and too small for profitable mining.

In prospecting for any of the above minerals it is important to consider the manner in which the pegmatites may be zoned. Lithium minerals and beryl are most likely to be found in the central or core zones of the pegmatite bodies. As already noted, many dykes have outer zones consisting largely of feldspar, quartz, mica, and tourmaline. In the case of a fairly flat-lying dyke these might be the only minerals apparent on the outcrop surface. If lithium minerals should occur in the central portion of such a dyke these would be visible only in section. Consequently it is important to examine not only the top of such outcrops but also the sides, and if possible to trench down into the dyke.

As already noted, cassiterite when present, occurs in the fine-grained wall zone of the wide coarse-grained pegmatite, or else in narrow fine-grained dykes. On the old Stannite claim it occurs in a coarse mixture of quartz and yellow mica, but here too, this is found in the wall zone of the pegmatite.

Satisfactory assessment of the potentialities of pegmatite bodies is most difficult. Lengthy experience by workers in the Black Hills region of South Dakota has shown that proper estimates of grade cannot be made from either diamond drilling or surface sampling. Large tonnage and fairly uniform distribution of the valuable minerals seem to be the most desirable features of mineable pegmatites.