Province of Manitoba
DEPARTMENT OF MINES AND NATURAL RESOURCES

MINES BRANCH

PUBLICATION 55-3

STRUCTURAL STUDIES of the SNOW LAKE - HERB LAKE AREA

Herb Lake Mining Division Manitoba

by

G. A. Russell

Winnipeg

1957

Province of Manitoba

DEPARTMENT OF MINES AND NATURAL RESOURCES

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STRUCTURAL STUDIES

SNOW LAKE - HERB LAKE AREA

INTRODUCTION

GENERAL STATEMENT

Most of the geological mapping in the area has been done by geologists of the Geological Survey of Canada. In addition to the areal geological mapping performed by the Geological Survey of Canada, more detailed observation of local phenomena have been made by persons employed by various mining companies. The varied interpretations of field data that have resulted are evidence of the complexity of the geology. In the present survey it was possible for the author to spend much time re-examining critical areas and to work across map-sheets produced by three different geologists.

Structurally, the most significant result of the present study has been the identification of an overthrust block bounded by a flat thrust fault on the southwest and by steeply dipping faults on the northwest and southeast sides. The most significant gold values discovered to date in the area occur along the overturned southwestern edge of the overthrust block. The most significant quantities of base metals (copper and zinc) are associated with the steep fault which marks the eastern boundary of the overthrust block. Other base metal values (nickel) are structurally localized in that the basic intrusives in which they occur are found to occupy openings formed by the moving apart of bedding planes during folding.

Geological literature of the area is listed in the bibliography at the end of this report and is referred to by numbers in parentheses in the text.

GEOGRAPHICAL LOCATION AND ACCESS

The geographical centre of the area is located about 90 miles northeast of The Pas, Manitoba.

From Winnipeg, Snow Lake may be reached by a combined rail and bus route via The Pas and Wekusko. The latter settlement is Mile 82 on the Hudson Bay Railroad.

By air, Snow Lake may be reached by aircraft based at The Pas and Flin Flon and from Wabowden at Mile 137 on the Hudson Bay Railroad. Canadian Pacific Airlines has daily flight schedules from Winnipeg to The Pas.

Access routes within the area are indicated on the map accompanying this report.

GEOLOGICAL LOCATION

The area is located within the Churchill Province defined by Wilson (17). The Churchill Province is separated from the Superior Province, in which the remainder of the Precambrian terrain of Manitoba is located, by a northeasterly trending boundary which lies approximately parallel to the Hudson Bay Railroad. This boundary zone is marked by three distinct characteristics. First, it is topographically low compared to the average shield elevation of about 1,000 feet above sea-level. Second, the boundary zone is marked by great irregularities in the earth's magnetic field as indicated by the sinuous course of isogonic lines. Third, the boundary zone is gravimetrically heavy compared to the main areas of the Churchill and Superior Provinces (3). It is interesting to note that this magnetically anomalous and gravimetrically heavy boundary area is just south of and parallel to the site of intensive exploration for nickel which has been carried out by various companies operating in the belt of Precambrian rocks between Flin Flon and Assean and Split lakes.

TOPOGRAPHY

Topographically, the area is composed of rock or drift-covered hills separated by lakes, swamps, muskegs and sand plains. Maximum relief in the area is about 100 feet where the rocky hills rise steeply along the southeast shore of West Snow Lake, just west of West Narrows.

AVAILABLE MAPS AND AIR PHOTOGRAPHS

The most recent topographic maps, available in the National Topographic Series from the Map Distribution Office, Ottawa, are the Cormorant Lake sheet (63K) and the Wekusko Lake sheet (63J).

The present map-area covers parts of three geological map-areas as follows:

a. File Lake. Map 929A, by J. M. Harrison (7).
b. Wekusko. Map 665A, by J. E. Armstrong (18).
c. Crowduck Bay. Map 987A, by M. J. Frarey (20).

The most recent airphotos were taken in 1952 and may be purchased from the National Air Photo Library, No. 8 Building, Ottawa. The following flights are relevant:

a. A13428 - 159 to 161
b. A13398 - 132 to 138
c. A13398 - 14 to 23
d. A12944 - 440 to 448
e. A12944 - 355 to 363
f. A12944 - 315 to 322
g. A13215 - 21 to 28

The flights are north and south. The photographs are on a scale of one inch to 2640 feet.

SURVEY METHODS

The mapping was recorded on enlargements of standard 10 inch by 10 inch Royal Canadian Air Force photos. Where outcrops were not visible on the photos or where uniform lithology permitted, pace and compass traverses were used. In the vicinity of Snow Lake there are many surveyed claim lines which were easily located on the ground and on air photos. South and west of Snow Lake a "blanket" of geophysical grid lines covers the area and date from exploration activity about 1944. Some of these lines were readily located on the ground but were not visible on air photos. Others have grown in, particularly those at the west end of West Snow Lake, and are difficult to follow.

As a result of intensive exploration work by Hudson Bay Mining and Smelting Co. Limited, of Flin Flon, from the fall of 1954 to the present, almost the entire map-area is covered by a new set of geophysical base lines and cross lines.

STAFF

In 1954, field assistants were Mr. C. M. Nixon of Dalhousie University and Messrs. Gordon Johnston, Dudley Brett, and Felix De Forest of the University of Manitoba.

In 1955, field assistants were Mr. T. C. Poulter and Mr. Jonathon Greenhalgh of St. John's College, Winnipeg.

ACKNOWLEDGEMENTS

We wish to acknowledge the hospitality and assistance rendered the parties by Mr. George C. Lipsey, General Manager and Mr. Nelson Hogg, Chief Geologist, Snow Lake Division, Howe Sound Exploration Company, Ltd.[1]

Mr. Cecil Smith, Forest Ranger, Manitoba Forest Service, helped the party in many ways and our thanks are extended to him.

Messrs. Walter Johnson, William English, Peter Kobar, William Kobar, and Roy Leslie, all contributed their time generously in guiding the author to showings in the Snow Lake - Herb Lake area.

A special word of thanks is due Mr. Gordon Crosby, Consulting Geological Engineer of Flin Flon, Manitoba, whose cooperation made it possible for the writer to examine important geological features of the Flin Flon area.

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1 In October, 1955 the name of Howe Sound Exploration Company Ltd., was changed to Britannia Mining and Smelting Co. Limited.

TABLE OF FORMATIONS

Intrusive Rocks (Age relations unknown)	Granite (19); quartz diorite (18a) Peridotite (17) Gabbro (16)
Intrusive Contact	
Younger Sedimentary Group	Arkose (15) Cross-bedded arkose (14) Staurolite-garnet-mica schist (13) Staurolitic greywacke and staurolite-garnet-mica schist, interbedded (12) Staurolitic greywacke (11); ferruginous, garnetiferous tuff interbed (11a) Greywacke and slate (10) Basal clastic formations (9)
Intermediate Group	Ferruginous, calcareous, and carbonaceous rocks (8) Acid volcanic rocks, amygdaloidal (7a) Acid volcanic rocks, fragmental (7) Basic volcanic rocks (6) Calcareous tuffs (5). Acid volcanics and siliceous sedimentary rocks (5a) Porphyritic basalt, inclusion-bearing (4) Porphyritic basalt (3)
Intrusive Contact	
Basement Group	Quartz-feldspar rocks (2) Basic volcanic rocks (1), some diorite sills and interbedded tuffs

COMPARATIVE STRATIGRAPHY

Reed-Wekusko area

Alcock Reed-Wekusko area	Stockwell Elbow-Morton area	Stockwell Herb Lake area	Armstrong Wekusko area	Frarey Crowduck Bay area	Harrison-Stanton File-Tramping area	Russell Snow Lake-Herb Lake area
	Diabase Garnet granite Trap dykes					
Granite and allied rocks	Granite and allied rocks "Quartz-eye" granite, etc. Basic intrusions	Granite and allied rocks Lamprophyre 'quartz eye' granite	Granite and allied rocks Basic intrusions	Granite and allied rocks Basic intrusions 'Quartz-eye' granite, dacite	Granite and allied rocks Basic intrusions	Granite and allied rocks Basic intrusive rocks
INTRUSIVE CONTACT	INTRUSIVE CONTACT	INTRUSIVE CONTACT	INTRUSIVE CONTACT	INTRUSIVE CONTACT	INTRUSIVE CONTACT	INTRUSIVE CONTACT
Wekusko group: Wekusko **series:** **sedimentary rocks** Kiski volcanics	**Wekusko group:** **sedimentary** rocks Volcanic rocks	Dacite, dacite breccia	Post-Laguna: conglomerate and clastic sedimentary rocks	Mainly clastic sedi- mentary rocks; some basic flows; includes Laguna and post-Laguna	Snow group: mainly clastic rocks; some volcanic rocks; some isolated areas of conglomerate; in- cludes some pre-La- guna	<u>Younger Sedimentary group:</u> mainly clastic rocks; some diorite sills. <u>Intermediate group:</u> acid and basic volcanic rocks; interbedded fer- ruginous, calcareous, and carbonaceous sedi- mentary rocks; diorite sills
			UNCONFORMITY	UNCONFORMITY	UNCONFORMITY	
			Dacite, quartz-feld- spar porphyry		'Quartz-eye' granite?	
		INTRUSIVE CONTACT	INTRUSIVE CONTACT		INTRUSIVE CONTACT	INTRUSIVE CONTACT
		Basic flows and in- ter-bedded rhyolite, conglomerate, ar- kose tuff, and brec- cia Greywacke and con- glomerate, slate, and staurolite schist	Laguna series: basic and acidic volcanic rocks, conglomerate, greywacke, arkose, argillite			
			Pre-Laguna series:	Mainly basic flows: some sedimentary rocks	Amisk group: mainly basic volcanic rocks; some interbedded sedimentary rocks	<u>Basement group:</u> Quartz-feldspar rocks; basic volcanic rocks, interbedded tuffs, dio- rite sills

GENERAL GEOLOGY

INTRODUCTION

All the consolidated rocks are of Precambrian age. One occurrence of Paleozoic limestone was noted on the west side of Arm Lake but it could not be satisfactorily established that this rock was in place.

The rocks have been subdivided into formations and groups according to the following definitions by Krumbein and Sloss (13):[1]

> "Formations should be established with boundaries that may be readily traced in the field and represented on geologic maps to best express the geologic development and structure of the area."
> "Successive formations, related by lithology or position with reference to unconformities, may be assembled as a group."

Following these definitions the rocks have been divided into four major groups. These are a Basement group, an Intermediate group, a Younger Sedimentary group and a group of intrusive rocks. No attempt has been made to apply any of the large variety of local names which exist for the rocks of northern Manitoba and no attempt has been made to add to the confusion by creating any new local names.

An important consideration in the interpretation of the geology is recognition of the gradational relationships between the layered rocks. Due to the interstratification of sedimentary and volcanic rocks and, especially, due to the manner in which these rocks grade both vertically and horizontally, a certain geologic time will not always be represented by the same rock type or formation. As stated previously, the writer has made an attempt to group the rocks so as to avoid short, lenticular units.

BASEMENT GROUP

The Basement group is composed of two formations. One formation consists of basic volcanics made up of pvroclastics, fragmental volcanics, and basic flows. The other formation is composed of two kinds of quartz-feldspar rocks, the origin of which is not certain.

Basic volcanic rocks (1)

The oldest rocks are basic lavas which are exposed adjacent to the granite south of Varnson Lake. They are green to greyish-green and exhibit a wide variety of structures and textures. The rocks vary from andesite to basalt and include pillow lavas, massive flows, amygdaliodal and vesicular flows, porphyritic phases and fragmental flows. Some tuff beds and sill-like masses of diorite are interstratified with these rocks. Many of the units are lenticular, and interfinger.

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1 Numbers in parantheses after author's names refer to the bibliography at the end of the report. Other numbers in parentheses refer to rock-units.

Quartz-feldspar rocks (2)

The second formation of the Basement group is composed of two types of indistinctly stratified (foliated ?) quartz-feldspar rocks. The rocks are interstratified with and also interfinger with the volcanic formation of the Basement group. One type of the quartz-feldspar rocks is pink to greyish-pink and is medium to fine grained. A few small red garnets are usually disseminated through the layers. The proportion of quartz and feldspar is not uniform but varies across the strike of the layers.

The second type of the quartz-feldspar rocks of the Basement group is also composed essentially of quartz and feldspar grains and is also distinctly layered. It is distinguished from the other quartz-feldspar rocks of the Basement group by the presence of irregularly distributed swarms of blue, opalescent quartz grains averaging about 5 millimetres in diameter. Similar swarms of bluish-white quartz grains were noted by the writer in the Missi sediments of the Flin Flon area. About 1500 feet south of the west end of the rocky point on the south shore of Tern Lake, two distinctly rounded fragments were noted in this formation of the Basement group. One fragment was of medium- to coarse-grained hornblende granite. The other fragment, lying within 2 inches of the first one, was of a medium- to fine-grained rock of the same composition. These fragments suggested a detrital origin for the rocks of the formation.

A large mass of the quartz-feldspar rock of the Basement group outcrops between Anderson Lake and Berry Creek. The periphery of this mass of quartz-feldspar rock is distinctly foliated in harmony with the basic volcanics. The centre of the mass is entirely massive and could only be identified as granite, the word granite being used here simply to define a certain assemblage of minerals. In the centre of this mass of granite, numerous dykes of porphyritic basalt (the oldest formation of the Intermediate group) were seen. Similar relations were noted in the area just south of Tern Lake.

At the north end of Angus Wood's Bay, Herblet Lake, and in the area between the bay and Wolverton Lake, a group of interstratified sedimentary and volcanic rocks (mainly basic tuffs) have been assigned to the Basement group. Age relations are obscure because of the scarcity of outcrops and because of the extreme complexity of the folded structures. On the southwest shore of Wolverton Lake, just northeast of the most southerly mineral occurrence noted on the map, gritty, feldspathic quartzite and arkose occur and are similar to those in the area between Squall Creek and Varnson Lake. Classification of these Wolverton Lake rocks as Basement group must be regarded as tentative.

The rocks of the Basement group are cut by acid and basic dykes. The acid dykes are of pink to red aplite and pegmatite and are most abundant in the area lying between Varnson Lake and Squall Creek, north of the powerline. Veins of white quartz are also distributed rather uniformly through this area. The basic dykes are of porphyritic basalt and cut sharply across the layering of the quartz-feldspar rocks south of Tern Lake. Some masses of porphyritic basalt also parallel the layering of the quartz-feldspar rocks.

The origin of the quartz-feldspar rocks of the Basement group is uncertain, particularly the formation characterized by the blue, opalescent, quartz grains. Harrison (11 - page 16), accepted an igneous origin for the rock, which he called "quartz-eye" granite, but was not sure of its age. He states:

> "Positive evidence, therefore, indicates that the 'quartz-eye' granite is younger than Amisk lavas and some associated

> sedimentary types, and is older than the basic intrusions and potash granite. Negative evidence suggests that it is older than the rocks of the Snow group, which suggests in turn that the Snow group and the Missi series of Flin Flon are of the same age. However, it must be emphasized that no positive evidence has been found for this relation."

The dykes of porphyritic basalt that cut the quartz-feldspar rocks south of Tern Lake are of the type mapped by Harrison as Amisk. The writer believes that these dykes of porphyritic basalt are feeders for a large flow of similar rock which lies immediately above the 'quartz-eye' quartz-feldspar rocks. The rocks of this flow were included by Harrison (7) in the Amisk group; they are placed in the Intermediate group in the present report. The intrusive nature of the dykes of porphyritic basalt indicates that the rocks Harrison mapped as 'quartz-eye' granite are, as he suggests, older than the Snow group.

Harrison (11 - page 36) discusses granitized rocks of the area and states:

> ".....south of Tern Lake .... the hybrid rock becomes increasingly more like granite and contains increasingly large numbers of 'quartz-eyes', so that it is seldom possible to indicate a definite contact."

The writer, as mentioned previously, saw similar variations in 'quartz-eyes' in the Missi sediments at Flin Flon. Further, in the Wallace Lake area of southeastern Manitoba, the writer (10) noted blue, opalescent, quartz as coarse grains marking the bottom of sedimentary beds, as phenocrysts in rhyolite-porphyry, as disseminations along fractures in basic intrusives, and in dykes and veins in acid and basic volcanics. The writer feels that in the area south of Tern Lake there is no more evidence to show that the 'quartz-eyes' are an indication of progressive granitization than there is to show that they may be detrital grains in a coarse, feldspathic sediment. The writer did note some bleaching, epidotic alternation, and pink coloration in some of the lavas of the Basement group and what appeared to be pinkish alteration in some of the quartz-feldspar rocks but no evidence was found to suggest that the quartz-feldspar rocks are entirely hybrid.

Although more detailed work in the area south of Tern Lake is necessary, there are strong indications that the quartz-feldspar rocks are of clastic sedimentary origin and this, with the occurrence of the feeder dykes, suggests an erosion interval between the Basement group and the Intermediate group.

The conformability of the quartz-feldspar rocks with the lavas, their interfingering (with sharp contacts) with the fragmental volcanics and tuffs, the uniform occurrence of sparsely disseminated garnets (which were not seen in the volcanics), the irregularity of distribution and swarm-like appearance of the blue quartz-eyes, and the variation in grain size according to layers at right angles to the strike all suggest to the writer that these quartz-feldspar rocks are chiefly feldspathic quartzites and arkoses of sedimentary origin.

A final point in connection with the quartz-feldspar rocks of the Basement group is the occasional occurrence in them of circular or elliptical fragments resembling amygdules. The writer believes that the rocks containing these amygdules have the characteristics of sediments and would therefore class the amygdules as being of detrital origin in the rocks in which they occur. A similar occurrence was noted by the writer in the Flin Flon area where the Amisk and Missi are in contact. The Missi sediments contain siliceous, almond-shaped fragments that are similar to amygdules in the overlying (overturned) Amisk volcanics.

INTERMEDIATE GROUP

Introduction

The Intermediate group is composed of volcanic and sedimentary formations. These formations grade vertically and interfinger laterally, the relationship being similar to that between the formations of the Basement group. The volcanic rocks are represented by both acid and basic types. Some of the sedimentary rocks are ferruginous, the iron occurring as pyrite or marcasite or pyrrhotite. Some beds of the sedimentary formations are composed of interbedded ferruginous limestone and chert or quartzite. On the map it will be seen that the Intermediate group occurs as a lenticular mass lying between the Basement group and the Younger Sedimentary group.

Porphyritic basalt (3)

Porphyritic basalt occurs mainly as a sill-like mass north and east of Threehouse Lake. It underlies an area a mile wide and three miles long and pinches out rapidly to the east and west. It forms some of the highest hills in the area. On the weathered surface poorly formed phenocrysts of feldspar give the dark greenish black rock a spotted appearance. The rock has some amygdaloidal, pillowed and vesicular phases. Dykes of this rock intrude the formations of the Basement group. Rock similar in appearance to the porphyritic basalt forms the matrix of the basic, fragmental volcanics in the vicinity of the Nor-Acme property north of Snow Lake.

Inclusion-bearing porphyritic basalt (4)

This rock is similar in appearance to the porphyritic basalt but is distinguished from it by the presence of cognate inclusions, the mode of formation of which is not clear. These inclusions, the composition of which appears to differ only slightly from the matrix, weather in such a way as to produce a bumpy surface. On some outcrops the inclusions are abundant; in other outcrops only a few inclusions appear and are recognized only by careful observation.

The inclusion-bearing porphyritic basalt is more extensively distributed than the porphyritic basalt, forming a continuous mass from West Snow Lake to the sharp bend in Snow Creek south of Whitefish Bay, Herblet Lake. The rock has participated in the overthrust folding in the hanging wall of the McLeod Road thrust fault.

On the south shore of Noteme Lake, the rock carries foreign as well as cognate inclusions. The foreign inclusions are fine grained, white to pinkish white, and strongly resemble some acid volcanics of the Intermediate group.

Calcareous tuffs (5), acid volcanics and siliceous sedimentary rocks (5a)

Due to the pronounced interfingering and interstratification of the rocks of this formation with both the overlying basic volcanics and the underlying inclusion-bearing porphyritic basalt, it is difficult to place them in any single position in the geologic column. Therefore they have been placed in the lowest position in which they are known to occur.

A typical specimen of calcareous tuff is made up of layers of reddish-brown weathering limestone separated by layers of amphibolite. The proportions of the two components vary considerably. Where the limestone component is abundant the limy layers contain paper-thin layers of chert and the amphibolite component occurs as thin lenses. The writer believes that the original rock, from which the calcareous tuffs probably developed by metamorphism, was composed of layers of limestone and basic tuff. The limestone layers recrystallized to sugary, crystalline limestone and the tuff recrystallized to layers of amphibolite.

The acid volcanics of this formation were noted first in the area just east of Tern Lake where they had been exposed by trenching. The rocks are dark grey on a fresh surface and weather to an almost chalk white colour. Most of the rocks are fine grained. They have been classified as volcanics because of their close lithologic similarity to the matrix of the acid fragmental volcanics on the Nor-Acme property. There is a good possibility that some of the 'volcanics' are fine-grained, siliceous sediments.

The siliceous sedimentary rocks of the Intermediate group occur throughout the entire group but are most extensive between Herblet Lake and Snow Bay, Herb Lake. The rocks are fine grained, pink to pinkish grey weathering and, in some cases, are difficult to distinguish in the field from some of the rocks which have been called acid volcanics. The rocks include arkose, feldspathic quartzite, and quartzite. The rocks are distinctly interstratified and interfingered with the volcanic rocks of the group.

Basic volcanic rocks (6)

This formation is composed of interstratified and interfingering volcanics of basaltic composition. The formation includes pillowed, amygdaloidal, vesicular, and massive lavas, and some beds of basic tuff. Rocks of this formation occur extensively throughout the area. Two occurrences should be noted, one along the northwest shore of Snow Bay and the second, east of the settlement of Herb Lake on the east shore of Herb Lake. The occurrence northwest of Snow Bay appears to be a faulted segment lying between the South Branch and the Centre Branch of the Berry Creek fault. The occurrence east of Herb Lake has been correlated solely on the basis of lithologic similarity and stratigraphic position with respect to the basal formation of the Younger Sed'mentary group.

The attitude of tuff beds and top determinations on pillowed flows of this formation constitute some of the most valuable structural data available.

Acid volcanic rocks (7) (7a)

These rocks occur as lenticular masses of varying lengths and widths and are interfingered and interstratified with inclusion-bearing basalt and basic volcanics. They are most extensive in the vicinity of the Nor-Acme property north of Snow Lake where, because of the sudden disappearance at their greatest width, they appear to be terminated by faulting on the McLeod Road thrust and the Creek fault. Eastward from Snow Lake the width of the lenses decreases rapidly.

The acid volcanics are of two main kinds. One unit is a fragmental rock (7) having the appearance of an agglomerate although containing a smaller number of fragments than is common in such a rock. In some places the matrix of this rock shows a suggestion of laminations and is quartzitic in appearance. The author has mapped quartzites in the Rice Lake area of southeastern Manitoba which contain basic volcanic bombs. With the exception of the fragments being acidic, some of the acid volcanics in the Snow Lake area are similar in appearance to the volcanic fragment-bearing, siliceous sediments of the Rice Lake area.

The other kind of acid volcanic, or, at least, a rock classified as an acid volcanic, is a massive to indistinctly stratified pink to greyish white weathering rock marked by uniformly present but not abundant almond-shaped cavities (7a). A feature of this unit is the presence, on the Nor-Acme property, of rounded "grains" some of which have hollow centres. It was suggested to the writer, by Mr. Nelson Hogg, that these rounded "grains" are amygdules. The writer suggests a further possibility that the "grains" may be of detrital origin even though they are truly amygdules. The author has seen such an occurrence on beaches on the north shore of Lake Superior where amygdules have weathered out of lavas, and in the Flin Flon area where detrital grains in the Missi sediments bear a strong resemblance to amygdules in the underlying Amisk flows. Whatever the true nature of this unit might be, it served as a valuable structural marker. Cherty tuff is closely associated with acid volcanics and appears as cream- to buff-colored beds composed of paper-thin laminae.

Ferruginous, calcareous and carbonaceous rocks (8)

Ferruginous, crystalline limestone

This rock is an extremely distinctive formation. It weathers to a grey-ribbed, reddish brown surface. The ribbing is due to the more resistant beds of chert and/or quartzite. The most typical outcrops of crystalline limestone occur along the north side of the McLeod Lake road south of Olsen Lake. The limestone outcrops almost continuously, around the curve of the formations towards Olsen Lake and then east along the south side of the road. A high hill located on the north side of the road, at the point where it turns almost due west, is underlain almost entirely by limestone. Another good exposure may be seen on the south shore of West Snow Lake, about half way along the shore between West Narrows and the west end of the lake, where three trenches have been blasted into the formation. In these trenches the calcareous phase is subordinate to the siliceous phase, the limestone occurring as thin beds (1/2 to 2 inches) separating thicker beds of cherty quartzite.

Another extensive occurrence of ferruginous crystalline limestone was noted along the southwest shore of Angus Wood's Bay, Herblet Lake.

In the vicinity of Herb Lake, the grey-ribbed, red-weathering crystalline limestone was noted in two places. One location, of limited extent, is on the northwest shore of Snow Bay, northwest of the centre of Woosey Island. A second occurrence was noted east of the settlement of Herb Lake but lies outside the map-area. This occurrence was described by Stockwell (20).

Ferruginous quartzite

Ferruginous quartzite outcrops along the south and west shores of Snow Lake, the west end of the south shore of West Narrows, and on the south shore of West Snow Lake. One bed continues eastward from Snow Lake, crosses the Snow Lake road about a mile and one-half north of Anderson Creek and continues eastward to the north side of Miller Lake. Several other thin beds of ferruginous quartzite were mapped on the south shore of Southeast Bay, Herblet Lake and in the area between Southeast and Whitefish bays, Herblet Lake, and the Berry Creek fault.

Most of the iron of the ferruginous quartzite is in the form of fine-grained pyrrhotite. The quartzite usually exhibits a light yellowish grey weathered surface but, if calcareous, the weathered surface is a deep reddish brown similar to that of the crystalline limestone.

Carbonaceous slate

This rock nearly always contains disseminated pyrite and, on the cleavage planes, scales of marcasite. The rocks are not well exposed owing to their extreme softness. One outcrop occurs on the north side of Tern Creek where it enters West Snow Lake. A fragment of carbonaceous slate, in which some cavities contained loose, powdery carbon, was found in glacial drift on the west shore of Snow Lake near the south end.

Carbonaceous slates have been encountered by diamond drilling in three places. On the tungsten showing on Squall Creek, about one-half mile north of West Snow Lake, up to 200 feet of thinly laminated pyritic slate was intersected. Drilling in West Narrows, Snow Lake also encountered similar rocks. On the north shore of Snow Bay, Herb Lake, at a point northwest of the southwest end of Woosey Island, a diamond drill hole bearing southeast cut black slates under the lake. Similar, black, pyritic slates outcrop on the south shore of Taylor Bay, Herb Lake.

YOUNGER SEDIMENTARY GROUP

Introduction

This group has been devided into seven formations. One formation contains a distinctive intraformational bed. The group includes a basal formation of medium- to coarse-grained clastics followed by greywacke and slate, staurolitic greywacke, interbedded staurolitic greywacke and staurolite-garnet-mica schist, staurolite-garnet-mica schist, crossbedded arkose, arkose.

Basal clastic formations (9)

These occur in the vicinity of Herb Lake settlement and were not noted anywhere else in the area. At Herb Lake settlement the formation is composed of interstratified beds of conglomerate, pebble beds, gritty quartzites and arkoses, and medium-grained uniform textured arkose. Some lava flows are interstratified with the sedimentary rocks. The rocks at Herb Lake settlement were examined chiefly for the purpose of completing the stratigraphic section begun in the Snow Lake area. The basal clastic formation of the Younger Sedimentary group, along the shore and offshore islands at Herb Lake settlement, dips to the east and faces west. Thus, the greywackes and slates, which "underlie" the clastics, are the next youngest formation of the group.

Greywacke and slate (10)

Hard, fine-grained greywacke is the predominant component of the formation. The slate occurs consistently but only in small volume. At the west end of Taylor Bay, Herb Lake, on the south shore of the bay a pyrite-pyrrhotite bearing bed of graphitic slate occurs. Many of the beds of greywacke contain basic volcanic bombs some of which are vesicular. North of Herb Bay, Herb Lake the greywackes and slates are closely folded and grade northward into the next younger formation.

Staurolitic greywacke (11)

Staurolitic greywacke occurs extensively on the south side of the Berry Creek fault northwest of Herb Bay, Herb Lake and along the north shore of West Narrows, Snow Lake and the north shore of West Snow Lake to Squall Lake. Towards the middle of West Narrows, on the north shore, there is dark-coloured, hard, massive greywacke, similar to the greywacke along the shores and on the islands of Herb Lake. Faulting in West Narrows has resulted in the omission of some formations of the Younger Sedimentary group (see Geologic Cross Section 0) but it is not possible to estimate the extent of the omission because of the lenticular nature of many of the sedimentary formations. Some "omission" may be due to narrowing of the beds.

The staurolitic greywacke is massive and contains small crystals of disseminated staurolite. A few thin beds of staurolite-garnet-mica schist occur in this formation. Basic volcanic bombs occur in some of the thicker beds of the staurolitic arkose and greywacke. The volcanic bombs frequently contain small red garnets but no staurolite crystals were found in them.

Included in the staurolitic greywacke formation of the Younger Sedimentary group is an interbed of ferruginous, garnetiferous, amphibolitic, black, slaty tuff (11a) that weathers to a yellowish-brown surface due to pyrite. This bed was first mapped on the best exposures on the north shore of the west end of West Narrows where it is about 250 feet thick. From this point it was traced northwestward but its continuity is interrupted by the West Narrows fault and the north-south faulting that strikes into the northern tip of West Snow Lake. A similar bed was mapped north of the north portage on Squall Creek. Here the bed is much thinner and indicates a northward pinching out of the formation. The ferruginous bed on Squall Creek and the bed on the north side of West Narrows could not be traced continuously because of extensive drift cover.

Interbedded staurolitic greywacke and staurolite-garnet-mica schist (12)

This formation of the Younger Sedimentary group is composed of about equal amounts of hard, staurolitic greywacke and soft, staurolite-garnet-mica schist. Basic volcanic bombs are more abundant in this formation and the beds of greywacke are much darker in colour than the lower beds of the group. Some sill-like masses of diorite are interstratified with the sedimentary beds.

Staurolite-garnet-mica schist (13)

This formation of the Younger Sedimentary group is composed almost entirely of staurolite-garnet-mica schist with only a few beds of staurolitic arkose and greywacke. Some sill-like masses of diorite are interstratified with the sedimentary rocks but basic volcanic bombs are less common than in the underlying formation. On the southeast shore of Squall Lake some of the thin, massive beds of staurolitic arkose and greywacke are ripple-marked. The ripple-marks appear only on the surfaces exposed by sapping of the cliffs along the shore.

Cross-bedded arkose (14)

This formation of the Younger Sedimentary group occurs in the McLeod Lake syncline between Squall and Cleaver lakes and in the Herblet Lake and Southeast Bay synclines. The rocks of the unit arkose, greywacke, and feldspathic quartzite. Rare pebbles of white quartz were seen in the outcrops lying southwest of McLeod Lake. The most distinctive feature of the formation is well-developed cross-bedding. A large number of sill-like masses of diorite are interstratified with the sediments and have been folded with them. Some of the diorite masses contain cognate inclusions and resemble the basic, volcanic breccia phase of the porphyritic basalt south of West Narrows. No volcanic bombs were found in this formation.

Arkose (15)

This formation is the youngest in the area and overlies the Cross-bedded arkose in the central portions of the McLeod Lake, Herblet Lake, and Southeast Bay synclines. The synclines plunge northeast at 12 to 20 degrees. The rocks consist of massive thick-bedded arkose which weathers pale pinkish grey.

INTRUSIVE ROCKS

The intrusive rocks are diorite, gabbro, amphibolite, peridotite, and granite. The time of intrusion of these rocks could only be determined in a general way and, for the purposes of this report, can only be said to be younger than the rocks they actually intrude.

Diorite

Diorite masses occur in the Basement group, in the Intermediate group, and in the Younger Sedimentary group. Sills of diorite are most abundant in the cross-bedded arkose formation of the Younger Sedimentary group but none of the masses observed are large enough to be indicated on the map. There are several possibilities as far as the time or times of intrusion of these rocks are concerned. First, they may represent igneous activity contemporaneous with the time of formation of the sedimentary and volcanic rocks which enclose them. Second, they may represent a period of activity younger than the rocks of the Younger Sedimentary group. Third, they may represent a combination of both. The writer prefers the first possibility and believes that the geologic section of Snow Lake indicates an area which was marked by alternating periods of extrusive volcanism and sedimentation with periodic intrusive activity of which the sill-like masses of diorite were a result.

Gabbro (16)

Three masses of gabbro were mapped. The most extensive mass occurs in the vicinity of Rice Island in Herb Lake, the island itself being composed entirely of this rock. On the southeast side of the island, the gabbro is medium grained, well jointed and hard. On the southern tip of the island, on the west side, the rock is soft weathering and contains disseminated copper and nickel sulphides.

Another mass of gabbro occurs on Eureka Island in Herb Lake. The mass is smaller than that on Rice Island but is similar in that it possesses both hard and soft phases and, in the soft phase, disseminated copper-nickel sulphides.

A third mass of gabbro, which is poorly exposed due to extensive drift covering, is located on the point between Snow Bay and Anderson Bay, Herb Lake.

In the area between Herb Bay and Crowduck Bay other masses of gabbro were mapped by Armstrong (1) but in the present survey these were mapped only along the south shore of Herb Bay. The gabbro in this area contains considerable pyrite, in addition to chalcopyrite and pyrrhotite. Nickel assays of the pyrite-bearing samples returned very low values.

Amphibolite

The best exposure of amphibolite was seen about one-half mile south of the west end of West Narrows. The rock occurs as a well-defined dyke cutting basaltic lavas of the Intermediate group. Another small outcrop was mapped on the west shore of Photo Lake. Several masses of amphibolite have been mapped on the Nor-Acme property by geologists of the Howe Sound Exploration Company Ltd.

Peridotite (17)

Peridotite outcrops were mapped at and south of Varnson Lake and at a point about one-half mile north of the Berry Bay dock on the Snow Lake road.

The peridotite weathers reddish-brown and is irregularly magnetic. The weathered surface exhibits a characteristic reticulated pattern due to the presence of intersecting veinlets of serpentine. The outcrops were examined for asbestos but none was found. No sulphides were seen in any of the outcrops. The rock intrudes basic volcanic flows of the Basement group.

Granite (18)

The main masses of granite are located west of Varnson Lake, in the area between Wolverton Lake and Northeast Arm, Herblet Lake and The Narrows, Herblet Lake; in the area between Northeast Arm, Herblet Lake and Southeast Bay, Herblet Lake; in the area between Herb Bay, Herb Lake and Crowduck Bay, Herb Lake, and in the area between Berry Creek and the southern limit of mapping west of Herb Lake.

All the granite masses are similar in appearance. The rocks are medium grained, pink to red biotite or/and hornblende granites. One small mass of quartz diorite was mapped on the north shore of Herb Bay.

STRATIGRAPHY

CONFORMITY OF THE STRATIGRAPHIC UNITS

The writer noted only one feature which suggests the presence of an angular unconformity between any of the layered rocks of the Snow Lake area. This feature is the presence of feeder dykes of porphyritic basalt just south of the south shore of Tern Lake.

The question of unconformable relations between the Basement group (Amisk) and the Younger Sedimentary group (Snow) has been discussed by Shepherd (18), Ebbutt (7) and Harrison (11) and may be summarized as follows:

Shepherd (1943) - An unconformity appears to separate staurolite-schist of the Snow group and the volcanic rocks that outcrop along the south shore of Snow Lake.

Ebbutt (1944) - Some evidence for an unconformity between the two rock groups (Amisk and Snow) but later he suggested the possibility of faulting through Snow Lake Narrows (West Narrows of the present report).

Harrison (1949) - "shearing marks the contact of the Snow and Amisk rocks along the shore of Snow Lake .... Diamond drill records and magnetometer surveys indicate that the lower contact of staurolite schist and argillite follows closely the south and west shores of Snow Lake, but nowhere is there any evidence of a basal conglomerate .... Another point against an unconformity is the lack of a basal conglomerate in the Snow group .... On the other hand it should be noted that 'quartz-eye' granite and its metasomatic derivatives are common in the rocks of the Amisk group but were not seen anywhere in the rocks of the Snow group though their occurrence would be expected if the two groups were conformable."

The writer found no evidence of shearing along the south shore of Snow Lake. Different interpretations of the origin of the sulphides, and the gossans they form, are involved. If the sulphides are of hydrothermal origin, as suggested by Harrison, then it is reasonable to suspect the presence of shearing. If the sulphides are of sedimentary origin, as suggested by the writer, shearing is not a pre-requisite for the occurrence of the pyrite, pyrrhotite, and marcasite of the ferruginous, calcareous, and carbonaceous facies of the Intermediate group, which does follow closely the south shore of Snow Lake, West Narrows, and West Snow Lake. A conglomerate is not a necessary feature of an unconformity and there are many instances on record where non-conglomeratic sediments directly overlie erosion surfaces.

The writer does not believe that a definite answer to the problem of conformability of the rocks on the north and south sides of West Narrows is possible at present. The present survey has made it possible to add some suggestions to the available evidence.

Harrison (11) refers to the problem as involving the Amisk group and the Snow group. In the present report the Amisk would include the Basement group and parts of the Intermediate group. The Snow group would include both sedimentary rocks and acid and basic volcanic rocks but the writer believes, as indicated on the cross-sections accompanying this report, that the volcanics of the Snow Group as mapped by Harrison are equivalent to the acid and basic volcanics exposed south of Snow Lake. The problem involving conformability then, in the present report, becomes one of interpreting the relations which exist between the base of the Younger Sedimentary group and rocks of both the Basement and Intermediate groups.

In the vicinity of Squall Lake the Younger Sedimentary rocks lie conformably above rocks of the Basement group. The two groups are separated by a narrow band of ferruginous sediments of the upper part of the Intermediate group. Going southward the thickness of this formation of the Intermediate group increases. The lithology of the formation also changes and, in the vicinity of West Narrows includes all rock types which have been included in the Intermediate group including acid volcanics, basic volcanics, ferruginous, calcareous and carbonaceous sediments, and sill-like masses of diorite. Thus, the Intermediate group is a lens lying between the Basement group and the Younger Sedimentary group.

In the vicinity of West Narrows it is believed that other observers have accepted, as evidence of unconformable relations, an abrupt termination of strong northeasterly lineaments which occur in the area south of the narrows but do not appear on the north side of the narrows. As far as the writer could determine the lineaments in the area south of the narrows are due to shearing and are not related to planes or layering or stratification in the rocks of the Intermediate group. Actually, these planes of stratification or layering were found to curve smoothly around from the west shore of Snow Lake to the east shore of West Snow Lake indicating a broad, northward plunging anticlinal fold whose axial plane would lie close to the middle of the narrows. A similar, conformable structure is indicated in rocks of the Younger Sedimentary group lying north of West Narrows. It is believed by the writer, in concurrence with Ebbutt (7), that a fault runs through West Narrows and has faulted the folded contact between the Intermediate group and the Younger Sedimentary group. This fault, which strikes N 70° W, has displaced the nose of the broad anticline located in the narrows resulting in the omission, from the rocks on the south shore of the narrows, of most of the ferruginous sedimentary facies of the Intermediate group, most of the acid volcanics, and at least some of the diorite sills. The relations and omissions indicate that the West Narrows fault is a normal fault, the north side being downthrown.

There remains the problem of the presence on the south shore of West Narrows of strong lineaments which do not appear on the north shore. There are several possible explanations of this phenomenon. First, as suggested by Harrison (11), the lineaments may represent faults that "tail" southward from faulting in the narrows. Second, the lineaments due to shearing may really be more abundant in the rocks south of the narrows and be due to a period of stress which affected all rocks of the Basement group and Intermediate group but not the rocks of the Younger Sedimentary group. Evidence for such a relationship does not contribute to a solution of the problem of conformability but merely "dates" a period of crustal stress. Third, the lineament-producing structures may really be just as abundant on both sides of the narrows but due to the difference, in resistance to erosion, of the rocks on opposite sides of the narrows, lineaments on the north side may have been destroyed by erosion. Of the formations of the Younger Sedimentary group, the staurolite-garnet-mica schist formation is least resistant. The north shore of West Narrows is fairly steep and is so because it is underlain by the massive, resistant staurolitic arkose and greywacke formation which forms the basal unit of the Younger Sedimentary group. Northward from the narrows the amount of the soft staurolite-garnet-mica schist formation increases and is responsible for a topographic basin from the powerline to the escarpment of the McLeod Road thrust. Thus, any lineaments from the south side of the narrows have only a narrow rim of harder rock, in which to appear, before they would disappear in the soft rocks of the basin. A glance at the map will show that some shears were found on the north shore of the narrows and that some of them "line up" rather well with strong lineaments on the south shore. The lack of more perfect alignment is probably due to the nature of the faulting in the area -- a mosaic pattern of block faulting, which will be discussed later under structural geology. Fourth, the shears may really be just as abundant on the north shore as on the south shore but due to a difference of shearability, the movement may have been absorbed differently by the rocks south of the narrows as compared to those north of the narrows. A good example of the way in which shears are developed differently in different rocks may be seen on the rocky ridge southwest of the McLeod Lake road just before it turns northeast to McLeod Lake. The Cleaver Lake fault, in the valley between the southwest end of the lake and McLeod Road, is marked by well-developed chlorite schist zones in diorite sills which occur in the cross-bedded arkose of the Younger Sedimentary group. On the rocky ridge southwest of the McLeod Lake road, which is underlain by staurolite-garnet-mica schist, the Cleaver Lake fault is represented by displacement of about 100 feet of a sill of diorite in the staurolite-garnet-mica schist. Little evidence of shearing normal to the bedding planes is apparent in the sediments (staurolite-garnet-mica schist) but a very prominent feature is an orientation of large staurolite crystals parallel to the strike of the fault and a pronounced wrinkling of the sedimentary beds at the point where the fault should come through. Away from the projected position of the shear the bedding planes are parallel, straight and uninterrupted and the staurolite crystals "box the compass". The zone of disruption in the staurolite-garnet-mica schist does not line up exactly with the projection of the Cleaver Lake fault. This may be due to the fact that faults are sometimes refracted when passing from rocks with one set of physical properties to rocks with a different set of physical properties.

In conclusion, as far as the evidence of continuity of lineaments can be applied to the problem of conformability of rocks on the north and south side of West Narrows, the writer believes that the entire Snow Lake area has been broken into a mosaic by block-faulting and whether the faults are apparent or not depends entirely on the physical properties of the rocks in which they occur.

The problem of conformability in West Narrows involves the ferruginous, calcareous, and carbonaceous facies of the Intermediate group which outcrops along the west shore of Snow Lake and the east shore of West Snow Lake but is, for the most part, missing along the south shore of the narrows. If the theory of sedimentary origin for these rocks, and the sulphides they contain, is correct, some evidence is provided that a period of erosion is involved in their presence. This distinctive facies of the Intermediate group, particularly the calcareous rocks, indicates they were derived from a relatively low lying land area being attacked by chemical weathering. On the other hand, the rocks on the north side of the narrows are clastic sediments of a type usually associated with physical weathering of higher land areas.

COMPARATIVE STRATIGRAPHY

It was stated in the first part of this report that no attempt would be made to apply local names or to correlate with other areas. However, in view of the differences in interpretation by the writer from that of previous workers, as to the nature of the carbonate rocks and associated iron-sulphide bearing rocks, it is believed that these formations require further discussion. The writer has reviewed all of the annual reports of the Ontario Department of Mines from 1922 to date and all memoirs of the Geological Survey of Canada, in preparation for this discussion. A summary of the review will comment, first, with regard to the carbonate rocks, and, second, with regard to iron sulphides in sedimentary rocks.

Carbonate-rich rocks are described in most of the publications reviewed though sometimes mention is very brief. In general, two possible origins are suggested for the carbonate rocks. First, they are described as being secondary rocks formed from a wide variety of primary rocks by the action of hydrothermal solutions. Rocks that have been altered to carbonate rock by these solutions include practically every type of igneous, sedimentary and metamorphic rock so far encountered in the shield. Second, they are described as being primary Precambrian limestones formed under rather specialized environmental conditions. There seems to be no doubt that carbonate rocks of Precambrian terrains have been formed in both ways and it becomes a matter of distinguishing between the primary rock limestone and the secondary rock carbonate formed by hydrothermal action.

The Precambrian areas of Northern Ontario and Quebec stand apart as areas in which the carbonate rocks have been attributed to a hydrothermal origin. Although the first geologists to work in these areas called the rocks limestone, later workers have attributed a large proportion of the carbonate to the action of hydrothermal solutions without, in most cases, considering at all the fate of the iron, magnesium, silica, and minor constituents of the primary rock, which have disappeared to make room for the abundant carbonate. In other areas, away from the Northern Ontario-Northwestern Quebec areas, geologists have referred many occurrences of carbonate rocks to a sedimentary origin. Thomson (22) illustrates the controversial problem in the following statement:

> "Traces of carbonate-rich beds, revealed by their reddish-brown weathering, are noted elsewhere in the greywackes. In some cases it is questionable how much of this is secondary carbonate replacement along the more argillaceous beds. The writer has seen identical carbonate replacement in greywacke adjacent to carbonatized zones in the Larder Lake country. The association of small quartz veins along the carbonate-rich layers, found in places along the shore of Hunter Lake, adds to the suspicion of some secondary carbonatization in this vicinity. However, it must be admitted that the main band of silt and carbonate-rich rock has a very definite rhythmic banding suggestive of primary sedimentation."

There seems to be an almost universal appeal to hydrothermal solutions as the source of iron sulphides in Precambrian rocks. According to Twenhofel (23,p. 432):

> "Sedimentary marcasite and pyrite are present to a greater or less degree in all kinds of sedimentary rocks. Usually the occurrences are in the form of isolated crystals or crystal aggregates in cherts and flints, shales, sandstones, and limestones. Less common occurrences are nodules, lenses, and beds in clays, shales, and coal."

In spite of the rather common occurrence of sulphides in sedimentary rocks the literature reviewed showed practically no tendency for geologists to suggest a sedimentary origin for iron sulphides in Precambrian sedimentary rocks. Most sedimentary petrologists suggest that bacteria perform an important function in the formation of sedimentary iron sulphide and it may be that previously held views regarding the lack of life in Precambrian times may have influenced geologists in devising a theory of origin for the uniformly disseminated iron sulphides which are a common feature of many Precambrian sedimentary beds. Doubt as to the abundance of Precambrian life, even though of very low forms, is gradually being dispelled. One of the most significant discoveries is that of Rankama (14) which suggests very strongly the presence of abundant life in Precambrian times. It is true that many geologists have always suspected the existence of life in the Precambrian because of the advanced development of the first species encountered in Cambrian rocks but Rankama's data concerning the existence of organic carbon is some of the first evidence available from the non-fossiliferous sediments of the Precambrian. In the writer's experience the ferruginous, calcareous, and carbonaceous rocks of the Precambrian are always closely associated in the field and it is believed that the specialized environmental conditions necessary for the formation of any one of these rock types would also be favourable for the formation of the others.

In the Snow Lake area, the writer has classified the carbonate rocks as being primary sediments for three reasons. First, they are similar to limestones mapped by the author (16) in southeastern Manitoba and to abundant exposures examined by him in the Precambrian rocks southwest of Padlei, District of Keewatin, Northwest Territories. Second, the rocks are interbedded with cherts and quartzites in the rhythmic manner which as Thomson (22) has stated, it is difficult to conceive of having formed in any other way except by primary sedimentation processes. Third, the rocks are severely restricted to a definite stratigraphic horizon and are furthermore characterized by distinctive lithologic associates, the iron sulphide-bearing quartzites are carbonaceous sediments. In connection with the significance of stratigraphic localization, it is interesting to note that Rovertson (15) has used the criterion to postulate a sedimentary origin for the carbonate rocks at the base of the Sherridon group and an organic, sedimentary origin for graphite at the top of the Nokomis group, in the Batty Lake area 25 miles northwest of Snow Lake. In some places the writer noted erratic distribution of carbonate but believes this is satisfactorily explained by the high mobility which this substance is known to attain under metamorphic conditions.

Other occurrences of Precambrian limestone in northern Manitoba have been described and mapped. Harrison (12) reports mappable units of limestone in the Sherridon area. In the Amisk-Athapapuskow lakes area Bruce (4) mapped similar rocks in the lower Missi series. Stockwell (19) mapped impure limestones in the Reindeer Lake region. Stockwell (20) also mapped, "....deeply weathered, thin beds of impure, limy sediment....", in the Herb Lake area about 5 miles east of Snow Lake.

Iron sulphide-bearing sedimentary rocks are referred to frequently in the literature reviewed by the writer. Two examples have been chosen. Derry (5) states:

> "The fine-grained sediments, consisting of quartzite and greywacke, cover a very small area.... The rocks vary from a dark-grey, cherty, fine-banded greywacke to a pure, white, finely granular quartzite which weathers rusty red, owing to the presence of fine, disseminated sulphides."

Satterly (17) states:

> "Normal clastic sediments mainly of arenaceous or argillaceous types are very common in certain parts of the area as narrow interbeds in volcanics.... Owing to the almost universal mineralization of pyrite or pyrrhotite, or both, the sedimentary interbeds now form conspicuous rust zones. On the south shore of the west arm of Sandborn Lake, typical varieties are sugary, white to grey to rusty weathering fine-grained quartzites with bands of garnet amphibolite, garnet-mica-schist, biotite-rich schist, pyritized slate and chert."

Iron sulphide-bearing sedimentary rocks were noted in the Snow Lake area chiefly near the upper contact of the Intermediate group. A typical exposure may be seen on the southeast shore of West Snow Lake at the west end of West Snow Lake at the west end of West Narrows. A pit has been excavated into the shore of the lake in a pyrrhotite-bearing, fine-grained bluish grey quartizite. At this point there is strong local magnetic attraction. The pyrrhotite is so fine grained that it is scarcely discernible with the naked eye. In addition to the exposures at water level the rusty weathering quartzite also occurs as scattered patches on the dip slope that rises from the edge of the lake.

Another typical exposure of iron sulphide-bearing sediments occurs on the dip slope which forms the west side of the valley of Sucker Creek from the tungsten property northward across the powerline. This rock must be closely associated stratigraphically with the pyritic black slates which diamond drilling has proved to exist beneath Squall Creek.

The author believes that the most valid evidence suggesting a sedimentary origin for the iron sulphides described in the preceding paragraph is their stratigraphic localization and their constant association with the siliceous, calcareous, and carbonaceous rocks that form a distinct facies of the Intermediate group. The entire Snow Lake area is broken by multitude of fractures and faults and yet the fine-grained pyrite, pyrrhotite, and marcasite are confined to a specific horizon and to certain definite rock types. It may be argued that they are of hydrothermal origin but the writer believes that the degree of selectivity exhibited is difficult to explain on the basis of hydrothermal processes.

There is one further point in connection with the iron sulphide-bearing rocks. While the occurrence of pyrite and marcasite of sedimentary origin is commonplace, most discussions of such sulphides do not mention pyrrhotite. In this connection, Harker (9) describes the metamorphism of pyrite as follows:

> "Finally it may be remarked that many calcareous rocks have a certain content of sulphides. In a high grade of metamorphism pyrites is converted to pyrrhotite by the loss of part of its sulphur. The change takes place at some temperature above 500° C., depending of course upon the pressure."

Some pyrrhotite was noted in all the ferruginous sediments of the Snow Lake area but pyrrhotite-graphite slate similar to that observed by the writer in 1952 in the Jackfish Lake area 18 miles southwest of Snow Lake was not seen. At Jackfish Lake up to 150 feet of this peculiar rock type were intersected by diamond drilling. The rock was a silty, graphitic slate with up to 50% of fine-grained, uniformly disseminated pyrrhotite. Robertson (15) mapped similar rock in the Batty Lake area which he describes as follows:

> "An elongate, heavily rusted lens of graphite and pyrrhotite was discovered just northwest of the sharp bend of the river leading from Walton Lake. It lies just south of the lime-rich zone and corresponds to lenses of graphite and pyrrhotite found in the Sherridon map-area to the west. Bodies of this type carry no valuable materials in this part of the province."

STRUCTURAL GEOLOGY

INTRODUCTION

The structural geology of the Snow Lake - Herb Lake area is complex. For this reason considerable time has been devoted to the preparation of two sets of vertical sections. As a means of arranging the sections and as a means of providing a uniform method of interpretation, a coordinate system was assigned to the map-area and is indicated on the map. One set of lines of the coordinate system is on a bearing of N 25° E and vertical sections along these lines are called Geologic Cross Sections. The other set of lines of the coordinate system is on a bearing of N 65°W and vertical sections along these lines are called Geologic Longitudinal Sections.

Topographic profiles were drawn along the lines of the coordinate system.

At the scale used and considering the low relief of the terrain in the Snow Lake area, no attempt has been made to plot true topographic profiles with elevations. Following preparation of the topographic profiles, the geology was plotted along the surface line and dips indicated. In the final step, the writer has made what he believes to be the best interpretation of structure on the particular section. Therefore, the sections must be used with discretion and with the full realization that they represent one person's interpretation of the data. Scaling may be done only in a horizontal direction along the surface of the section. The location of any structures indicated is not exact and is meant to serve simply as a guide to areas which may be structurally favourable to ore occurrence and in which more detailed work, to mine mapping standards, could be used to locate the structures more accurately. One stratigraphic unit of special importance in the delineation of structure is the ferruginous, calcareous, and carbonaceous facies of the Intermediate Group. This facies, because of its distinctive lithology, serves as a valuablemarker.

FAULTING

Rocks of the area have been broken into a mosaic of blocks by numerous faults. Statistical analysis of this fault pattern shows the strongest sets to be at N 40° E and N 70° W. In addition to these two well developed sets, there is a third set which strikes west of north. A fourth important fault is a low angle thrust - the McLeod Road thrust.

In the field and on air photos the N 40° E set is readily visible due to its parallelism to the direction of movement of glacial ice which striae indicate moved S 40° W. On the other hand, the N 70°W set of faults, being oriented almost at right angles to the direction of ice flow, is much less apparent in the field or on air photos.

N 40° E Set

The most prominent faults of the N 40°E set are the Cleaver Lake and the Berry Creek faults. These two faults form the northwest and southeast boundaries of a block of ground which has moved southwestward along the McLeod Road thrust. A third, minor, fault of this set is the Northern Canada fault.

The Cleaver Lake fault is poorly exposed but appears to be marked by a single plane. Southwest from Cleaver Lake the fault occurs in a pronounced topographic depression to the point where it crosses the McLeod Lake road. Southwest of the road the line of the fault cuts across rock ridges but the rocks occurring on these ridges are staurolite-garnet-mica schists which are not well adapted, by virture of their physical properties, to give much evidence of the presence of a fault surface in them. On the projected strike of the Cleaver Lake fault, the staurolite-garnet-mica schists possess four features which are believed to indicate faulting. First, offset of about 100 feet was mapped on a diorite sill which occurs in the staurolite-garnet-mica schists south of the McLeod Lake road. Second, in the staurolite-rich beds of the staurolite-garnet-mica schist formation a pronounced orientation of staurolite laths, parallel to the direction of the Cleaver Lake fault, was noted. Elsewhere, away from the probable position of the fault, the staurolite laths exhibit a completely random orientation that "box the compass". Third, erratic lenses of barren, white quartz occur near the probable position of the fault. Fourth, shear folds were noted in the vicinity of the probable position of the fault but not elsewhere. Shear-folds, which are not flexures in the strict sense of the word, are formed by successive displacements of a key bed along closely spaced fractures by an amount which is something less than the thickness of the key bed. The limbs of shear-folds are formed by slices of the key bed arranged en echelon and touching each other. Due to a lack of exposures of bedrock southwest of the McLeod Lake road, it was not possible to determine the southwest extension of the Cleaver Lake fault.

The Berry Creek fault is one of the most distinctive structural features of the area. It has been mapped for a distance of at least twenty-five miles, from Osborne Lake on the northeast to Reed Lake on the southwest. The present survey is concerned only with that portion of the fault which lies in the Snow Lake - Herb Lake area.

The Berry Creek fault, towards the eastern limit of mapping, is marked by a single line. In the vicinity of Bart Lake the single fault braids out into three separate faults, the North Branch, the Centre Branch, and the South Branch. The North Branch strikes southwest through Kormans Lake, thence to the south side of Miller Lake, crosses the Snow Lake road north of Anderson Creek and appears to develop a horsetail pattern when it enters the Anderson Lake granite mass. The Centre Branch strikes south of Kormans Lake and appears to underlie the extensive, drift-covered area northeast of Anderson Bay, Herb Lake. The next location at which the Centre Branch was mapped was on the point at the north side of the entrance to Anderson Bay where it is marked by a wide zone of quartz-sericite schist. The Centre Branch appears to continue southwest under Berry Bay, Herb Lake, rejoining the South Branch in the valley of Berry Creek.

The South Branch splits away from the single line portion of the Berry Creek fault south of Bart Lake and appears to parallel closely the northwest shore of Snow Bay and joins the Centre Branch in the valley of Berry Creek.

N 70° W Set

The most prominent fault of the N 70° W set is the West Narrows fault. The presence of a fault through West Narrows is suggested by the following evidence. First, offsetting of the ferruginous interbed (11a) of the staurolitic greywacke in the Younger Sedimentary group about 1500 feet north of the east end of West Snow Lake. Second, abrupt disruption of the bedding planes of formations of the Younger Sedimentary group on the north shore of West Narrows. Third, disappearance of the ferruginous sediments, acid volcanics and diorite sills at West Narrows whereas they occur uniformly on the west shore of Snow Lake and the east shore of West Snow Lake. Fourth, the straight lineament which marks West Narrows. Fifth, escarpments in rocks of the Younger Sedimentary group north of the east end of West Snow Lake. Sixth, lineaments, visible on air photos, but not easily discernible on the ground, which are co-linear with the direction of West Narrows in the ground north of West Snow Lake.

On the east shore of Squall Creek, at the point where it leaves Squall Lake, two faults of the N 70° W set are exposed. They dip to the north at 75 degrees. Offset beds indicate the faults are of the normal type with a dip slip of about 22 inches. The offset beds were dragged on both sides of the fault.

On the high ridge about 1 1/2 miles west of Squall Creek several faults of both sets were noted. In the brittle, siliceous, metamorphosed sediments of the Basement group the faults appear as a zone of closely spaced joints in linear depressions across the surface of the outcrops. At one place faults of the N 40° E set displace faults of the N 70° W set. At another place the opposite is true.

Northerly Trending Faults

In addition to the two major sets of faults, N 40° E and N 70° W, there is a third set which trends northerly. The most prominent fault of this set is exposed by trenching about 300 feet south of the south end of Snow Lake. This fault, here called the Creek fault, is believed to strike NNW up the middle of Snow Lake towards Bridge Creek which empties into Snow Lake about 2,000 feet west of the shaft and buildings of Howe Sound Exploration Company Limited.

It is extremely difficult to assess the nature and structural significance of the Creek fault. Except for its exposure in the pit at the south end of Snow Lake it is covered by the waters of Snow Lake and the low, swampy or drift-covered ground along the course of Bridge Creek. The chief evidence for suggesting that the fault is present under Snow Lake is the attitude of the formations of the Younger Sedimentary group on the islands, at the south end of Snow Lake just east of the assumed position of the fault. For the most part these beds strike due west towards the assumed position of the fault whereas they should strike northwest if they are part of a fold whose west limb follows the west shore of Snow Lake and whose axial plane strikes northeast through the most southerly tip of Snow Lake. A second feature suggesting the existence of the fault, also found on these islands, is a pronounced orientation of lath-like staurolite crystals parallel to the assumed direction of the fault and at right angles to the bedding. Eastward, the staurolite crystals are arranged at random. A third significant feature is the occurrence of quartz veins parallel to the orientation of the staurolites. A fourth significant feature is that the zones of oriented staurolites and associated quartz veins are usually marked by shear-folds in the sedimentary beds.

Though there may be no logical connection between the two features the writer believes it is necessary to describe the similarity of the fold pattern of the acid volcanics just east of Bridge Creek on the Nor-Acme property and the fold pattern of beds on the east side of the Northern Canada fault east of Mofin Lake. At the latter place beds striking smoothly northwest begin to curve as a narrow draw is approached. Good evidence of faulting through the draw is provided by the marked difference in rock types on either side of the draw. There are calcareous tuffs with some interbeds of siliceous sediments on the east side and massive basalt on the west side. On the east side the stratified rocks are folded by dragging into complementary anticlines and synclines that plunge north at about 20 degrees. On the geologic map the size of these folds has been exaggerated so that they could be shown. The distance from limb to limb of the most westerly syncline is about 20 feet. This fold pattern, with a proven fault adjacent to it, is almost an exact replica of the fold pattern of the acid volcanics on the Nor-Acme property just east of Bridge Creek. The writer suggests that there is a good possibility that the complementary anticlines and synclines in the acid volcanics just east of Bridge Creek on the Nor-Acme property may also be the result of drag along a fault, the Creek fault.

Though positive proof is not available without sub-surface information the writer would also suggest that movement on the Creek fault has displaced the contact between the Intermediate group and the Younger Sedimentary group. The apparent movement is that the east wall has moved south, relative to the west wall.

The relative ages of the West Narrows fault and the Creek fault are not known so it is impossible to determine how each may have affected the other. The relations between these two faults are the most important structural problem encountered to date. This problem involves the north end of Snow Lake, where there seems to be some evidence for the presence of three faults.

Towards the south end of Snow Lake, about 1,000 feet west of the shore, other faults of the northerly set were noted. In this area most of the northerly faults were mineralized and had been trenched or diamond drilled or both. The northerly faults had been displaced by faults of the N 40° E set.

Other faults related to the northerly set were noted north of West Snow Lake and southward from Tern Lake to Photo and Arm lakes.

Most of the faults of the three prominent sets have steep dips between 75 and 90 degrees.

Thrust Faulting

A low-angle thrust fault, which is here called the McLeod Road thrust, is responsible for a marked escarpment along the north side of the McLeod Lake road, southeast of Cleaver and Olsen lakes. There is some question, as noted by Harrison (11), whether this fault continues northwest and north to Squall Lake. Southeast, towards the depression marked by Bridge Creek, the McLeod Road thrust is totally obscured by drift and swamp so that its relations with the Creek fault are impossible to determine. At the Nor-Acme property a low-angle fault, marked by well-developed gouge, has been intersected in the lower workings. If projected from its underground position its surface outcrop would lie somewhere in the valley of and roughly parallel to Bridge Creek.

FOLDING

The rocks have been involved in at least two periods of folding. One period, the results of which extend throughout the entire area, was responsible for the formation of anticlines and synclines the axial planes of which strike northeast and the axes of which plunge northeast at from 10 to 20 degrees. Several distinctive structures have been developed and will be mentioned individually.

Between Varnson Lake and Squall Creek, rocks of the Basement group have been folded into a series of upright, rather open, anticlines and synclines.

The McLeod Lake syncline (Harrison, 11) is a northeasterly striking, northeast plunging structure developed in rocks of the Younger Sedimentary group. The axial plane is believed to have been disrupted by faulting and, in the author's opinion, the plunging, synclinal structure in which West Snow Lake is located can be correlated with the McLeod Lake syncline.

Going eastward from the McLeod Lake syncline the next fold which occurs is a broad, northeast plunging anticline, here termed the West Narrows anticline. The nose of this fold has been truncated by the West Narrows fault resulting in the omission of some beds from the present surface geology. The West Narrows anticline, disturbed by thrust faulting and drag folding in the hanging wall of the McLeod Road thrust, continues northeast, the axial plane being located about half way between Olsen and Birch lakes. As a result of the superimposition of two periods of folding in this area, rocks of the Intermediate group have been folded into dome structures.

East of the West Narrows anticline the rocks curve smoothly into a broad, northeasterly plunging syncline, the Threehouse syncline (Harrison, 11). The axial plane of this syncline strikes northeast through Snow Lake and then appears to continue in a more easterly direction paralleling the south shore of Herblet Lake.

The next structure to the east of Threehouse syncline is a broad, open anticline followed by a somewhat more closely folded syncline. The axial plane of the anticline is located in the vicinity of Anderson Lake and thus the fold is here designated the Anderson Lake anticline. The axial plane of the syncline, which lies just to the east of the Anderson Lake anticline, is located about on a line between the west end of Miller Lake and the small lake located about one mile south of Anderson Lake. The syncline is here designated the Miller Lake syncline.

Two well-developed folds occur in the vicinity of Southeast Bay, Herblet Lake and are readily apparent on the map. A northeast plunging anticline was mapped on the southwest shore of Southeast Bay and is here designated the Southeast Bay anticline. The strata of the Southeast Bay anticline curve rather abruptly to a form a synclinal fold in the vicinity of Whitefish Bay. This fold, an east-northeast plunging syncline, is here designated the Whitefish Bay syncline. The Southeast Bay anticline and the Whitefish Bay syncline may correlate with the Anderson Lake anticline and the Miller Lake syncline, respectively, but relationships are indistinct because of folding and faulting associated with the McLeod Road thrust.

The Miller Lake syncline marks the east boundary of a series of anticlinal folds which continues to Varnson Lake. The Berry Creek fault appears to truncate this series of folds.

In the area southeast of the Berry Creek fault the only stratigraphic unit mapped in detail was the Younger Sedimentary group. The rocks of this group have been folded in a series of tightly compressed, almost isoclinal, anticlines and synclines and in some cases the limbs have been overturned. The number of folds which could be delineated with any degree of accuracy was limited because of the extent to which the rocks are covered by water. The folds in this area have steeply inclined limbs but the plunge of the axes remains about the same as in other parts of the Snow Lake - Herb Lake area, i.e. northeast at from ten to twenty degrees.

The folding pattern in the area bounded by Snow Lake, Birch Lake, and Mofin and Olsen lakes requires some special note. The structure in this area is illustrated particularly by Geologic Cross Section 0 and Geologic Longitudinal Section 1 N.

The folding is a combination of two periods of folding. One period folded the rocks into a series of anticlines and synclines (McLeod Lake syncline, West Narrows anticline, Threehouse syncline, etc.). Another period of folding, as a result of drag in the hanging wall of the McLeod Road thrust, resulted in the development of dome-shaped folds. While the discussion here has been concerned chiefly with the area bounded by Snow, Birch, Mofin and Olsen lakes, it is reasonable to presume that similar features will occur all along the area just north of the McLeod Road thrust.

ECONOMIC GEOLOGY

INTRODUCTION

Since the discovery of gold at Herb Lake in 1914 the area has been prospected continuously.

Records of mining and prospecting activity in the area prior to 1947 may be found in reports and maps by Harrison (11), Stockwell (20), Armstrong (1), Alcock (3), Frarey (8) and Wright (22). The present report deals with more recent developments.

TUNGSTEN

A considerable amount of work and money for equipment were expended at the property of Northern Tungsten Limited on the west shore of Squall

Creek, about one-half mile north of West Snow Lake. A small mill was constructed, a short adit driven into the steep rock face on the west side of the creek and a small amount of drifting completed. From the north drift a stope was taken through to surface, a distance up the vein of about 50 feet. At least three diamond drill holes were drilled from the east side of Squall Creek at right angles to the strike of the showing. The project was abandoned, mainly due to the low grade of material which was mined. Another reason was that the mill flow sheet was inadequate to produce a commercially salable concentrate. Wilfley tables were the only concentrators used and as a result the concentrates that were produced were highly contaminated by sulphide.

The scheelite-bearing quartz occurs as lenses parallel to the bedding of the country rock which is composed of the upper formation of the Intermediate group. The hanging wall of the deposit, as revealed by diamond drilling, is made up of pyritic black slates. The footwall is composed of interbedded quartzite and calcareous tuff with a few thin layers of basic volcanics. These beds strike almost due north, and dip to the east at about 50 degrees. Faults of the N 70° W set have displaced the formations. Some strong fractures which have the same bearing as the N 40° E fault set are also present. At some points in the area both sets of faults are associated with quartz veins which appear to be filled tension fractures related to the faults. The quartz veins at the tungsten showing appear to be tension fractures related to the two prominent fault directions rather than a shear in the valley of Squall Creek.

COPPER, NICKEL

Since 1947 The International Nickel Company of Canada Limited has been actively engaged in the search for nickel in a large section of northern Manitoba of which the Snow Lake - Herb Lake area is part. In 1948 The Canadian Nickel Company Limited was registered in Manitoba as a wholly owned subsidiary of The International Nickel Company of Canada Limited to conduct the exploration operations of the latter in Manitoba.

Preliminary investigations were carried out by airborne magnetometer surveys. The airborne magnetometer surveys were followed by ground magnetometer and electromagnetic surveys and, where encouraging anomalies were detected, by diamond drilling. The only deposit of commercial proportions reported in the map-area is at Rice Island in Herb Lake. A group of claims covering the Rice Island depsit are now owned by The International Nickel Company of Canada Limited.

The copper-nickel-bearing sulphides (chalcopyrite, pyrrhotite and pentlandite) of the Rice Island deposit occur in a soft, rusty weathering phase of the basic intrusive rocks which form the island. On the northeast side of the island the rock is hard, massive, medium- to coarse-grained, jointed gabbro containing a few specks of sulphide. At the southwest tip of the island, on the northwest side, the gabbro weathers to a yellowish brown colour. Weathering has proceeded most rapidly along the joints and has penetrated joint blocks. The result is an outcrop composed of soft yellowish brown rock containing hard, residual cores of joint blocks. The soft material does not contain sulphides; the hard cores of the joint blocks, when broken into, reveal the disseminated sulphides. According to the arrangement of diamond drill holes used to explore the deposit, the orebody plunges to the northeast.

The basic intrusive at Rice Island resembles other intrusives in the area as far as the mode of emplacement is concerned. Most of the intrusive rocks of the area appear to have been intruded into openings formed by the pulling or forcing apart of sedimentary beds during orogenic periods. If this is true, the mechanism involved would be similar to that which has been postulated for the formation of the saddle-reef type of quartz veins in which differential slippage along bedding planes has resulted in the arching of some beds with an opening forming between the arched bed and the next lower bed. Armstrong (2) has suggested a similar type of mechanism in the localization of quartz lenses in the Elbow Lake area.

Another mass of gabbro which contains copper-nickel bearing sulphides occurs on Eureka Island in Herb Lake near the south limit of mapping. Hard and soft phases similar to those on Rice Island are present but the Eureka Island intrusive appears to be smaller than the Rice Island intrusive. Again, the sulphides occur with soft, yellowish-brown weathering gabbro.

On the point between Anderson Bay, Herb Lake and Snow Bay, Herb Lake, near the southwest end of the point, several outcrops of gabbro were noted but due to extensive drift covering it was difficult to determine the extent of this intrusive.

In the area between Herb Bay, Herb Lake and Crowduck Bay, Herb Lake, other masses of sulphide-bearing gabbro were examined. Armstrong (1) has outlined these masses of basic intrusive. About one-half mile inland from the shallow bay on the south shore of Herb Bay, several large pits have been excavated in reddish-brown weathering gabbro. The gabbro is hard, medium to fine grained, and contains some chalcopyrite and pyrrhotite. A large proportion of the sulphide is pyrite. In addition to the disseminated sulphides a nearly horizontal lenticular vein up to ten inches wide of massive pyrrhotite containing some chalcopyrite occurs in one trench. The reddish-brown weathering of the mineralized rock and the presence of more abundant pyrite, as compared to pyrrhotite, distinguish the mineralized zones here from those on Rice Island and Eureka Island. Samples taken from all three deposits indicate that the pyrite-bearing deposits have the lowest nickel content.

Due to the mode of intrusion by which the author believes that basic intrusives were emplaced, it is concluded that plunge of the mineralized zones will be an extremely important factor in planning any exploration program. It is suggested that a "step-out" plan of drilling, similar to that employed by oil companies, will be most efficient. Such a plan would involve drilling vertical holes on the predetermined grid arrangement and then, as the attitude of the mineralized zone becomes apparent, "stepping out" and drilling additional vertical holes. Once the attitude of the mineralized zone was determined adequately, inclined holes could be laid out to intersect the zone.

COPPER, ZINC[1]

The presence of copper-zinc mineralization has been known since 1914 when a mineralized zone at Osborne Lake was staked. In the last two years this deposit has been intensively explored by diamond drilling by the Hudson Bay Mining and Smelting Co. Limited and mineralized zones of commercial grade and size have been outlined.

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1 Early in 1956 two important base metal discoveries were made in the Snow Lake area by Hudson Bay Mining and Smelting Co. Limited. One of these is located at the west end of Miller Lake, one and one-half miles east of Anderson Lake. The ore, reported to be principally chalcopyrite was located by diamond drilling an electromagnetic anomaly under the swamp at the west end of the lake. The other deposit, discovered by similar means, is located beneath and east of the south end of Chisel Lake, five miles south-

Most of the occurrences of copper-zinc mineralization in the map-area are confined to the zone of rocks along the course of the Berry Creek fault. At present the entire zone of the Berry Creek fault, from northeast of Osborne Lake to Reed Lake is being explored by electromagnetic surveys followed by diamond drilling.

Most of the copper-zinc mineralization occurs as stringers in shears or in gash fractures adjacent to shears. Southwest of the southwest end of Anderson Lake, disseminated chalcopyrite with some sphalerite occurs in a well-defined band of garnet-chlorite schist.

Geophysical work followed by X-Ray diamond drilling indicated the presence of copper mineralization under the extensive drift covered area located northeast of Anderson Bay. Here the mineralization occurs in garnet-chlorite schist.

In the area between Whitefish Bay, Herblet Lake and Herb Bay, Herb Lake, several rusty weathering zones occur. Some of these contain small amounts of chalcopyrite but most of the sulphide is pyrrhotite which appears to be of the kind believed to be of sedimentary origin and which is commonly associated with the ferruginous sedimentary rocks of the Intermediate group.

Some copper-zinc mineralization occurs on the northeast shore of Angus Wood's Bay, Herblet Lake, at the north end of the bay.

LITHIUM, BERYLLIUM

Deposits of spodumene and beryl were discovered near Crowduck Bay in 1931. The most important of these is on the northwest shore of Crowduck Bay, just east of the limit of mapping. These deposits have been explored and acquired by Sherritt Gordon Mines Limited.

In 1955, interest in lithium increased considerably and numerous lithium-bearing pegmatite dykes were discovered south of Crowduck Bay, just east of the present map-area. Considerable stripping and diamond drilling has been conducted, principally by Green Bay Mining and Exploration Limited and Combined Developments Limited, both of Edmonton.

The net effect of recent exploration has been to establish a belt of favourable ground for prospecting which is about 25 miles long.

RADIOACTIVE MINERALS

Periodical attempts have been made at prospecting for uranium but to date no deposits have been located. There are numerous radioactive zones in the eastern part of the map-area. On the northwest shore of the northeast arm of Herblet Lake, a radioactive yellow staining occurs in the granite portion of a contact zone composed of granite and remnants of arkoses of the Younger Sedimentary group. In outcrop the yellow stain gives a strong signal on a geiger counter. However, when chipped off and tested separately, the radioactivity decreases rapidly to background within two days. Similar yellow staining was noted on the north shore of Southeast Bay, Herblet Lake on the curving shoreline located north-northeast of the entrance to Whitefish Bay.

A large number of geiger counter readings were taken along the shores of Herblet Lake. In particular, the pebble beds on the southeast shore of the lake were checked but failed to give any interesting readings.

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west of Snow Lake and south of the present map-area. The principal ore mineral is sphalerite, with minor amounts of chalcopyrite, galena, and gold. No surface indications of these deposits are visible. At time of writing, the company had not released information relative to size and grade.

PRECIOUS METAL EXPLORATION

Introduction

In recent years the emphasis in exploration has been directed more to the search for base metals than for gold. Careful stripping, trenching, diamond drilling, and geological mapping on a scale of one inch equals eighty feet has been conducted by Howe Sound Exploration Company Limited on the Nor-Acme property. The investigation was carried to Birch Lake and to the property of Snow Lake Gold Mines Limited east of the Howe Sound property.

Association of Quartz Veins and Garnets with Siliceous Volcanic and Sedimentary Rocks

Prior to the 1954 field season Mr. Frank Ebbutt, Chief Geologist for the Howe Sound Exploration Company Limited, pointed out to the writer a relationship which seemed to exist between the occurrence of quartz veins and the presence of siliceous volcanic and sedimentary rocks. Later discussions with Mr. Nelson Hogg revealed more data concerning the relationship. During the field season the writer found this association of quartz veins and siliceous rocks to be readily apparent. In most of the Basement group and Intermediate group quartz veins are rare except in the vicinity of siliceous rocks. This is particularly true in the ground north of the Nor-Acme property. A glance at the geological map shows how frequently prospects in the vicinity of Snow Lake occur near formations which include acid volcanics and siliceous sediments. Of interest too, in this respect, is the fact that the Nor-Acme orebody is associated with the largest volume of acid volcanics in the area.

Another relationship noted by the writer was the marked tendency for garnets to appear in almost every type of rock whenever these rocks lay in close proximity to sedimentary rocks. In the area west and northwest of Birch Lake, otherwise non-garnetiferous basic volcanics became garnetiferous as their contact with the overlying sediments was approached. South of West Narrows and West Snow Lake, sill-like masses of diorite and basic volcanic flows become garnetiferous as their contact with the overlying sediments is approached. On the south shore of the west end of West Narrows joint surfaces in a mass of diorite are studded with irregular patches of poorly formed garnets whereas the rock itself contains very small, euhedral garnets.

The writer believes that the occurrences of quartz and garnet described above are evidence of migration of material during metamorphism. The distribution of these minerals does not show any relation to the granite masses near the area. The basic volcanics and intrusives do not have garnets or quartz veins except in the vicinity of acid volcanics and siliceous sediments. It is suggested that silica required for the formation of quartz veins and silica required for the formation of garnets, in silica-poor rocks, was derived from the siliceous rocks.

The Economic Significance of the Carbonate Rocks

Carbonate rocks occur mainly as extensive occurrences of ferruginous crystalline limestone and to a lesser extent as a gangue mineral in mineralized shears.

Most of the ferruginous crystalline limestones weather to a deep, reddish brown colour. Deep weathering of these rocks has produced extensive areas of reddish brown soil on the hills just north of the McLeod Lake road from Bridge Creek to Olsen Lake. According to Mr. Alex Mosher, (personal communication) a large number of samples taken from these gossans were tested for gold with negative results.

As in the case of the ferruginous sediments which contain pyrite and pyrrhotite, prospectors cannot ignore the gossans produced by weathering of the limestone. However, the gossans can be tested easily by panning and if no gold is obtained there is practically no chance of finding values in the bedrock below.

Carbonate gangue minerals in shear zones include calcite and ankerite.

The Economic Significance of Arsenopyrite

The most important gold values in the Snow Lake area are associated with arsenopyrite. In spite of this there is no fixed relationship between the presence of arsenopyrite and the presence of gold.

The writer examined showings on a group of claims held by Mr. William English and associates. These claims are located about two miles east of Snow Lake north of the Snow Lake road. The arsenopyrite which carries high gold values on the English claims has an appearance different to barren arsenopyrite noted by the writer elsehwere in the map-area. The gold-rich arsenopyrite is characterized by a light, yellowish brown surface stain which also appears along fractures and grain boundaries of the specimen.

An example of barren arsenopyrite noted by the writer is located on the north shore of West Narrows about 200 feet west of the west boundary of the Howe Sound property. Here, the arsenopyrite was fresh, unstained, and assayed less than 0.02 ounce of gold. The mineralization is located along a shear in rocks of the lower part of the Younger Sedimentary group. The wall rock of the shear is a fine-grained, greenish black rock which contains disseminated small red garnets. Several of the individual garnets in this wall rock are surrounded by arsenopyrite.

The Significance of Structure in the Occurrence of Gold Values

Gold mineralization is associated with shears or folds or a combination of both. At the Nor-Acme property the orebody is located on a fault (the Howe Sound fault) which truncates the nose of a fold. Some gold values have been found along West Narrows, Snow Lake where, as noted previously, the author believes the nose of the West Narrows anticline has been truncated by the West Narrows fault.

In the area between Birch Lake and Olsen and Mofin lakes, Northern Canada Mines Limited carried out an intensive program of exploration, as reported by Harrison (11). No further work has been done since that time but in view of the writer's interpretation of the structural geology of this area, it is believed that some discussion should be presented. Stripping and trenching by Northern Canada Mines Limited exposed one zone of mineralization which strongly resembled that of the Nor-Acme orebody. Diamond drilling, which included some vertical holes, seemed to indicate that the mineralized zone was a nearly horizontal lens. The writer's interpretation of the structure here is that cross folding has produced a series of domes. The writer further believes (see Geologic Cross Section 0 and Geologic Longitudinal Section I N) that there is a strong possibility that the occurrence of gold values in this area is similar to that reported for the Bendigo field in Australia where saddle reef orebodies are located in the hanging wall of a thrust fault, (Thomas, 21). It is believed that the idea of mineralized planes would have to be abandoned almost completely as far as further exploration work is concerned in the area between Birch Lake and Olsen and Mofin lakes.

From the south end of Snow Lake to Noteme Lake, mineralized quartz veins occur in northerly trending shears which are parallel to theCreek fault. The continuity of these northerly trending, mineralized shears is broken by faults of the N 40 E set. Many of these shears were prospected during the rush of exploration which followed the decision to develop the Nor-Acme property. The prospects in this part of the area appear to be haphazardly distributed and made up of many short lengths of vein. In the writer's opinion, most of this erratic distribution is a result of faulting by the N 40 E set and there is a good possibility that the scattered showings, instead of being individual veins, may be faulted segments of a much smaller number of larger veins.

As far as the structural control of gold localization is concerned, one significant result of the present survey has been the delineation of a structure, with which some gold values are known to be associated, in the area between Herblet Lake and Snow Creek. The structure occurs near the east end of a large swamp southwest of Southeast Bay, Herblet Lake. According to the writer's structural and stratigraphic interpretations this structure is quite similar to that at the Nor-Acme property (see structure sections). In the corner where the large swamp turns from a north-northeast trend to a southeasterly trend, on the south side of the swamp, a limited amount of trenching and diamond drilling are reported to have found material containing up to 0.318 ounces of gold per ton. The mineralization is composed of gold associated with arsenopyrite and occurs in siliceous rocks of the Intermediate group. The wall rocks are chiefly feldspathic quartzite and arkose.

Some gold mineralization occurs along the Berry Creek fault, particularly along the North Branch. Three showings are indicated on the map, one at the east end of Miller Lake and two south of Anderson Lake. In all three of these occurrences, the gold values are found in shear zones in the older granite.

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