CANADA
DEPARTMENT OF MINES
HON. W. A. GORDON, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

GEOLOGICAL SURVEY
W. H. COLLINS, DIRECTOR

Summary Report, 1930, Part C

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OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1931

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NOTE. Part B of the Summary Report formerly included reports relating to the provinces of Manitoba, Saskatchewan, and Alberta, and to the part of the North West Territories lying north of these provinces. It now contains only reports that deal with the southern and western parts of this region underlain chiefly by Palæozoic and later formations. Part C is a new part comprising reports that relate to the northern and eastern portions of the same region, which are underlain chiefly by Precambrian formations. What has hitherto been called Part C is now part D. It relates to the provinces of Ontario, Quebec, New Brunswick, Prince Edward Island, and Nova Scotia, and to the part of the North West Territories lying north of these provinces and east of Hudson bay.

GEOLOGY AND MINERAL DEPOSITS OF NORTHWEST MANITOBA

By J. F. Wright

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Illustrations

INTRODUCTION

The present report summarizes the general features of the geology, and describes in some detail many of the mineral occurrences of the main prospecting belts in that part of northwest Manitoba extending east 150 miles from the Manitoba-Saskatchewan boundary and 60 miles north from latitude 54° 30′ (*See* Figure 1). The report is based on field observations by the writer during the summers of 1928 and 1930, and the writings of Bruce, Alcock, Wallace, and Spurr. During 1930, mineral deposits were visited in all the prospecting areas within this large district, and in this work Messrs. E. D. Kindle, Ernest Shaw, and Roland Quesnel assisted ably. The writer wishes to thank the officials of all companies prospecting and developing deposits in the area, and local prospectors, for many courtesies extended the party and other acts of friendliness and co-operation.

The two important types of mineral deposits of the district are replacement sulpnide bodies and gold-bearing quartz bodies. The sulphide bodies are massive and disseminated replacements along zones of schist in volcanic, sedimentary, and intrusive basic rocks. Either pyrite or pyrrhotite is abundant in all deposits. In some, chalcopyrite and sphalerite occur with the iron sulphides to make an ore of copper and zinc. The combined gold and silver content of the deposits is low. Nickel occurs in some deposits

in or near bodies, of quartz gabbro, and a few deposits contain galena. Since 1928 many sulphide bodies have been explored by surface work and diamond drilling and Flin Flon and Sherritt-Gordon are now producing copper. The gold deposits are confined for the most part to the areas about Elbow and Wekusko lakes. They have received little attention since 1925. The exploration of these deposits indicates that the high-grade quartz bodies are small and lenticular, and the gold content of the large deposits is disappointingly low.

Up to the present the majority of the mineral discoveries in northwest Manitoba have been made near Kississing, Schist, Athapapuskow, Elbow, Reed, and Wekusko lakes (*See* Figure 1). The main prospecting fields in the district are outlined by the areas of volcanic and sedimentary rocks, and these lakes occupy large, irregular-shaped basins within these rocks. In most of the district, granitic rocks underlie large portions of the country between these large lakes and few mineral discoveries have been made in such areas.

Most parts of Kississing, Schist, and Athapapuskow Lakes prospecting areas are now easily accessible by canoe or motor boat from points on the Canadian National branch lines to Flinflon and Sherridon. Elbow Lake area can be reached in one-half day from Cranberry Portage using canoe and motor. This route is navigable for large canoes or small barges if the water is high. There are no portages after leaving the east end of Cranberry portage, across which a wagon road leads from the railway station. Wekusko Lake area is reached by a 12-mile motor road from Mileage 85 on the Hudson Bay railway. The south end of the prospecting field extending north and northwest from the west end of Reed lake across Morton, File, Loonhead, Limestone Point, Batty, and Walton lakes is accessible by canoe from Wekusko lake following Grass river west, or from Cranberry Portage following Grassy river east or down stream. The northwest end of this belt can be reached quicker by a canoe route east from Sherridon to Walton lake.

The areas of volcanic and sedimentary rocks in the eastern end of the district are smaller than those of the areas mentioned in the foregoing paragraph, and here granitic rocks are widespread. Small areas of sediments and lavas, however, lie on or near Setting, Paint, Ospwagan, Mystery, Wintering, and Partridge Crop lakes, and mineral prospects have been discovered in all these areas. Setting lake is easily reached by a wagon road, about a mile long, from Wabowden. The canoe route to Paint lake is either from Wabowden down Grassy river or from Thicket Portage. From Thicket Portage two routes may be taken, the short route is from the northwest bay of Wintering lake, with two long portages, and the longer route, recommended if using a motor attached to the canoe, follows the river northwest from Wintering lake to Partridge Crop lake, thence west up Grassy river. A canoe route leads from the north shore of Paint lake across two short, and one long, portages over a height of land to Ospwagan lake and thence northeast down Manasan river to the Burntwood, and it is followed east to the first large river from the north, which leads to Mystery lake. Mystery lake can be reached in two days by following the canoe route leading either from Wabowden or Thicket Portage.

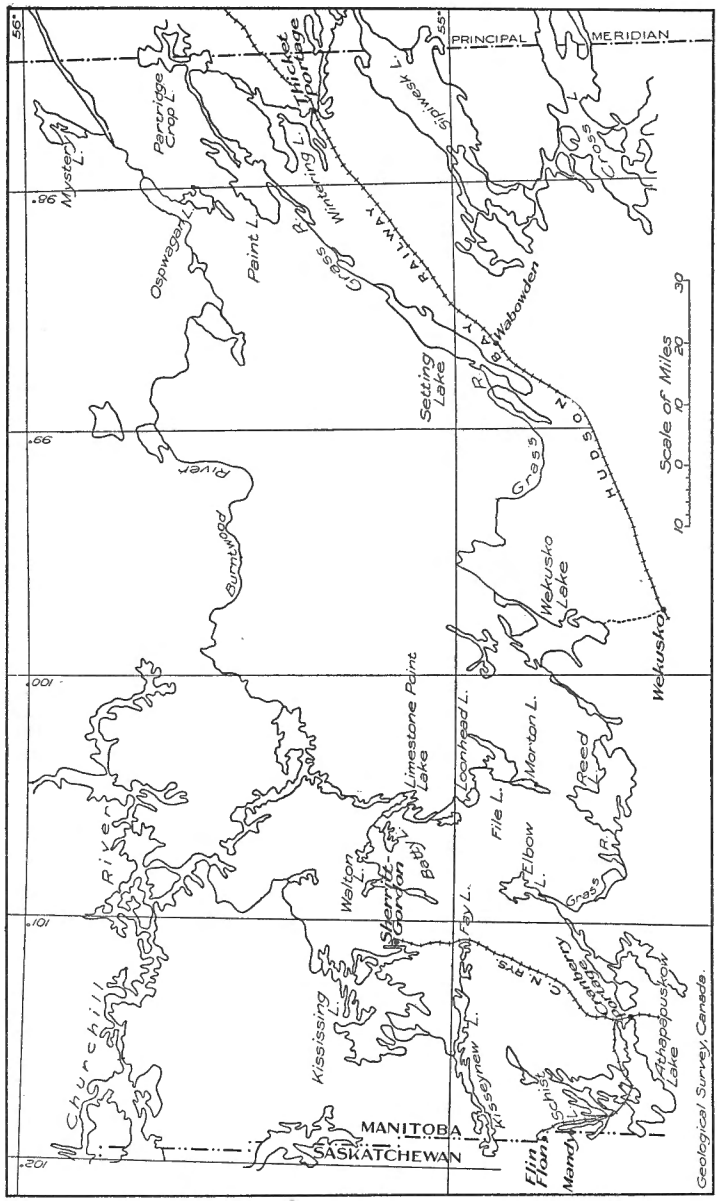

Figure 1. Index map of part of northwest Manitoba.

The many large and small lakes in the district and the proximity of the prospecting ground to these lakes makes the country ideal for the use of hydroplanes for transportation in prospecting work. Hydroplanes have been used extensively by some of the mining companies operating in the district during the past few years. The Royal Canadian Air Force maintains airports at Cormorant lake and Thicket Portage on the Hudson Bay railway. During the summers of 1929 and 1930, Consolidated Mining and Smelting Company used a Moth plane successfully in transporting their mining scouts and some light equipment from point to point in this large area.

PHYSICAL FEATURES

All the prospecting areas in northwest Manitoba exhibit the same general physical features. The region lies along the southwest margin of the Canadian Shield, and typically displays the general flat appearance and hummocky surface so characteristic of this extensive area, especially around parts of its margin. In the area described in this report only a few of the hills rise over 100 feet above the neighbouring lakes and surrounding swamps. Most of the rock exposures inland from the lakes or rivers are along the side or on top of the ridges, as the large, flat, intervening areas are floored with thick deposits of Glacial drift and post-Glacial stratified clay. In such areas any rock exposures are small and hard to find as here the trees and thick underbrush limit the visibility to about 100 feet in every direction. In some such areas bedrock can be seen only by pulling moss off the sides of knolls or at points where a tree has blown down and a small patch of rock is exposed where the roots of the tree grew. In the eastern end of the region, the surfaces of large areas are nearly flat, the depressions being practically filled with deposits of drift and muskeg. Here, bushes grow for the most part only on scattered knolls and near the lakes and rivers. If the season is rainy, the large muskegs are saturated with water, and the surfaces of some such areas are so soft that they can be crossed only with difficulty and danger.

Large areas of the prospecting fields of northwest Manitoba have been swept by severe forest fires and the moss, thin deposits of peat, and timber have been burned. In such areas rocks are fairly well exposed. Several years after a fire, however, the burned trees are blown down in various directions and this, combined with a new growth of thick bushes, makes travel across such an area more difficult than before the fire.

The rocks are as a rule well exposed along the lake shores and rivers and most of the geological work and prospecting to date have been done along or near the waterways. At least 90 per cent of the mineral deposits discovered to date are along or within one-half mile of the lakes or rivers of the district. The large inland areas are difficult of access and up to the present have been examined only in a general way. In most areas this appears to be justified, for the areas of volcanic and sedimentary rocks carrying the mineral occurrences are limited in extent to belts passing through the lakes and along the rivers, the large inland areas for the most part being underlain by granitic rocks not likely to carry valuable ore-bodies.

GLACIATION, GLACIAL AND POST-GLACIAL DEPOSITS

In Pleistocene time northwest Manitoba was crossed by one or more continental ice-sheets, the last of which advanced from the northeast. The surfaces of many rock exposures are polished, grooved, and striated, and the profile of many knolls and islands, trending in a general north direction, exhibit on the north side a gradual slope to the summit and an abrupt drop to the swamp or lake level on the south end. The direction of ice movement as indicated by glacial striæ was variable in any one area, and from west to east across the district there was a marked difference in direction of the general movement of the ice. In the vicinity of Kississing, Athapapuskow, and Elbow lakes the striæ vary in trend from south 20 to south 50 degrees west.[1] On Reed and Wekusko lakes two sets of striæ are recognizable, the one bearing south 30 degrees west and the other crossing the first, bearing south 10 degrees west. The striæ on some outcrops about Wekusko lake trend south 5 to 10 degrees west. The striæ are at about south 20 degrees west as far east as Setting lake. Northeast of this lake and about Paint, Mystery, and Wintering lakes the last ice-sheet moved south from 68 to 75 degrees west. A few poorly defined striæ were noted on Wintering lake running south 20 degrees west. The striæ trending from south to southwest are considered to have been formed by the Keewatin ice-sheet, originating west of Hudson bay, whereas the westward striæ may have resulted from a later invasion from the east by the Labradorean ice, which spread as far west as Burntwood river north of Paint lake. J. B. Tyrrell[2] concluded that the Labradorean ice-sheet reached as far west as White Forest rapid on Grass river, or about 15 miles west of the southwest end of Setting lake. Prospectors should note carefully blocks of quartz or rusty, sulphide-bearing rock, and, by determining the direction of striæ on nearby outcrops and noting carefully the character of the rock of the block, attempt to locate the source of the drift. This has been done successfully in a few cases where quartz blocks have been traced to their source, which was nearby, but hidden under a thin mantle of moss and drift.

The glacial deposits are largely covered with moss, soil, muskeg, or stratified clay, and are exposed only in prospect trenches, or a few small cuts along rivers or lake shores. The drift includes boulder clay, gravel, and sand, and in character and distribution is typical of ground moraine deposits formed by a retreating ice-sheet. No typical esker or kame-shaped deposits were noted, although some of the gravel is roughly stratified. A gravel ridge whose larger axis trends northeast occurs northwest of Mystery lake, and is a part of a long terminal moraine formed in front of the ice-sheet during an interval when its front was stationary. In the part of the district from Wekusko to Partridge Crop lakes, varved and stratified clays lie on top of the drift. As already stated, the clays here fill the shallow depressions in the surface and, over some large areas, cover all the rocks. These clays were deposited in post-Glacial Lake Agassiz that extended southward in front of the ice-sheet and, for a time, covered the eastern side of the district. The clays are excellent soil for farming if the forest or thick, peaty overburden is removed. Tests of samples of

[1] All bearings given in this report are magnetic.
[2] Geol. Surv., Canada, Ann. Rept., vol. XIII, pt. F, p. 46 (1900).

the clay from Wintering lake indicate that it is not satisfactory for the manufacture of brick.[1] The recent deposits include peaty materials accumulating in some shallow lakes, and sand and clay forming about the entrance of some streams into shallow bays of lakes.

NATURAL RESOURCES OTHER THAN MINERALS

Previous to the commencement of prospecting, fur-bearing animals were an important resource of northwest Manitoba. Many Indians and a few white trappers were scattered throughout the district during the winter months. The chief varieties of fur included fox, muskrat, otter, martin, lynx, fisher, mink, weasel, wolf, and bear. In recent years the southern part of the district has been trapped intensively, and fur-bearing animals are now scarce. Large areas of the forests here have also been burned, thereby destroying the habitat of the wild animals. In some areas moose and woodland caribou are fairly abundant. A few deer are entering the southern part of the district. Ducks are fairly abundant in some lakes in the autumn and in September, 1930, geese were abundant on Burntwood river east of the first falls east of Manasan river.

Some of the larger lakes near the Hudson Bay railway have been fished intensively during the winter months. Whitefish, pickerel, and trout are the varieties of fish most sought. Fishing is a profitable industry some winters. According to a statement by the Canadian Government Information Bureau, dated April 25, 1931, thirty-eight lakes were being fished in northern Manitoba in 1930, and over 2,175,000 pounds of fish were caught. The catch from Athapapuskow lake amounted to 118,000 pounds of whitefish, 15,000 pounds of trout, and 18,000 pounds of other varieties of fish.

The forests have been burned over wide areas and most of the timber of commercial size remaining is localized to patches on large islands or along lake shores. White spruce and in some areas balsam are the most valuable timber. Jackpine of commercial size grows on some of the sandy areas. Black spruce and tamarack grow in some poorly drained areas. Small black spruce grow in some muskegs, and jackpine bushes are thick in some rocky granite areas. Poplar and small white birch are abundant on some rolling clay areas. An area of good timber is reported on some of the large islands in Sipiwesk lake on Nelson river. The mining companies operating in the area have found imported timber as cheap and more satisfactory than timber available near the mines.

Agriculture has not been undertaken anywhere on a large scale. Many prospectors and traders have excellent vegetable gardens, situated for the most part on islands in lakes. On July 30, 1930, cucumbers were 8 inches long in Mr. Bartlett's garden on the south shore of Reed lake. Potatoes and peas were abundant in the gardens about August 10. Tomatoes ripen near the end of August. A few varieties of annual and perennial flowers and roses have been grown successfully. Excellent wheat has been grown at Thicket Portage, Hudson Bay railway. Large tracts of land along certain parts of Grassy river between Wekusko and Setting lakes are suitable for agriculture. In the western side of the district no large tracts of land near the Flin Flon or Sherritt-Gordon mines are suitable for agriculture, and a large farming community is not likely

[1]For details *See* section of this report dealing with the geology about Wintering lake.

to develop about these mines, as has been the case in parts of northern Ontario. Some small areas of land between rocky ridges have already been cultivated successfully about the northern Manitoba mines. The summer growing season is from about June 20 to August 30, but growth is rapid as the days are long and hot. The first heavy frost in 1930 was on September 6, when ice formed in a water pail at camp on Burntwood river near the mouth of Manasan river.

The falls on Churchill and Nelson rivers form valuable sites for hydro-electric plants. Island falls on Churchill river has been developed by Hudson Bay Mining and Smelting Company, and this site will supply power for both Flin Flon and Sherritt-Gordon mines. Bloodstone falls on Churchill river, east of Island falls, is estimated to be capable of developing over 40,000 horsepower. Whitemud falls on Nelson river at the east side of the district is an excellent natural power site and here 290,880 horsepower can be developed.[1] Some of the falls on Grass river might be a source of a small supply of electrical power. The flow of water in this river during winter months, however, is reported to be low, thus these sites are not attractive, except where large natural storage basins can be developed above the falls.

GENERAL GEOLOGY

The information regarding the lithological character and age relations of the various groups of Precambrian rocks of northwest Manitoba is based on reconnaissance surveys by Bruce and Alcock between 1914 and 1918, and by the writer in 1928 and 1930, and on a more detailed examination of a few small areas near the more important mineral deposits. The detailed investigations have not been extended over wide enough areas to establish a well proved geological succession for the whole district. The rocks, however, may be divided conveniently on the basis of their origin into two main groups: (1) those of superficial origin, that is lavas and sediments, and (2) those of intrusive, deep-seated origin, the granites, gabbros, and related types. The main members of these two groups are listed in the following two tables.

Formations of Surficial Origin

Missian sediments.....	Greywacke, quartzite, arkose, conglomerate, and derived mica and hornblende schists
	Unconformity
Wekuskoan sediments and lavas....	*Kisseynew sedimentary gneisses*, including gneissic quartzite, quartz-mica-garnet gneiss, quartz-hornblende-plagioclase-garnet gneiss, and crystalline limestone
	Wekusko-Kiski sediments and lavas, including mica schist, garnet, staurolite and cyanite gneisses, greywacke, arkose, conglomerate, iron formation, basalt, andesite, rhyolite, and chloritic and sericitic schists
	Amisk lavas and sediments, including basalt, andesite, rhyolite, agglomerate, tuff, cherty quartzite, slate, chlorite and sericite schist

[1]Attwood, C. H.: "The Power Possibilities of the Nelson River"; Trans. Can. Inst. Min. and Met., vol. 28, pp. 330-338 (1925).

Formations of Deep-seated Origin

Younger Basic intrusives.....	Olivine diabase
	Intrusive contact
Post-Missian granitic and basic intrusives.....	Hornblende and mica lamprophyre Pegmatite and aplite Granite Quartz diorite and granodiorite Pyroxenite, peridotite, gabbro, and quartz gabbro
Older (?) intrusives.....	Granite-gneiss, syenite-gneiss, and quartz porphyry

The relative ages of the two groups of surficial rocks have been clearly established at a few localities, and there the Missian sediments unconformably overlie the Wekuskoan strata. At other localities, however, Missian sediments or strata of other ages may have been included within the Wekuskoan. The age relations of some bodies of the intrusive rocks to each other and to the two groups of surficial rocks are not definitely known. Some bodies of granite are known to be younger than the Missian sediments. Pebbles of granite in members of both the Missian and Wekuskoan groups prove that granite was somewhere exposed in the district at the time these rocks were deposited. It is not known definitely, however, whether any of the granitic bodies now exposed in the district were the sources of these pebbles. At some localities granitic gneisses are cut by pyroxenite and gabbro and these basic rocks are cut by dykes of granite and pegmatite. These relationships suggest granitic intrusions of two ages, but present information does not indicate whether the apparently older granites were intruded in the interval between the deposition of the Wekuskoan and of the Missian strata or whether their intrusion took place during or earlier than the Wekuskoan period of vulcanism and sedimentation.

WEKUSKOAN SEDIMENTS AND LAVAS

Alcock in his report[1] on the Reed-Wekusko Lakes region introduced the term Wekusko group to include "a complex of volcanic and sedimentary rocks that have been closely folded and metamorphosed and intruded by granite batholiths". To the volcanic members of this group he gave the name Kiski volcanics and the sediments he named Wekusko series. Bruce,[2] writing at an earlier date, did not give a name to a lithologically somewhat similar group of volcanic and sedimentary strata about Athapapuskow and Kisseynew lakes, but described the lavas as being the Amisk series or Amisk volcanics and the sediments as the Kisseynew gneisses and both series as being older than the Missi series. In the present report the term, Wekuskoan group (not Wekusko group), is employed to include all the sedimentary and volcanic strata of the region that are older than the Missian sediments. Future detailed work may prove this group to include two or more series of rocks widely separated in age.

[1]Geol. Surv., Canada, Mem. 119, p. 16 (1920).
[2]Geol. Surv., Canada, Mem. 105, p. 9, and Map No. 1726 (1918).

Amisk Lavas and Sediments

The general character of the Amisk rocks about Athapapuskow lake is described by Bruce[1] as

"a complex of very ancient surface flows, fragmental rocks of volcanic origin such as ash beds and agglomerates, and to a lesser extent intrusive rocks that are probably closely related to the surface types. Most of the rocks were originally of medium basicity, probably dioritic in composition, but they are now altered to rocks consisting almost entirely of secondary minerals, chiefly chlorite, uralite, calcite, serpentine, and iron oxides. Shearing and compression have changed many of the members of this complex into schists."

The more massive lavas are black to grey, medium-grained basalts, andesites, or rhyolites. In the basalts and andesites black hornblende and plagioclase, either labradorite or andesine, are the essential minerals. Grains of quartz are visible on the weathered surfaces of the grey rhyolite or rhyolite porphyry. The black, basic lavas are far more abundant than the grey, acidic types. A few flows of andesite exhibit pillow or amygdaloidal structure. Some rocks included in the lavas are coarser grained than the abundant type, and these may be either the interior of thick flows or else intrusives formed during the period of volcanic activity. At some localities, the lavas present a marked variation in composition and texture within half a mile across the strike of the flows. Hornblende, chlorite, and sericite schists derived from lavas are widespread among the Amisk volcanics. The hornblende schists are for the most part localized to areas adjacent to the bodies of granite. Long needles of hornblende and actinolite are the abundant minerals of such rocks, and the plagioclase is recrystallized to albite, quartz, and calcite. The hornblende needles are arranged parallel. They are fresh, highly pleochroic, and contain included grains of quartz. The chloritic and sericitic schists are localized to narrow bands between rock ridges or along the lake shores. They are green, grey, or white, highly fissile rocks. Many of the quartz veins and sulphide bodies about Athapapuskow and Elbow lakes are within chloritic and sericitic schists, derived from lavas or associated tuff beds. The minerals of many of the massive-appearing lavas are altered to an aggregate of secondary minerals with or without parallel orientation.

Narrow bands of fragmental rocks of volcanic origin occur at many localities within the areas of lavas. In places the fragmental rocks are breccias, produced by movements of the lava after a part of the flow had consolidated. Others are of fragments of lava of various shape and size, up to 3 feet across, embedded in a matrix of bedded, grey, ashy-appearing materials or slightly schistose lava. These fragmental volcanics are exceptionally well exposed from Bakers narrows along the north arm of Athapapuskow lake. Here, agglomerates, tuff-like and other quartzose and slaty sediments, and basic and acidic lavas are interlayered.

Bands of quartzose and slaty sediments up to half a mile across are present at some localities in the Amisk volcanics. One such area of sediments west of the northeast arm of Schist lake was mapped by Bruce[2] as belonging to the Lower Missi series, and, therefore, as younger than the Amisk volcanics, but Bruce wrote[3] that "the structural relations of this

[1]Geol. Surv., Canada, Mem. 105, p. 23 (1918).
[2]Geol. Surv., Canada, "Athapapuskow Lake Region," Map No. 1726.
[3]Geol. Surv., Canada, Mem. 105, p. 31.

belt with the Amisk volcanics and the lack of any observed unconformity between the two types make it seem possible that the Schist Lake belt is merely a slaty zone in the volcanic series rather than a representative of the Lower Missi sediments." Other bands of sediments occur about Thompson lake and the east end of Kisseynew lake. Some of the beds about Thompson lake are of quartzite and calcareous quartzite. On Weldon bay, Kisseynew lake, quartzite, quartz-mica-garnet gneiss, and lava apparently are conformably interbanded. In all the areas of sediments studied in detail, including the one on the northeast arm of Schist lake, the sediments appear conformable with the lavas, and no evidence was seen to suggest folding or faulting of these strata within the lavas. Such beds of sediments are interpreted as deposits formed in bodies of water at certain localities over the volcanic field during intervals when volcanic activity had subsided.

The Amisk strata are closely folded, for everywhere the dip of the schistosity of the lavas and the bedding of the sediments is steep. The details of the folding, however, are unknown. Bruce[1] states "the volcanics are of such a heterogeneous nature that the solution of their structure has not been attempted". Alcock,[2] in mapping a small area about Flinflon lake, attempted to work out the detailed structure of the lava by using pillow structure as a criteria to determine the strike, dip, and top side of the flows. Alcock states

"the longer axes of the pillows mark the strike of the flows. The upper and lower surfaces could commonly be inferred from the shape of the pillows for, during cooling, the viscous materials making up the ellipsoids shaped themselves against the underlying layer of pillows, filling the irregularities of the surface. Care is necessary in applying this criterion, but often both strike and dip can be determined with a reasonable degree of confidence. A considerable number of such determinations were made, but not enough to work out the structure of the flows over the whole area and to plot structure sections."

Wekusko-Kiski Sediments and Lavas

The general character of this group of rocks developed about Wekusko lake is summarized by Alcock[3]

"as representing a series of interbanded sediments and volcanic rocks of varying composition. Though the sedimentary division contains members which have pebbles of granite, quartz, and volcanic rocks, no evidence was found that these pebbles were derived from any rocks now exposed in the area, nor was any evidence found, aside from the presence of these boulders and pebbles, which would suggest that the members containing these fragments represent a younger series infolded with the complex and separated from it by an erosional unconformity. The whole group is regarded as a series of flows and contemporaneous sediments. The absence of limestone, the dominance of clastic sediments, the irregularity of the beds, the great thickness locally, the recurrence of conglomerate horizons, point to a continental rather than to a marine origin for the series."

An abundant member of the sedimentary phase of the Wekusko-Kiski group is a fine-grained, banded, grey, garnet gneiss. In addition to garnet, quartz, orthoclase, andesine, biotite, and in some specimens hornblende, are the essential minerals. Some of the highly foliated gneisses are essentially of quartz, mica, and garnet. The irregular outlines and interlocking nature of the mineral grains indicate that the rock is recrystallized.

[1]Geol. Surv., Canada, Mem. 105, p. 52 (1918).
[2]Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 11.
[3]Geol. Surv., Canada, Mem. 119, p. 24 (1920).

The high alumina, excess of potash over soda, and magnesia over lime, of the following analysis[1] of this gneiss from Crowduck bay, Wekusko lake, indicate that it is a recrystallized sediment.

SiO_2	63·84
Al_2O_3	20·34
Fe_2O_3	3·34
FeO	3·98
MgO	2·20
CaO	0·64
Na_2O	0·95
K_2O	2·42
$H_2O\pm$	1·05
TiO_2	0·80
Total	99·56

Analyst, M. F. Connor.

Beds of sedimentary gneiss and schist carrying garnet, staurolite, and cyanite are locally present about Wekusko lake, especially on Crowduck bay, south of the southwest bay of Crowduck bay, on Snow and Anderson lakes, and other localities. Some of the staurolite crystals form crosses and other twinned forms characteristic of this mineral. Some crystals are 4 inches long, the majority, however, being under an inch long. The cyanite is in fan-shaped aggregates of long-bladed crystals. It is white and reddish in colour. Many of the staurolite and cyanite crystals are arranged in parallel rows in narrow bands, representing lines of original bedding. The matrix of the garnet staurolite and cyanite rocks is either a greenish chloritic schist or a light grey quartz-biotite-muscovite gneiss. Wallace,[2] who has studied in some detail the cyanite and staurolite gneisses about Anderson lake, concludes that the chemical composition of certain beds is the controlling factor in determining the minerals to be formed. This author states

"There is evidence that the staurolite crystallized late in the period of mineral rearrangement, as the flakes of muscovite and biotite are frequently bent around the crystals of staurolite as though by force of crystal growth of the staurolite."

The garnets formed before the growth of the staurolite crystals had been completed. It is concluded, however,

"the shearing has also affected the orientation of the staurolite crystals, which are arranged with their vertical axes in the main in the shearing planes though the banding is parallel to the planes of sedimentation.....Cleavage lines of cyanite crystals swing from the plane of schistosity to an angle of 43 degrees with that plane, due it is thought to the effect of movement through pressure during the period of crystallization in overcoming the natural tendency of the crystals to go in the direction of its C axis."

These features of the staurolite and cyanite beds suggest that pressure effects were still in progress while these minerals were crystallizing. As the quartz, feldspar, mica, and garnet grains of all the sedimentary gneisses of the area show little evidence of pressure effects during or after recrystallization, the study of the relationships of the staurolite and cyanite crystals to deformation are specially interesting as indicating that shearing movements were in progress at least during the late stages of the recrystallization period. No beds of staurolite and cyanite gneiss have been noted among the Kisseynew gneisses about Kississing lake, where, except locally, the beds are not so closely folded as they are about Wekusko lake.

[1]Bruce, E. L.: "Schist Lake and Wekusko Lake Areas, Northern Manitoba"; Geol. Surv., Canada, Sum. Rept. 1916, p. 167.

[2]Am. Min., vol. 9, pp. 129–135 (1924).

Other more massive, fine and coarse-grained sediments occur about Wekusko lake. Some of these are grey to black greywacke and slate. Beds of this type outcrop along the northwest shore and adjoining islands of the lake. Arkose and conglomerate beds are interbanded with rhyolite lavas on the east side of Wekusko lake (*See* description of Rex gold deposit). From Puella bay northeast to and beyond Dion lake a large area of sediments are separated from the surrounding lavas by zones carrying conglomerate horizons. The conglomerate contains well-rounded boulders and pebbles of granite and of various types of schistose volcanic rocks in a matrix of arkosic and quartzitic sediments. Bruce,[1] reporting on a brief visit to Wekusko lake, assigned the area of conglomerate, arkose, and quartzite east of the lake to a group unconformably above the lavas and sedimentary gneisses, but Alcock[2] found no evidence that the conglomerate, arkose, and quartzite represent downfolded or faulted members of a younger series. At other localities about Wekusko lake, strata containing conglomerate beds are definitely interlayered with the lavas. This condition has not been noted farther west in the region of the Amisk volcanics and Kisseynew gneisses, in neither of which have conglomerate beds been recognized.

The volcanic rocks of the Wekusko-Kiski group include rhyolite, andesite, and basalt with porphyritic phases and derived hornblende, chlorite, and sericite schists. Fragmental volcanic rocks also are locally developed. Some bands of the latter type of rocks are well bedded and represent water-deposited volcanic products, whereas other outcrops are of breccia formed by flowage during the consolidation of the flows. Lenticular lumps, weathering epidote-green, and perhaps representing bombs, are abundant in some of the andesitic pillow lavas. The rhyolitic lavas are hard, massive-appearing rocks with grains of quartz and feldspar standing out slightly on their weathered, light to pinkish grey surfaces. When freshly broken the rhyolites are of dark grey colour. The rhyolitic lavas are limited in distribution to a lenticular-outlined area on the east side of Wekusko lake and to a small area along the southeast side of Goose bay. No typical rhyolite lava was recognized among the andesitic and basaltic flows about Reed and Morton lakes west of Wekusko lake.

The general structure of the areas of sediments and lavas of the Wekusko-Kiski group is not known. The general trend of the bedding foliation and schistosity for the area, however, is from north to northeast. Alcock does not discuss the folding of the strata except to give the dip and strike of the beds at a few localities and to state that nearly everywhere the sedimentary rocks "stand vertically or at high angles. Low dips are the exception".[3] The work of 1930 was too localized to determine the regional structure of this group of strata. The information gathered regarding local structures is presented in the section of this report dealing with the mineral deposits about Wekusko lake. The sediments and lavas are cut by bodies of quartz gabbro, granodiorite, granite, quartz porphyry, and lamprophyre. Small and large boss-shaped bodies of granite are surrounded by members of the Wekusko-Kiski group throughout the whole area.

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[1]Geol. Surv., Canada, Sum. Rept. 1916, p. 166.
[2]Geol. Surv., Canada, Mem. 119, p. 24 (1920).
[3]Geol. Surv., Canada, Mem. 119, p. 23.

The flat-lying, quartz-mica-garnet gneisses about Loonhead lake, in the northwest corner of Reed-Wekusko Lakes region, described by Alcock as belonging to the Wekusko series, were traced northwest last summer to Kississing lake and found to belong to the Kisseynew group of gneisses about that lake.[1] The Kisseynew sedimentary gneisses about Loonhead lake are separated by an area of granite and lavas from the areas of garnet, staurolite, and cyanite gneisses interbedded with the volcanic rocks about Wekusko lake and it may be that the Kisseynew gneisses of Loonhead lake are not of the same age as the sedimentary gneisses about Wekusko lake.

Kisseynew Sedimentary Gneisses

This complex of metamorphic sedimentary rocks outcrops from Kisseynew lake north to and beyond Kississing lake and southeast from Kississing lake to Loonhead lake in the Reed-Wekusko Lakes region. These sedimentary gneisses also extend for some distance west of Kississing lake into Saskatchewan. Field evidence clearly indicates that the gneisses originally were sandstone, clayey and limy sandstone, clayey arkose, and limestone. These sediments were intimately invaded by granitic intrusives, and many outcrops are of an intimate mixture of granite and sediment. The sediments vary in mineral content from bed to bed, and this original difference, combined with varying degrees of recrystallization and intensities of regional and contact metamorphism, has produced a great variety of gneisses, some beds of which have the appearance of intrusive rocks. In some areas intrusives are abundant in the sediments in the form of boss and sill-like bodies and as dykes of granite, aplite, and pegmatite.

A grey, medium-grained, quartz-mica-garnet gneiss is a widespread type. It is a foliated rock showing relics of bedding represented by alternating layers of either mica or quartz-rich types. Red garnet is abundant in most beds of this gneiss. Beds of gneissic quartzite, black hornblende-plagioclase-garnet gneiss, quartz-calcite-hornblende gneiss, and crystalline limestone[2] occur at several horizons within the quartz-mica-garnet gneisses. The detailed lithological character of the Kisseynew gneisses is given in the report on the Kississing Lake area.[3]

The Kisseynew strata everywhere exhibit a gneissoid structure, and where foliation and bedding are both present the two structures are parallel. The gneissoid structure is only poorly developed in some beds and, in these, bedding is prominent. When the sediments were recrystallized the abundant, new-formed minerals were garnet, plagioclase feldspar, hornblende, and biotite. These minerals are developed in different proportions in alternating beds, and many of the individual mineral grains lie with their longer directions parallel, giving the sediments their characteristic foliated appearance.

The Kisseynew sediments have been folded into a series of open folds and along certain zones into tight overturned folds. About the central and western part of Kississing lake, the dip of the beds is low, ranging from 10 to 50 degrees. At some localities low dips in opposite directions may be encountered in traversing the strata across their strike. The strike of

[1]For details, *See* section of this report describing the area between Kississing lake and the northwest corner of Reed-Wekusko Lakes region.

[2]Wright, J. F.: "Crystalline Limestone in the Kisseynew of Northern Manitoba"; Can. Min. Jour., vol. LI, p. 762 (1930).

[3]Geol. Surv., Canada, Sum. Rept. 1928, pt. B, pp. 78-82.

the beds is also variable from point to point. The folding is more complex in the east side of Kississing lake where an overthrust anticlinal fold is developed about the Sherritt-Gordon deposit. The marked variation in the degree of metamorphism, attitude, and structural disposition of the gneisses in closely adjoining areas suggests the possibility of complex thrusting along certain zones. The black hornblendic and unusual types of gneisses appear to be localized where anticlinal folds are developed, and the synclines are occupied by the grey quartz-mica-garnet gneiss. Dykes of pegmatite cross the beds at right angles to their strike along the axis of some anticlinal folds. This feature is well shown along the Sherritt-Gordon fold.

The Kisseynew gneisses overlie the Amisk volcanics apparently conformably. The relations of the sedimentary gneisses about Kississing lake and the Wekusko gneisses interbedded with the volcanic rocks on Wekusko lake are not, as already stated, known definitely, but probably the two groups of rocks are only different phases of the same series.

MISSIAN SEDIMENTS

Bruce[1] proposed the term Missian sediments to include two sedimentary groups, largely developed on Missi island, Amisk lake. He thought the two groups might be separated by an unconformity and he named them, respectively, Lower Missi series and Upper Missi series. Both series were described as being unmistakably younger than the Amisk volcanics. In this present report the term Missian sediments is used to designate the sedimentary strata younger than the Wekuskoan group.

The Missian strata are quartzose sediments and include conglomerate, arkose, quartzite, and greywacke. At some localities these rocks are recrystallized and sheared to mica gneiss and quartz-sericite schists. The conglomerate contains well-rounded and disk-shaped pebbles of granite, quartz porphyry, quartz, basic lava, cherty quartzite, jasper, and grey gneiss. Alcock[2] states that "the boulders have suffered extreme deformation, for many that had a diameter of over a foot have been compressed to a thickness of little over an inch." The elongation of the boulders is in the bedding planes parallel the dip, and thus nearly at right angles to the strike of the series. The conglomerate beds occur at many horizons in the series, and, at some localities, are absent at the base. Dark grey to black greywacke is an abundant member of the group. Some beds close to the volcanic rocks contain fragments of the older lavas. At many horizons, the greywacke is thick bedded or very obscurely bedded. The arkose is also grey, but it contains numerous rounded grains of bluish quartz. In thin sections, the arkose is of subangular fragments of quartz and feldspar in a matrix of quartz and flakes of biotite, sericite, and some chloritic materials. Beds of fairly pure quartzite are interbedded with some of the arkose.

The Missian sediments about Athapapuskow lake are separated from the Amisk volcanics and sediments by a marked unconformity. The younger strata lie in either synclinal troughs or downfaulted blocks within the older group. The Missian sediments south of Cliff lake are bordered

[1]Geol. Surv., Canada, Mem. 105, p. 31.
[2]Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 14.

on their east side by a large fault, the sediments having moved downward relative to the lavas on the east. The dip of the schistosity of the older volcanic rocks is steep everywhere, whereas the dip of the beds of the younger group is low, 30 to 40 degrees, except near faults or in narrow, tightly compressed parts of synclinal folds. The conglomerate member of the younger series also contains boulders derived from the older volcanic group. Alcock[1] concluded, from a study of the contacts between the Amisk volcanics and sediments and the Missian sediments in Flinflon area, that the region was rugged at the time of deposition of the Missian sediments. At some places the sediments were deposited against the slopes of hills of the older volcanics and this and other evidence suggests "a rugged topography undergoing erosion, with deposition in river valleys, small deltas, or on piedmont plains."

Granite has not been described in contact with the Missian sediments about Athapapuskow lake. Some of the granite, however, is younger than basic intrusives that cut the Missian sediment.

Bruce,[2] as already stated, recognized two series of sediments, one of which he named the Lower Missi series and considered to be older than what he called Upper Missi series, and which as developed about Flinflon and Athapapuskow lakes has been briefly described in foregoing paragraphs. The Lower Missi sediments were recognized by Bruce in two areas only. One of these areas is in the vicinity of Schist lake and, as already stated, the rocks of this area were only doubtfully referred to the Lower Missi and since have been found to be interbedded with the Amisk volcanics of the Wekuskoan group. The other area is along the west side of Amisk lake. The Lower Missi of this area, as described by Bruce, includes conglomerate, slate, quartzite, and carbonate rocks, exhibiting drag-folding, and in places recrystallized and sheared to various gneisses and schists. The carbonate beds are considered to represent limestones and calcareous arkoses. The series is stated to be clearly later than the Amisk volcanics. Members of the Lower and Upper Missi series were not found in contact, and, therefore, their age relations were not definitely known. The basis of separation of the two series is the difference in "lithological character and the presence in the conglomerate-arkose series (Upper Missi of Bruce and Missian of this report) of pebbles of quartzite that may have come from the quartzite slate series" (Lower Missi). In the present report the term Missian sediments is applied to all strata that lie unconformably above the Wekuskoan group. So far as is known the Lower Missi, as developed about Amisk lake, does not occur in the area eastward from Flinflon. Possibly the Lower Missi of Bruce may be a less metamorphosed phase of the Kisseynew sedimentary gneisses. It is to be noted that about Amisk lake, on the west side of the district, the majority of the sediments are unconformably above the Amisk volcanics, whereas to the northeast on Kisseynew lake the sediments, as represented by the Kisseynew gneisses, are conformably above the Amisk volcanics, and farther east about Wekusko lake, the sediments, as represented by the Wekusko gneisses, are interbanded with the volcanics.

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[1]Geol. Surv., Canada, Sum. Rept. 1922, pt. C, pp. 14-15.
[2]Geol. Surv., Canada, Mem. 105, pp. 31-34 (1918).

DEEP-SEATED INTRUSIVES

Granite-gneiss, Syenite-gneiss, and Quartz Porphyry

The grey gneissic granite and syenite included in this group occur in the eastern part of the district from west of Setting lake to northeast to Paint, Wintering, and Partridge Crop lakes. The usual type is a grey, foliated granite carrying inclusions of older schist and sedimentary gneisses. Some bands are a dark-coloured gneiss containing little or no quartz, and these are syenite. At some localities the grey and black, granitic gneisses have a bedded appearance. Some outcrops of the grey granite near included masses of sediments contain red garnet. These gneisses are cut by pegmatite dykes and massive, pink granite forming lit par lit gneisses. They are also cut by bosses and dykes of pyroxenite and gabbro, which are in turn cut by dykes of pink and white, massive granite and pegmatite. These relationships were observed at several localities on Setting and Wintering lakes and have been described in more detail in the section of this report dealing with the geology of these areas. J. E. Spurr,[1] who visited this district, states that

....."on Paint lake and Wintering lake I found the red granite intrusive into the gneissic and metamorphosed grey granite. This red granite has no gneissic structure, and occurs in the various forms of granite pegmatite and aplite, it has a close connexion with both ore deposition (gold, molybdenite, chalcopyrite, pyrrhotite, etc.) and metamorphism (development in the older granite-gneiss of garnet, pyroxene, pyrrhotite, etc.)".

Large sill and boss-like bodies of the pink or white, massive, and, locally, pegmatitic granite do occur amongst the grey gneisses, but at no place was a sharp intrusive contact seen between the massive and the foliated granites. The dykes of pegmatite and aplitic granite cutting the grey gneisses may, however, represent a phase of the magma forming the bodies of massive granite, and if so suggest two distinct periods of granite intrusion. In most areas the massive and the foliated granites are intimately intermixed. About Paint and Wintering lakes, however, the two types of granite may occur in separate bodies large enough to map. Both northeast and southwest from these lakes the two types of granite are more intimately intermixed. Farther to the west about Wekusko and Athapapuskow lakes no outcrops of the older, grey granite-gneiss were recognized.

Dykes and small bodies of schistose granite and quartz porphyry intrude the Amisk volcanics at a number of localities about Amisk and Athapapuskow lakes. These are grey to white, schistose rocks exhibiting rounded grains of dark-coloured quartz on their weathered surfaces. Bruce[2] writes as follows regarding the age relations of the quartz porphyry:

"This rock is found in dykes cutting the volcanics of the Amisk group. It is believed to be older than the sedimentary series of Missian age because no dykes of it have been recognized in either of the Precambrian sedimentary formations and because in the conglomerate there are pebbles lithologically similar to some facies of the quartz porphyry."

Alcock recognized similar acidic, porphyritic intrusive rocks in Flinflon area and groups them with the Amisk volcanics. He concludes that the majority of the quartz porphyries "were introduced as dykes and sills into the volcanic complex, but clearly belong to the same period of volcanic activity as the extrusives."[3]

[1] "The Ore Magmas"; vol. 1, p. 163 (1923).
[2] Geol. Surv., Canada, Mem. 105, p. 26 (1918).
[3] Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 12.

A number of dykes and irregular-shaped bosses of schistose granite and quartz porphyry occur among the Amisk volcanics about Athapapuskow lake. One such body, on the Billy Boy group of mineral claims, definitely intrudes the lavas and is highly schistified. Other dykes of granite cutting the lavas near the margins of the main bodies of post-Missian granite are massive. This marked difference in character suggests a difference in age and as all the acid dykes intruding the Amisk lavas do not resemble in texture and lithology the dense, glassy-appearing, porphyritic dyke rocks regarded as an intrusive phase of the volcanic period, it is concluded that the dykes of schistose granite invading the Amisk lavas may belong to a period of granitic invasion older than that of the granite cutting the Missian sediments. Regarding the granites of Flinflon area Alcock[1] concludes "A fact which seems to suggest that granites were introduced into the volcanics prior to the deposition of the Missi sediments is that there are in the Missi conglomerates boulders (of granite) which were apparently sheared before their inclusion in the sediments." It has not yet been possible to differentiate and map large bodies of the older granite in Athapapuskow Lake area.

Pyroxenite, Peridotite, and Gabbro

A variety of basic intrusive rocks have been recognized and in different areas these may be of different age. The basic rocks occur in dykes and larger, boss-shaped masses. In some areas the minerals of these rocks are fresh, whereas in other areas they are highly altered. Some bodies of basic rock cut the Missian sediments, others are considered to be related closely in age to the granitic intrusives, and the age relations of others are unknown except that they are older than the nearby granite. Thus the bodies of basic intrusives of one area cannot be definitely correlated with those of another area and their relative ages thereby established.

At the eastern side of the district, especially about Wintering and Partridge Crop lakes, bodies of basic rock cut a grey, gneissic granite, and are themselves cut by dykes of granite and pegmatite. These basic rocks are of medium to very coarse grain and are massive or slightly schistose. Some specimens are of pyroxene and olivine, with magnetite and pyrrhotite as abundant accessories. In other types a few crystals of labradorite or a more basic plagioclase occur. The olivine is in small, rounded grains within the pyroxene. Red garnets are abundant in some small areas of these rocks. The pyroxene and olivine are in part altered to secondary minerals, and the margins of some bodies of this rock are recrystallized to an aggregate of amphibole, mica, feldspar, and carbonates. The nickel-bearing sulphide bodies on Wintering and Partridge Crop lakes are within or near bodies of pyroxenite.

On Wekusko lake bodies of medium to coarse-grained, massive quartz gabbro cut the Wekusko-Kiski sediments and lavas, and near the Apex gold deposit quartz gabbro is intruded by granodiorite and granite (*See* description of Apex deposit). Some bodies of granitic rocks of this area are bordered by a basic rock[2] near quartz gabbro in mineral content and, as these definitely pass inward without intrusive contacts into more acidic rocks, the bodies of quartz gabbro may be an early phase of the magma

[1]Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 15.
[2]Alcock, F. J.: "The Reed-Wekusko Map-area, Northern Manitoba"; Geol. Surv., Canada, Mem. 119, p. 26 (1920).

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that later differentiated to form the granitic rocks. Bodies of quartz gabbro forming early in the intrusive period are cut by the later more acidic differentiates, which in some medium-sized bodies also have a basic border phase.

The quartz gabbro is black, massive, and medium to coarse grained. In thin section the minerals are fresh or only very slightly altered. Labradorite and hornblende are the abundant constituents. Orthoclase, quartz, and, in some specimens, biotite occur. Hornblende may be more abundant than labradorite and vice versa. The rock exhibits minor variations in mineral content and texture from outcrop to outcrop, and even in the same large outcrop, but no large areas could be mapped as either more basic or more acidic than the average rock. Included masses of the older sediments and lavas are present locally in the larger bodies of quartz gabbro. In some small areas the gabbro is jointed and slightly schistified, and contains deposits of copper and nickel-bearing sulphides. The lithological character and age relations of this group of intrusives are discussed in more detail in the section of this report describing the copper-nickel deposits about Wekusko lake.

Bodies of basic rocks also cut the Amisk volcanics and sediments of Athapapuskow Lake area. The minerals of some bodies of these rocks are highly altered and short fibres of asbestos occur along joint planes crossing some of the basic rock. The less altered phases of such rocks are of pyroxene and olivine. The basic intrusives of this area have not been mapped or studied in detail. They are known, however, to be widespread and to be especially abundant in certain small areas. In Flinflon area Alcock[1] mapped and described a number of bodies of these rocks in the Amisk volcanics and sediments. The types recognized in this area include lamprophyre, gabbro, and peridotite, and they are younger than the Missian sediments and are cut by granitic dykes. Although the basic intrusives studied in detail are of different lithological character, all are considered to be probably of the same origin.

Basic rocks also cut the Kisseynew sedimentary gneisses in Kississing Lake area.[2] These have the mineral content of pyroxenite, peridotite, and gabbro. They are massive-appearing, coarse-grained rocks. The olivine and pyroxene of the specimens studied microscopically are altered in part to amphibole, and chloritic, talcy, serpentine-like, and carbonate minerals. Red garnets are abundant in the rock of some outcrops. The basic intrusives are cut by dykes of pegmatitic quartz.

Granodiorite and Quartz Diorite

Certain, small, intrusive masses and the marginal phases of some large bodies of the district are more basic than the normal granites of the area. The more basic rocks are dark grey to black, massive, fresh appearing, and medium grained. They are porphyritic locally. The quartz diorite is black and its essential minerals are andesine, hornblende, and some quartz. The granodiorite is dark grey or pinkish grey and it contains abundant oligoclase and hornblende, and some quartz, orthoclase, and biotite. In some bodies these rocks pass into granite without sharp intrusive contacts and are interpreted as basic phases of the granite magma. Other dark grey to black phases of the granite bodies about Athapapuskow lake were

[1] Geol. Surv., Canada, Sum. Rept. 1922, pt. C, pp. 16–17.
[2] Geol. Surv., Canada, Sum. Rept. 1928, pt. B, pp. 84–85.

mapped and described by Bruce[1] as hybrid granite rocks. They are regarded by this author as "the result of the action of granite on the intruded rocks." The so-called hybrid granite east of the south end of Schist lake is cut by aplite in numerous dykes and lens-shaped masses up to 4 inches or thereabouts across. This body of hybrid granite or granodiorite cuts the older rocks with sharp contacts.

Granite, Aplite, and Pegmatite

Granitic intrusives are widespread in northwest Manitoba and the areas of Wekuskoan and Missian strata are surrounded by younger intrusive granite. At some localities included masses of the older rocks occur a mile or more within the bodies of granitic rocks. The granites are pink, pinkish grey, grey, and white in colour. They are massive except in some bodies where locally a gneissic structure is developed. No large area of typical, well-developed granitic gneiss was noted in the bodies of granite that are definitely younger than the Missian sediments. The granites are variable in mineral content within the same body and in different bodies. In some bodies microcline is the abundant feldspar and in others orthoclase predominates. The plagioclase may be albite, oligoclase, or a variety intermediate between these two. Biotite is the abundant dark mineral; in some bodies both biotite and hornblende are present. The variable character of the granite is illustrated by the following chemical analyses of representative specimens collected in Kississing and Athapapuskow Lakes area.

Table of Analyses of Granites from Kississing and Athapapuskow Lakes Area, Northwest Manitoba

—	I	II	III	IV	V	VI	VII
SiO_2	56·91	74·14	76·47	72·87	72·34	67·72	66·76
Al_2O_3	17·67	14·76	12·64	13·58	13·91	14·69	15·39
Fe_2O_3	1·63	0·81	0·11	0·41	0·58	2·07	1·27
FeO	5·30	0·66	1·49	1·38	1·97	3·72	1·49
MgO	4·55	0·39	0·22	0·67	0·67	1·00	1·50
CaO	7·15	0·66	0·90	3·32	1·51	4·94	2·56
Na_2O	3·12	3·00	3·61	2·81	3·61	3·39	4·47
K_2O	1·25	5·40	3·71	3·58	4·11	1·28	3·35
H_2O	1·33	0·20	0·28	0·36	0·41	0·25	0·60
H_2O-	0·06	0·10	0·03	0·04	0·03	.....	.....
TiO_2	0·67	.....	0·16	0·26	0·33	0·30	0·15
CO_2	.....	.....	0·12	0·47	0·10	.....	undet.
P_2O_5	.....	.....	0·15	0·33	0·34	.....	.....
MnO	.....	.....	0·03	0·04	0·05	.....	.....
	99·64	100·12	99·92	100·12	99·96	99·36	97·54

Analyses Nos. I to V, through courtesy of Dr. F. F. Grout. No. I and II, analyst R. B. Ellestad, Nos. III to V, analyst T. Kameda. Nos. VI and VII from Mem. 105, analyst M. F. Connor.

No. I, quartz diorite collected by H. J. Fraser from east of Bartlett lake, Kississing area. No. II, granite collected by H. J. Fraser from southwest bay of Kississing lake. No. III, granite collected by J. F. Wright from large body one-half mile south of Kississing river and 7 miles southwest of reference mound H 15. No. IV, granite collected by J. F. Wright from sill-like body at west end of Sherritt-Gordon deposit west of north end of Camp lake. No. V, Kaminis granite collected by J. F. Wright 1 mile southeast of Weldon bay, east end of Kisseynew lake. Nos. VI and VII collected by E. L. Bruce. No. VI of granite-gneiss from north of Wabishkok lake and No. VII Kaminis granite from shore of long bay of Athapapuskow lake into which Mistik lakes empty.

[1]Geol. Surv., Canada, Mem. 105, p. 42 (1918).

In the eastern side of the district about Setting, Paint, and Wintering lakes, massive, medium-grained, pinkish and white granite occurs as dykes, bosses, and batholith-like masses in grey granite-gneiss. The massive granites may belong to a period of intrusion later than that of the grey gneisses which have been described in a foregoing section of this report. About Wekusko lake the granitic rocks are as a whole massive and in the form of dykes, bosses, and batholith-like masses cut the older sediments and lavas. The rocks of some of these bodies exhibit variations in composition, quartz monzonite, granodiorite, and normal granite being the main types. About Athapapuskow lake, Bruce[1] divided the granites into two main groups, the one wherein areas of granite-gneiss are developed and the other the Kaminis group of massive granites. The granites there occur as dykes, sill-like, boss-shaped, and batholith-like bodies. The Cliff Lake granite porphyry of this area described by Bruce as older than the Missian sediments is considered by Alcock[2] to be younger than these sediments. About Kississing[3] lake, sill-like and larger batholith-like bodies of granite are abundant in the Kisseynew gneisses. Some bodies of the granite cut the sedimentary gneisses with sharp contacts, whereas other bodies exhibit a zone between sedimentary gneiss and granite wherein banded rocks are developed that are an intimate mixture of granite and sediments. The sill-like bodies of granite follow bedding or foliation planes in the sedimentary gneisses and the contacts between the two rocks do not show shearing effects to indicate intensive folding since the granite formed.

Dykes of pegmatite are abundant in the Wekuskoan strata and in the grey granite-gneiss. In the Amisk volcanics and sediments they are confined to narrow areas adjacent to bodies of granite, whereas in the Kisseynew sedimentary gneisses pegmatites occur throughout the whole area of these rocks. Some bodies of pegmatite are 100 feet or more across and others are only a few inches thick. Many of the pegmatite bodies are not continuous over a few hundred feet along their strike. The majority of the dykes follow the bedding, foliation, or schistosity of the older rocks. A few, however, cross these structures. Some dykes paralleling the foliation of the sedimentary gneisses may turn nearly at right angles to cross the beds. This relationship was noted especially along or near the axis of anticlinal folds in the Kisseynew sedimentary gneisses. Parts of certain pegmatite bodies along the Sherritt-Gordon ore zone have been brecciated, schistified, and replaced by sulphides in the same way as the adjoining sedimentary gneiss. Some narrow pegmatite stringers follow in detail the crenulations of the foliation of the older rocks. Such bodies exhibit sharp, sealed contacts against the gneiss.

The abundant type of pegmatite is a coarse aggregate of quartz, microcline, and biotite. Dykes of this type appear similar in their general mineral content over wide areas. They have not been searched carefully, however, for the rarer minerals that characterize the pegmatites of some areas. A few pegmatites are of unusual composition and contain abundant grey or greenish coloured plagioclase. Some of these also contain crystals of hornblende an inch or more in length. Some narrow dykes are almost

[1]Geol. Surv., Canada, Mem. 105, pp. 39–44 (1918).
[2]Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 19.
[3]Geol. Surv., Canada, Sum. Rept. 1928, pt. B, pp. 85–88.

entirely of biotite. The pegmatites of unusual mineral content were noted only near sulphide bodies, though they may occur at as yet unnoted other localities. Some of the granitic pegmatites contain small areas of aplitic granite and in some large bodies pegmatitic granite and aplite are intermixed. The aplites and pegmatites are thus probably closely related in origin, though at some localities in Kississing Lake area dykes of pink aplite occur separately from the pegmatite.

Hornblende and Mica Lamprophyre

Narrow dykes and small, boss-shaped bodies of hornblende and mica lamprophyre occur in the lavas east of Wekusko lake and in Flinflon area. The gold deposits east of Wekusko lake are closely associated in distribution with the lamprophyre dykes. They are massive or slightly schistose rocks composed chiefly of hornblende and biotite. Some specimens contain bits of feldspar and in some dykes red garnet and grains of pyrite are fairly abundant. Alcock[1] states these dykes "are found locally traversing the granite and all the older rocks." This author has also described in detail a number of bodies of similar rocks[2] in the Amisk volcanics of Flinflon area. Future detailed work may prove that basic dykes of this character are fairly widespread in some other areas of northern Manitoba outside of those wherein detailed investigations have been completed.

Olivine Diabase

These rocks occur as dykes in the eastern side of the district and were studied about Landing, Wintering, Partridge Crop, and Mystery lakes. They are fresh-appearing, black rocks, locally weathering brownish red. Many of the dykes are narrow, 20 to 100 feet across, only a few are up to 600 feet wide. The wider dykes of this rock form ridges rising slightly above the level of the nearby hills. The dip of the majority of the dykes is nearly vertical and their strike is north 20 degrees east. One dyke is known to extend at least 6 miles along its strike. These dykes cross all the rocks of the area and at some localities cut the foliation of the older rocks at an angle of about 45 degrees.

In thin section the minerals of the diabase are fresh. Olivine and augite are abundant in most specimens. These minerals lie in part between laths of labradorite. Magnetite is an abundant accessory mineral. In some specimens olivine is not abundant or may be absent and in these specimens, hornblende, and in one specimen, biotite, occur with augite. The augite of specimens carrying hornblende and biotite is slightly altered to chloritic materials. In the field the diabase is readily differentiated from the older basic intrusives by its fresh, massive appearance and by its occurrence as dykes crossing all the other rocks, including the massive pink granite.

[1]Geol. Surv., Canada, Mem. 119, p. 26 (1920).
[2]Geol. Surv., Canada, Sum. Rept. 1922, pt. C, p. 16.

ECONOMIC GEOLOGY

Introduction

Active prospecting in northwest Manitoba commenced in 1913 when gold-bearing quartz was discovered near Amisk lake in Saskatchewan a few miles west of the Manitoba boundary. Prospectors gradually worked east from here and in 1914 discoveries of gold-bearing quartz were made on Wekusko lake. In 1915, the Flin Flon and Mandy copper-zinc deposits were discovered, and in the following year many more sulphide bodies were located about Athapapuskow lake. The details of the history of early prospecting in the area are given in a letter by Mr. Hugh Vickers, one of the early prospectors to enter the field, and published by Wallace in the Northern Manitoba Bulletin for 1919. In 1922, some of the gold deposits about Elbow lake were prospected intensively, and between 1922 and 1925 several gold deposits about Wekusko lake were explored by underground work. Of these deposits, the Rex is reported to have produced about $150,000 in gold. The development of Sherritt-Gordon during 1927 indicated a promising deposit of copper-zinc ore, which was actively explored in 1928 and 1929. A concentrating plant was built in 1930, and in March, 1931, a 600-ton unit of this plant commenced to produce copper concentrates. In the summer of 1925, Whitney interests began an investigation of the commercial value of the large, complex Flin Flon sulphide body, and in November, 1927, decided to purchase this property. Hudson Bay Mining and Smelting Company was organized and by the summer of 1930 a concentrating and metallurgical plant of 3,000 tons daily capacity was about completed and one unit was put in operation in September. In 1928, Canadian National railways built a branch line some 87 miles long to Flinflon, and in 1929 a branch of some 43 miles from this line to Sherritt-Gordon. Representatives of a number of mining companies have examined many of the deposits of the whole district and some exploration has been completed at a few localities during the past four years. This work, however, has not proved additional ore-bodies and at present little or no work is in progress outside of that at Flinflon and Sherritt-Gordon.

Types of Mineral Deposits

The mineral deposits of northwest Manitoba are of two main types: (1) sulphide replacement bodies, and (2) gold-bearing quartz bodies. The sulphide bodies are massive and disseminated replacements, and may be grouped according to their important minerals into deposits carrying: (a) nickeliferous pyrrhotite and chalcopyrite; (b) pyrrhotite or pyrite with only traces of chalcopyrite and sphalerite; (c) pyrrhotite or pyrite with chalcopyrite and sphalerite; and (d) silver-bearing galena and sphalerite with some pyrite and stibnite. The gold-bearing quartz bodies include groups carrying the following characteristic minerals: (a) molybdenite and scheelite; (b) arsenopyrite, tourmaline, and pyrite; (c) galena, chalcopyrite, and pyrite; and (d) pyrite, galena, and stibnite.

Distribution and General Character

Though sulphide replacement and gold-bearing quartz bodies occur in the same area, the majority of the sulphide bodies, and especially the copper-zinc deposits, are at the west side of the district in Athapapuskow

and Kississing Lakes areas, and the gold deposits in the central part of the district about Elbow, Morton, and Wekusko lakes. Gold-bearing quartz is present, also, about Amisk lake in Saskatchewan and west of Athapapuskow lake. The two types of deposits have not been found in contact to prove their age relations. The sulphide bodies, and especially those carrying copper and zinc, are within the large areas of Wekuskoan strata and several miles from large bodies of intrusive rocks, though small bodies of both acidic and basic intrusives may occur near these deposits. Some sulphide bodies, however, as those about Copper and Brunne lakes, are in small areas of the older rocks surrounded by granite, and there gold-bearing quartz occurs in the same area near large bodies of pyrrhotite. Gold-bearing and barren quartz are the predominant deposits of the areas of Wekuskoan strata from 2 to 12 miles across and within the granite about Elbow lake and on the east side of Wekusko lake. Deposits of nickeliferous pyrrhotite and chalcopyrite are associated in distribution with bodies of quartz gabbro in Wekusko lake, and to the east in Wintering and Partridge Crop lakes, similar deposits are near or within pyroxenite. The silver-bearing galena deposits occur north of Wekusko lake, and on Setting and Mystery lakes. They are within small areas of Wekuskoan-like sedimentary gneisses and lavas close to bodies of granite.

The following paragraphs summarize briefly only the main features of the various deposits of the district. A more detailed account of representative occurrences of each group is given in the section descriptive of individual deposits.

Nickeliferous Pyrrhotite and Chalcopyrite Deposits

These deposits are associated with bodies of quartz gabbro on Wekusko lake and with pyroxenite on Wintering lake. Nickeliferous pyrrhotite and chalcopyrite are the important sulphides. If pentlandite occurs it is in small grains or intergrown with pyrrhotite. The deposits are within the intrusive basic rock close to its margin, and in some instances may extend into the older rocks. Some deposits in the interior part of intrusive bodies are near included masses of the old sediments or lavas. The sulphides are either massive and distributed in lenses and veinlets or disseminated in small blebs and grains throughout zones of jointed and schistified basic rock. Some bodies of gabbro carrying massive and disseminated sulphides are up to 75 feet wide and 300 feet long. The sulphides, however, are not uniformly distributed throughout these large masses and only narrow, short zones wherein the basic rocks are more highly jointed and schistified, carry enough to assay 2 per cent combined copper and nickel. Some specimens assay as high as 5 per cent nickel and 12 per cent copper. The more massive and only slightly mineralized basic rock intermixed with the high-grade lenses assays on the average only about 0·10 per cent combined copper and nickel.

The pyrrhotite and chalcopyrite of the massive lenses include bits of pyroxene, amphibole, and feldspar of the basic rock. The sulphides cross these minerals in veinlets and clearly were introduced after the silicate minerals crystallized. Some veinlets of sulphides occur along joint planes in massive rock. Grains of pyrrhotite occur in some of the basic rock outside the main sulphide bodies and may be accessory minerals of the

rock. The silicate minerals within the massive sulphides are fresh or only slightly altered. In a few specimens bits of grey carbonate and chloritic material are associated with the sulphides. There is little evidence that the minerals of the basic rocks were altered extensively during the deposition of the sulphides.

Pyrrhotite and Pyrite Bodies

These sulphide bodies are widespread in the district and occur along schistified zones in all members of the Wekuskoan strata and in grey, granitic gneiss on Paint lake. Many of them have been trenched in a preliminary way. Pyrrhotite is the abundant mineral of the deposits in the sedimentary and granitic gneisses, whereas pyrite predominates in the bodies in volcanic rocks. Some of the deposits are large, being up to 90 feet wide and continuous 1,000 feet along the strike and perhaps farther. The deposits consist of massive and disseminated bodies of fine-grained, bronze or greyish coloured pyrrhotite or fine-grained, white or brassy yellow pyrite. The massive sulphides of many deposits exhibit a spotted appearance due to included grains of the wall-rock. The majority of these deposits carry no values, though nickel may occur up to 0·5 per cent and traces of platinum have been reported. Grains of chalcopyrite occur along the margins of some bodies and in central areas of some bodies small lenses carry some chalcopyrite. Sphalerite occurs less sparingly than chalcopyrite in these deposits. A few deposits with some chalcopyrite and sphalerite at the surface have been drilled in the hope of locating a larger quantity of the copper and zinc-bearing sulphides at depth. The results have been disappointing in all cases. Wallace concludes as follows regarding these deposits.[1]

"Experience in this field has sufficiently demonstrated the conclusion that the fine-grained pyrrhotite bodies do not justify the expenditures of diamond drilling; but that, on the other hand, the coarse-grained pyrrhotite bodies, if they contain at the surface chalcopyrite or sphalerite of even somewhat less than economic grade, justify exploratory work....."

Chalcopyrite and Sphalerite-bearing Sulphide Bodies

These desposits are similar in their general features to the iron sulphide bodies described in the foregoing paragraphs, except that chalcopyrite and sphalerite are present in variable quantity throughout practically the whole mass. They are lens-shaped or flat, tabular bodies of fairly regular outlines. The Flin Flon lens is 2,593 feet long on the surface and has a greatest width of 400 feet, including some bands of unmineralized lava. The Sherritt-Gordon bodies are tabular in outline, the west ore-shoot being 5,200 feet long and averaging 15·5 feet in width. Some sections are much wider and others narrower than the average thickness. These deposits are along jointed and schistified zones in the Wekuskoan volcanic and sedimentary strata and follow closely the dip and strike of the schistosity or bedding of the enclosing rocks.

The sulphide bodies contain two distinct types of ore, the one called massive ore consists of sulphides with only small bits of the older rocks, and the other, known as disseminated ore, consists of schistose rock impregnated with grains, blebs, and small lenses of sulphides. The Mandy

[1] "Copper-Zinc and Gold Mineralization in Manitoba"; Trans. Can. Inst. Min. and Met., vol. XXXI, p. 45, (1928).

lens was a large body of the massive type of ore and no other lens has been discovered in the district comparable with it in size and content of copper. Iron sulphides greatly predominate in most bodies of massive ore and the average content of copper is lower and of zinc higher in the massive ore than in disseminated ore. The average content of copper also is higher than that of zinc in most disseminated ore. The small bits of silicate minerals and schistose rock in massive ore are considered to be replacement relics. Some massive sulphide ore is banded, due to alternating layers wherein dark sphalerite and yellowish chalcopyrite or chalcopyrite and white pyrite are the abundant minerals. In some parts of a deposit, massive and disseminated ores have sharp boundaries against each other, whereas at other points the massive ore gradually passes outward into disseminated ore. In the Flin Flon deposit, the massive sulphide ore is for the most part in the central or near the hanging-wall side of the lens, and the disseminated ore is along the foot-wall. The average copper content of disseminated copper ore along the hanging-wall is less than that of similar ore along the foot-wall. Disseminated sulphide bodies are the characteristic type in the sedimentary gneisses, and so far as is known the bodies of massive ore are not as large as they are in the schistose volcanic rocks. The shearing movements in the banded sedimentary rocks were more localized along narrow zones between bedding planes and the massive sulphides are localized along these zones. The more massive intervening rock was jointed, brecciated, and only slightly schistified, and such zones carry varying proportions of sulphide in veinlets, small lenses of massive sulphide, and small grains and patches distributed irregularly throughout the rock. Some beds of highly schistose gneiss are, also, of the disseminated type.

The sulphide bodies of both the massive and disseminated type carry on the average less than $1 a ton in combined gold and silver. Some bodies of massive, white pyrite may assay $5 to $10 a ton in these metals, and disseminated ore, cut by small veinlets of quartz, may also assay higher than the average given above. Some galena occurs in the massive sulphide ore where sphalerite is abundant. At Sheritt-Gordon scattered crystals and small bodies of massive galena occur at several points in the hanging-wall gneiss. Arsenopyrite is present sparingly in the Flin Flon and Mandy ores.

The age relations of the abundant sulphides to one another are fairly definite in most polished specimens of the ore. Pyrite, pyrrhotite, and arsenopyrite were the first minerals to crystallize. They were followed by chalcopyrite and sphalerite, which crystallized together or the sphalerite slightly earlier than chalcopyrite. Galena cuts the sphalerite. Pyrite and pyrrhotite are cut by veinlets of chalcopyrite and sphalerite, and these minerals carry included bits of both pyrite and pyrrhotite. Chalcopyrite and sphalerite are intimately intermixed in some specimens and in others needle-like veins of chalcopyrite penetrate sphalerite. Some of the copper-bearing sulphide is the slightly magnetic variety, chalmersite, and much of the zinc sulphide is the dark-coloured, high iron variety, marmatite.

The silicate minerals in thin sections from the different sulphide bodies, include hornblende, actinolite, chlorite, epidote, feldspar, sericite, biotite, garnet, quartz, and others in lesser quantities. In different deposits one or other of these minerals is more abundant than the others, and the quantity and proportion of the various gangue minerals vary in different specimens from the same deposit, as well as in different deposits. The

abundant minerals in a particular deposit are those characteristic of the adjoining wall-rock. The sulphides include bits of these minerals and locally fragments of rock up to 5 feet or more across. Sulphides penetrate the crystals of feldspar, hornblende, and other silicates, and clearly were introduced later than these minerals. An interesting feature of specimens studied microscopically is the small amount of alteration of the gangue minerals during the deposition of the sulphides. About fifty specimens of sulphide-bearing rock have been studied microscopically and these exhibit no evidence of widespread silicification or chloritization of the wall-rocks, which is a characteristic feature of some deposits of similar type in other parts of the world. Fresh silicates are included within sulphides and the minerals adjoining veinlets of sulphides are unaltered. In some specimens biotite or hornblende is slightly bleached and some feldspar is altered to saussurite in small areas. Some quartz, and calcite were deposited later than the sulphides. Veinlets of quartz cut across the sulphides of many deposits. Chlorite and sericite are abundant in some sulphide bodies, but these minerals are also characteristic minerals of the metamorphosed rocks outside the deposit. Where pyrite crystals are developed these cut across foils of chlorite; bits of chlorite, sericite, and epidote occur within massive sulphides. Although in some specimens it is difficult to prove that the secondary silicates resulted entirely from metamorphism along shear zones before the sulphide bodies formed, nevertheless the available evidence suggests strongly that this is the important source of these minerals rather than alteration associated with the mineralization.

Silver-bearing Galena Deposit

These are small bodies of calcite and quartz, locally carrying abundant galena and developed along jointed and schistified zones in lava and quartzose sediments. The calcite is in small veins and lenses and the galena occurs as small patches of massive sulphide and as scattered grains in the calcite or quartz, and also in the adjoining rocks. In some deposits calcite is the abundant mineral with the galena, whereas in others calcite is only sparingly present or absent and quartz may be abundant; at some localities galena occurs in a schistose rock with practically no vein quartz or calcite. Besides galena, pyrite, chalcopyrite, and sphalerite also occur in some deposits. Stibnite, also, occurs locally. The galena cuts the calcite and quartz in veinlets and was deposited later than these minerals. Galena also cuts across sphalerite and chalcopyrite. The galena carries silver in the general ratio of about 3 units of silver for each percentage of lead. Ruby silver (pyrargyrite) and perhaps argentite occur in a galena-bearing quartz vein on the Dominion group of mineral claims near Copper lake. Samples from this deposit assay up to 45 ounces of silver a ton. The silver-bearing galena, calcite, or quartz bodies are all small.

Gold-bearing Quartz Bodies

These deposits are in both acidic and basic lavas, in fine-grained sediments such as quartzite, in quartz-mica-garnet gneiss, and in the granitic intrusives. The deposits east of Wekusko lake are in rhyolitic lava and interbedded arkose and conglomerate near or within dykes of mica or hornblende lamprophyre cutting these rocks. Farther east from

Wekusko lake gold-bearing quartz occurs in andesite lava. The Apex deposit on Wekusko lake is a large body of jointed and slightly schistified granodiorite, cut by veinlets of quartz and impregnated with arsenopyrite. The gold deposits on Elbow lake are in the volcanic rocks or fine-grained, sheared granite.

The rocks along some shear zones carrying gold-bearing quartz are completely altered to chloritic and sericitic schists, whereas thin masses of massive rocks are interlayered with schist in many deposits. No evidence of marked displacement of one wall relative to the other has been recognized along the shear zones, and they perhaps are formed by a distributive type of faulting wherein movements are taken up by a great number of minor breaks instead of being limited to a few planes of marked displacement. A shear zone 8 feet wide may extend less than 1,000 feet along its strike and gradually end in both directions. Another shear may or may not be developed along the projected strike. A few shear zones are traceable on the surface for a mile or more, but in this distance the zone of schist may narrow to only a few inches at one or more points. Shear zones in the volcanic rocks are larger and more continuous than those in the sedimentary strata, where small, lenticular zones may be developed between beds across a zone up to 100 feet wide. Shear zones in the granitic rocks are small and lenticular.

The gold-bearing quartz is distributed along the shear zones in the form of veins, lenses, and stringers. Some veins may be continuous for 1,000 feet or more along the strike. In many deposits, however, the quartz is not in continuous veins, but instead, a lens-shaped body 100 feet long and up to 5 feet wide may be followed along the strike by 100 feet or more of schist and massive rock carrying only quartz stringers, and this in turn by another tabular mass of quartz perhaps 200 feet long and up to 3 feet wide. This lenticular feature of the distribution of the quartz is characteristic of the deposits. The schistose rock adjacent to some bodies of quartz may carry quartz in veinlets and small lenses. Although the wall-rock schist of a deposit is well mineralized with sulphides, such material never assays over a trace in gold unless quartz is fairly abundant.

In some bodies fine and coarsely crystalline quartz is intermixed. The coarse quartz is generally of dark colour and the fine-grained quartz is white. Some very fine-grained quartz has a dark, cherty appearance. The quartz of most deposits is crossed by numerous cracks and joint planes running in various directions. The walls of some joints are smooth and slightly slickensided, and foils of white, sericitic mica occur along such fracture planes. Some coarsely crystalline, dark greyish to white quartz carries white and pink feldspar, and, locally, flakes of molybdenite, bits of scheelite, and bunches of crystals of pyrite. Free gold is present only sparingly in quartz of this type and is localized either to narrow seams in the margin of the quartz body or to parallel stringers in the adjoining wall-rock. Such quartz bodies are not likely to contain shoots of gold ore of commercial size and the flakes of molybdenite and bunches of scheelite are of erratic local distribution throughout the whole mass. Other quartz bodies are characterized by abundant needles and crystals of black tourmaline and grains and crystals of arsenopyrite and pyrite. These carry abundant free gold along narrow seams. Arsenopyrite is the abundant sulphide of the gold deposits about Wekusko lake. Other quartz bodies contain

some chalcopyrite and galena, in addition to pyrite or pyrite and arsenopyrite. Stibnite is also reported in a few of the gold-bearing quartz bodies. Free gold is erratically distributed throughout most quartz bodies that are well mineralized with sulphides. In some large quartz bodies the gold is limited in distribution to narrow streaks near the margin of the quartz, the interior part of the body being barren or containing gold only at a few scattered points. Gold tellurides have been determined definitely only in two deposits of the district. Iron carbonates occur in the gold-bearing quartz of a few deposits about Elbow lake.

Origin and Relationships of Deposits

The wide distribution, general character, and mineral content of the deposits of northwest Manitoba indicate clearly that they originated from some deep-seated source. The sulphide bodies are clearly of the replacement type and they, and also the gold-bearing quartz veins, were introduced after the folding, metamorphism, and intrusion of the igneous rocks of the district. Some gold-bearing quartz bodies east of Wekusko lake are in lamprophyre dyke rocks, which cut the granite, and some of the Sherritt-Gordon ore is in pegmatite, which is regarded as an end phase of the youngest granitic intrusion of that area. Bruce[1], Alcock,[2] and the writer[3] have presented evidence for the belief that the deposits, with the exception of the bodies of nickeliferous pyrrhotite, originated from a granitic magma, probably at a late stage of its crystallization. Wallace[4] has briefly summarized the evidence for this belief as follows:

"The mineralization is closely associated with the granite, occurring either in the neighbouring invaded rock, or in some instances, in shear zones in the granite itself. The massive granite is found to contain, though rarely, scattered sulphides, particularly arsenopyrite, which is a widely distributed mineral in the area. And, though in special cases basic (lamprophyric) dykes closely associated with the sulphide replacements, as in the Flin Flon ore-body, might be suggested as the parent body of the sulphides, a survey of the sulphide bodies throughout the area points convincingly to the conclusion that the granite was responsible for the sulphide mineralization as well as the other types of ore-bodies."

The copper-nickel sulphide bodies associated with bodies of quartz gabbro about Wekusko lake were not known until 1928, and these deposits are interpreted by the writer as being closely connected in origin with the basic magma forming the quartz gabbro. The deposits are all within or very close to bodies of quartz gabbro, and they are similar in their general features to the nickel deposits of Norway and other parts of the world. The Norwegian nickel deposits have been studied intensively by J. H. L. Vogt[5], and this author concludes that there is not only a close genetic connexion of the deposits and intrusive bodies of basic rock, but that there is a direct connexion between the quantity of nickel of the deposit and the percentage of magnesium oxide in the parent rock, the quantity of nickel increasing with the magnesium oxide content of the rock.

The materials forming the nickel and copper-bearing sulphides of the northern Manitoba deposits may have been distributed throughout the magma, and, as the mass cooled and crystallized, the sulphides separated as immiscible fractions. These were later concentrated in areas located

[1]Geol. Surv., Canada, Mem. 105, pp. 63-64 (1918).
[2]Geol. Surv., Canada, Mem. 119, p. 33 (1920); Sum. Rept. 1922, pt. C, p. 34.
[3]Geol. Surv., Canada, Sum. Rept. 1928, pt. B, p. 91.
[4]"Relationships in Mineral Deposits in Northwest Manitoba"; Econ. Geol., vol. 20, p. 432 (Aug., 1925).
[5]"On the Content of Nickel in Igneous Rocks"; Econ. Geol., vol. 18, pp. 307-353 (1923).

near the margin of the body or adjacent to included masses of older rock in the quartz gabbro, and where the rock was jointed and slightly schistified. The large bodies of rock carrying disseminated, nickeliferous pyrrhotite and chalcopyrite thus represent areas where there was only a slight segregation of the sulphides. The lenses and veinlets of relatively solid sulphides are interpreted to be a later and more complete segregation phase that migrated upward along the jointed and schistified zone. These materials were able to attack and replace slightly the silicate minerals of the quartz gabbro, but little or no alteration of the minerals accompanied the deposition of the sulphides. In some specimens, bits of carbonate, quartz, and a few veinlets of chloritic material were deposited later than the sulphides.

For the copper-zinc and gold deposits it is impossible even to suggest a source of the minerals in any particular intrusive body of igneous rock exposed. Some sulphide bodies are later than the pegmatite dykes, and some gold deposits later than basic lamprophyre dykes. Both these types of rocks cut the granite. Some gold deposits are also in granodioritic phases of the granite intrusives. By way of speculation the origin of these deposits may have been as follows: In depth below the present surface a large body of magma was undergoing differentiation and basic and acidic magmas were separating under the influence of gravity. Large bodies of the granitic magma thereby formed, moved upward into the overlying strata, and commenced to crystallize. During this process certain volatile components accumulated in the interior of the mass and remained liquid. Acidic phases of these residual products migrated outwards along lines of weakness and formed pegmatites of varying mineral content in the granite body and the surrounding rocks. The basic fraction of the residual magma also migrated upward to form lamprophyre dykes. At the next stage, a residual magma or solutions carrying the various metals concentrated during the crystallization of the original magma advanced, in some cases following the same channels as the pegmatite and lamprophyres, and copper-zinc and gold-bearing deposits formed in some instances beside the pegmatite and lamprophyre dykes and also along jointed and schistified zones of the intruded rocks not occupied by intrusive bodies. Evidence supporting the theory of a close genetic relationship of deposits of the types of those in northwest Manitoba with differentiates derived from magmas during the different stages of their crystallization has been outlined by Niggli[1] and Spurr[2], and Wallace[3] has presented evidence to support the theory that the copper-zinc and gold mineralization is closely related in origin. Wallace concludes that there is a general sequence from quartz vein to sulphide body in the order of falling temperature, though there may be a wide overlap between the lower temperature varieties of quartz veins and the higher temperature sulphide bodies.

No definite evidence is available on a number of interesting problems bearing on the origin of the deposits, such as the influence upon the type of mineralization exerted by the character and degree of shearing and jointing of the wall-rock, and by general and detailed structures such as anticlinal, synclinal, and drag-folding. These factors and others have had some direct influence on the formation of every deposit, and, for a

[1] "Ore Deposits of Magmatic Origin". Translated by H. C. Boydell, Thomas Murby, and Company, 1929.
[2] "The Ore Magmas"; McGraw Hill, 1923, pp. 61–156, 560–603.
[3] "Relationships in Mineral Deposits in Northwest Manitoba"; Econ. Geol., vol. 20, pp 431–441 (Aug., 1925).

particular deposit, some one may be very important. The observations presented in this report are based on examinations of the outcrops of the deposits; no deposit in the area has been developed below the 1,000-foot level. The geology of the underground workings of the Sherritt-Gordon, Flin Flon, and Mandy deposits was studied hurriedly in 1928, through the courtesy of the superintendents of these mines. Until more detailed information is available regarding the character of the deposits in depth, it does not seem advisable to discuss these problems further, for conclusions based on insufficient evidence may be misleading in exploring a particular deposit, and thereby retard progress.

Weathering of Mineral Deposits

Many of the mineral deposits of northwest Manitoba are weathered for a few feet below the surface or junction with overlying drift deposits. This is especially the case of the sulphide bodies, as the iron, copper, and zinc-bearing sulphides of these deposits react fairly readily with the downward-circulating surface waters to form soluble copper and zinc sulphates. The gold-bearing quartz bodies are less affected by the weathering agencies, owing to the massive and insoluble character of the quartz and the scarcity of sulphides. At the surface, however, the few bits of sulphides that originally were present in the quartz are oxidized to form cavities stained with limonite and frequently containing particles of free gold. The thin film of rusty materials covering some bodies of gold-bearing quartz will generally pan free gold.

The capping of the weathered sulphide bodies is a porous rock stained by limonite. The weathered material varies in colour from lemon-yellow through orange and brownish tints to brick-red. The colour of many cappings is yellowish. If the sulphides originally were abundant in the schist, a light, porous, siliceous material remains. If pyrite were present, square cavities formed by cubes of this mineral are readily recognized. The cavities after pyrrhotite and chalcopyrite are of irregular shape. Such limonite-stained material does not extend below 40 feet, and at most localities not below 5 feet, in depth. Below the level of complete leaching of sulphides, may be a zone, a few feet in depth, wherein some sulphides remain in the cavities, and here limonite stain is abundant. Below this the sulphides are unoxidized, except along joint planes and cracks. Freshly broken sulphide ore on the 125-foot level of the Sherritt-Gordon east deposit is slightly oxidized along joint planes. The depth of oxidation of a particular deposit depends largely on the amount of fracturing of the rocks. Some trenches through cappings exposed a band of greyish or rusty-stained, putty-like material, up to 5 inches in thickness, between fresh sulphides below and the capping above. This seems to be an impervious layer of material leached downward, and thus preventing the further downward circulation of the surface waters and oxidation. At some localities, as at the Mandy, fresh sulphides outcrop at the surface.

In some trenches the limonite-stained capping is overlain with sharp contact by fresh Glacial drift, and at one locality at the east side of the district, by post-Glacial stratified clay. Such relations of the drift to the oxidized materials indicate that at these localities the oxidation took place before the Glacial drift was deposited. The relation of capping and

drift is best shown in freshly dug trenches, and it was studied in detail in 1928 at Sherritt-Gordon where, in two pits, oxidized materials extend at least 10 and 16 feet, respectively, below fresh drift. The overlying gravel and boulder clay here are up to 9 feet thick, and at other points 5 feet or more of drift, and, at one locality, 3 feet of stratified clay, cover the capping. At the Huronian property, on Wintering lake, bits of the rusty rock from the capping occur in the bottom layers of stratified clay overlying the rock 2 feet to one side of the oxidized zone. The pre-Glacial weathered materials were eroded from the projecting outcrops. As the sulphide bodies outcrop along depressions, their deeply weathered upper parts naturally would be protected from glacial scour, especially if the depression were narrow and trended nearly at right angles to the direction of ice movement. At a few localities glacial scour was not intense enough to remove the adjoining fresh rocks of the ridges down to the bottom limit of the oxidation of the sulphide bodies along the depressions.

The soluble copper and zinc sulphates formed by the oxygenated groundwater naturally were carried downward. As carbonates are not abundant gangue minerals of the deposits, only traces of the green and blue copper carbonates, malachite and azurite, were deposited in the cappings. A few specks of native copper were formed, but, so far as observed, no secondary copper ore was formed near the bottom of the oxidized zones. In some oxidized, copper-bearing sulphide deposits of the United States, rich copper ore was formed by the deposition of copper sulphides from the circulating copper sulphate solutions at the level of permanent groundwater. The copper and zinc-bearing solutions in the Manitoba area may never have reached the favourable reducing conditions at the level of permanent groundwater before they migrated laterally along joints and other channels in the wall-rock. The copper thereby would be widely scattered instead of being concentrated within the ore zone.

It would be important to be able to distinguish from a study of the capping of a deposit whether or not copper in quantity may be expected in depth. If this could be done, much useless trenching might be saved, for then barren or practically barren pyrrhotite and pryite bodies would be eliminated without extensive trenching. If cavities of square shape are present, pyrite may be expected to be the predominant iron sulphide below. Small streaks and irregular-outlined patches of maroon limonite with a slightly purplish sheen occur in cappings where copper has been found below, in addition to pyrite or pyrrhotite. Cappings carrying small quantities of brownish or maroon limonites should be investigated. The cappings of the deposits throughout the whole district have been studied only in a general way. No definite set of criteria were noted to indicate positively that copper was absent below a particular capping.

DESCRIPTIONS OF DEPOSITS

The geology and mineral deposits of each of the main prospecting areas of northwest Manitoba are described in the following pages. The different areas are described in the order they were visited in 1930, commencing at Kississing lake. The situation of the main topographical features of the different areas is shown on Figure 1.

Kississing Lake Area

The general features of the geology and mineral deposits of Kississing Lake area are described in some detail in the Summary Report for 1928, part B, and, as no extensive new operations have been undertaken in the area since 1928, only a few days of the 1930 field season were spent in this area, reviewing recent developments. The development of the Sherritt-Gordon deposit of this area has been described recently in a paper by members of the staff of this mine, and prepared under the direction of Mr. E. L. Brown, General Superintendent.[1]

General Geology

The bedrock on and about Kississing lake consists of the Kisseynew sedimentary gneiss intruded by bodies of basic rock, by many sill-like bodies and dykes of granite, aplite, and pegmatite, and by batholith-like masses of granite. The sediments include gneissic quartzite, quartz-biotite-garnet gneiss, hornblende-bearing garnet gneiss, and crystalline limestone. These rocks are assumed to represent recrystallized beds of sandstone, clayey sandstone and arkose, limy arkose, and limestone. Many beds are so highly granitized that locally it is difficult without many observations to determine the position of the contact between granite and sedimentary gneiss.

Of the sedimentary gneisses mentioned above, the grey, medium-grained, quartz-mica-garnet gneiss is the most widespread, the gneissic quartzite, grey and black hornblende-bearing gneiss, and crystalline limestone being developed only at a few horizons. Over large areas the bedding and coincident foliation of the quartz-biotite-garnet gneiss dip at low angles, ranging from nearly horizontal to 30 degrees. The beds may dip in opposite directions within a mile across the strike, and, in the central and western part of Kississing lake, the strata appear to be folded into small anticlines and synclines. At other localities, as on the east side of Kississing lake and especially near the Sherritt-Gordon deposit, the strata are folded complexly and the beds locally are overturned. The dark grey to black, and other more unusual types of gneiss are exposed at points where the beds are closely compressed or overturned, and as many of the sulphide bodies in the sedimentary gneiss are within or near outcrops of the gneissic quartzite or dark grey, hornblende-bearing gneiss, they are at points where either the strike or dip of the strata varies from the normal. The bedding and foliation of the sedimentary gneisses appear to be everywhere parallel, and the small bodies of granite, those of aplite, and many of the pegmatite bodies follow the bedding and foliation planes. Along the axis of the anticlinal folds, a few pegmatite dykes cut the strata at right angles to their strike.

General Features of Sulphide Bodies

The sulphide bodies in the sedimentary gneiss are in zones of shearing and brecciation that in many cases lie along or near the contact between thick, massive beds of gneissic quartzite and thinner beds of fine-grained, dark-coloured quartz-mica or quartz-hornblende gneiss. So many of the zones of deformed gneiss are so located, as to suggest that the shearing and

[1] "Proposed Mining and Milling Practice at Sherritt-Gordon Mine"; Can. Min. and Met. Bull., No. 220, pp. 1012-38 (Aug., 1930).

brecciation resulted from movements between competent and incompetent beds during folding. At Sherritt-Gordon, the sulphide-bearing gneiss follows closely the dip and strike of the strata even around folds, and there appears to be a direct connexion between the localization of the ore-shoots and the thickening and thinning of the beds through stretching in folding. The abundant sulphide of the deposits is pyrrhotite, pyrite being present only sparingly. Many of the bodies of iron sulphide carry only small quantities of chalcopyrite and sphalerite (marmatite). At Sherritt-Gordon, however, fairly large bodies of the pyrrhotite contain enough chalcopyrite to be an ore of copper. An analysis of copper concentrates, published in the paper by the staff of Sherritt-Gordon and referred to above, shows only 0·09 per cent lead and only traces of arsenic, antimony, bismuth, cadmium, and nickel. The sulphides of most deposits are coarsely crystalline, there being only a few fine intergrowths, the most widespread and characteristic being that of small bits of chalcopyrite throughout some of the larger areas of sphalerite.

The sulphide bodies consist of lenses and tabular masses of variable size of sulphide and small quantities of silicate minerals, intermixed with larger masses of jointed and schistified gneiss carrying sulphides both disseminated and as veinlets along joint planes. Veinlets of sulphide penetrate and surround the silicate gangue minerals, which for the most part are quartz, feldspar, biotite, hornblende, and garnet, the characteristic minerals of the enclosing sedimentary gneiss. At some points sericitic and chloritic minerals are much more abundant in the sulphide bodies than in the unmineralized gneiss, but it is probable that these micaceous minerals were developed for the most part during the shearing of the beds of gneiss along which the sulphides later were deposited, rather than at the time the sulphides were introduced. Small bodies of pegmatite are present along some sulphide-bearing zones, and locally pegmatite carries pyrrhotite and chalcopyrite, apparently as accessory minerals. At other points, however, these sulphides penetrate the pegmatite along cracks with relations that indicate clearly that some sulphide was deposited after the pegmatite magma had crystallized. The pegmatite along sulphide zones, moreover, is massive and not mineralized, except for small areas along the margin of some dykes, where the rock has been sheared and jointed and replaced by sulphides similarly to the nearby gneiss. Some pegmatite along sulphide-bearing zones is characterized by an abundance of a greyish and greenish plagioclase. This association of sulphide mineralization with pegmatite bodies carrying unusual-coloured feldspar appears to have some significance in prospecting, and it may prove advisable to explore carefully all sulphide-bearing zones wherein the unusual type of pegmatite is present. Some bodies of massive sulphide are cut by veinlets of quartz of pegmatitic character, and quartz veins carrying gold are present in the gneiss near the Sherritt-Gordon sulphide deposit.

Sherritt-Gordon

This deposit was discovered by Philip Sherlett, a Cree Indian trapper of the district, and the first mineral claims were staked by him in 1922. Later Carl Sherritt and Richard Madole, also local trappers and prospectors, discovered additional rusty outcrops of the deposit and located a group of

mineral claims adjoining Sherlett's. In 1925, Sherlett lost the title to his ground and, later, Messrs. Sherritt and Burke staked this ground, thereby gaining control of the property. The occurrence was visited by a number of mining scouts, and during 1925 and 1926, Messrs. Earle and Fasken commenced exploration and outlined in part by twenty-eight diamond drill holes, two sulphide bodies, and it was estimated that some 450,000 tons of copper ore were proved. Their option was dropped and between September, 1926, and July, 1927, several companies optioned the property, but did little additional exploration. Work was commenced on the deposit in the summer of 1927 by Sherritt-Gordon Mines, Limited, and has continued to the present under the direction of this company. Many mining claims have been acquired in the area adjoining the original group, and now the property consists of about one hundred and sixty-five claims.

The development of the deposit to August, 1930, by Sherritt-Gordon Company, has been described in a paper, already mentioned, prepared by the staff of the mine. The facts regarding the developments given in the following sentences are from this paper. In the summer of 1927, this company trenched at all points along the strike of the sulphide zone where the drift mantle was thin. In January, 1928, diamond drilling was commenced and four drills were working until late in the autumn of 1928. In all, sixty-four holes were drilled, totalling 27,360 feet. In the early winter of 1928-29, the east or No. 1 shaft and the original west or No. 2 shaft were started. Diesel-driven compressors were used and the cost of power using oil was $232 per horsepower-year, whereas it is estimated that steam power developed by using wood would have cost nearly $350 per horsepower-year. No. 1 shaft is 370 feet deep and drifting has been completed on the 125- and 250-foot levels. No. 2 shaft is 480 feet deep and drifts have been run on the 125, 250, and 375-foot levels. In all, 14,179 feet of drifting and crosscutting and 979 feet of raising have been done from No. 1 and No. 2 shafts. No. 3 shaft was commenced in 1929 to explore the deposit at the northwest end. This is a five-compartment shaft, inclined at an angle of 51 degrees, and follows the foot-wall gneiss. The main haulage level is 500 feet down the dip and the ore-body is to be mined in blocks 1,000 feet long by the sub-level system of stoping. The underground work checked closely the diamond drill results regarding the size and average grade of the ore. The east ore-body is estimated to contain 866,175 tons of 2·14 per cent copper ore, and the west or Ook ore-body is estimated to contain 3,271,900 tons of 2·91 per cent copper ore with a lower grade section of 1,116,500 tons carrying 1·40 per cent copper. The average zinc content of these deposits is 5·78, 2·76, and 0·80 per cent, respectively, but the zinc probably will not be recovered unless the market price of this metal improves. The copper concentrates recovered from the pilot mill assayed 0·145 and 4·60 ounces of gold and silver, respectively. During 1929 a 10-ton pilot mill was built and operated until a complete method of concentrating the ore was evolved. The preliminary metallurgical testing of the ore was done by the Mines Branch of the Department of Mines, Ottawa.[1] The concentrating plant has been built at the No. 3 shaft. The copper concentrates are to be shipped to the Flin Flon smelter and the blister copper to the Copper Cliff smelter.

[1]Parsons, C. S., Anderson, A. K., and Godard, J. S.: "Concentration of a Complex Copper-Zinc Ore from the Sherritt-Gordon Mine, Cold Lake, Manitoba"; Mines Branch, Investigations in Ore Dressing and Metallurgy, 1928, pp. 26-37.

Electric power is being purchased from the Island Falls plant of the Hudson Bay Mining and Smelting Company. One unit of the Sherritt-Gordon concentrator commenced to operate in March, 1931. At the end of April, 1931, the copper recovery is reported at 94 per cent, and the concentrates to average 24 per cent copper. It is estimated that the cost of the copper will be under 9 cents a pound.

The Sherritt-Gordon ore-bodies lie in sedimentary gneisses, along the side of or just within a wide band of thick beds of gneissic quartzite. The foot-wall is formed by the gneissic quartzite, the hanging-wall is of beds of grey to black, hornblende-bearing garnet gneiss with intercalated beds of grey, acidic gneiss and thin beds and lenses of crystalline limestone. The dip of the bedding and of the foliation of the gneiss and of the ore-bodies is from 35 to 60 degrees northeast, except near the east end where the strata steepen to vertical and to steep dips to the south and southeast. A study of the structure of the sedimentary gneisses of an area of about 30 square miles surrounding the deposit, indicates that the ore-bodies are on the southwest and overturned limb of an anticlinal fold. In folding many small drag-folds have developed along incompetent beds and the axial planes of these folds dip northeast. Drag-folds are especially well developed along a zone at the top of the gneissic quartzite horizon about 750 feet south of the ore-bodies. Some beds have also been stretched, resulting in marked changes in their thickness along the strike. Southeast of the east end of Camp lake and southeast of Lost lake the dip of the beds locally is less than 30 degrees, and here the maximum dip of the beds in some outcrops is at right angles to the general trend of the strata. This suggests the possibility of crossfolding along a southwest axis. The details of this crossfolding and also of transverse normal faulting and strike slice faulting of this overthrust structure have not been determined, as such features are hard to locate definitely unless a series of beds are very closely followed along their strike. Little exploration has yet been undertaken to determine the possibility of ore being present along the structure below the 750-foot horizon. A detailed study of the structural relations of the ore-bodies already developed, combined with very careful work in correlating beds along their strike, may give important suggestions as to the most likely places to concentrate explorations of deeper horizons.

The ore-bodies are tabular masses of gneiss carrying pyrrhotite, pyrite, chalcopyrite, and sphalerite in varying proportions. In some sections the gneiss has been almost completely replaced by the sulphides, only small bits of country rock remaining. In other sections country rock is abundant, and thick, massive masses of gneiss only slightly replaced by sulphides are present. Calcite is abundant in some thin sections of ore and it is believed that originally thin beds of limestone were present among the quartzose beds along the sulphide-bearing zone. The gangue minerals, quartz, feldspar, hornblende, biotite, calcite, tremolite, and garnet are for the most part fresh, there being only very small amounts of secondary chloritic and sericitic minerals in the specimens studied. Some large areas of pyrrhotite are veined by both chalcopyrite and sphalerite. Minute rods and round grains of chalcopyrite are abundant in some sphalerite. The iron sulphides apparently were deposited first and later were in part replaced by chalcopyrite and sphalerite, which are regarded as of contemporaneous deposition. According to the information furnished by the staff of the mine,

the east ore-body is 4,200 feet long and averages 15·2 feet in width; and the west deposit is 5,200 feet long and averages 15·2 feet in width. The west deposit includes the body of low-grade ore mentioned in a preceding paragraph. Diamond drilling along the strike of the sulphide-bearing zone shows that there is some mineralization in the area between the two main deposits, but no large tonnage of ore has been proved between or beyond the ends of the two deposits mentioned.

Deposits Near Sherritt-Gordon

Premier and Other Groups. Surface trenching and a few diamond drill holes have been completed on a number of sulphide deposits in the area surrounding Sherritt-Gordon deposit. The Premier and other groups of mining claims staked by Willsie Brothers and associates were taken over in the spring of 1929 by Sherritt-Gordon Company. These mineral claims are to the north along the strike of the beds of sedimentary gneiss enclosing the Sherritt-Gordon deposit, and here the beds change their strike and dip to form the end of a large anticlinal fold. Sherritt-Gordon Company did additional surface work on the group and drilled a few holes to determine the structure at depth and to test the possibilities of bodies of sulphides being present around the end of this anticlinal fold. The gneiss is fractured and sparingly mineralized with pyrrhotite and chalcopyrite at a few points on the surface. Pegmatite, carrying abundant garnet and small amounts of chalcopyrite and sphalerite, is exposed in a few trenches. In addition to the work on the Premier group, Sherritt-Gordon Company has completed extensive surface investigations on other mineral claims of their large group and on other claims optioned.

Found Lake and Molly Lake. In the winter of 1929, Raymon Syndicate drilled six holes on showings near the shore of the southeast bay of Found lake. Schistose gneiss at this locality carries cupriferous pyrite and a little chalcopyrite. This syndicate also did some diamond drilling to explore a sulphide body north of Molly lake.

Sherlett Lake and Threefinger Lake. During the summer of 1929 additional surface prospecting was done in the area northwest from the north shore of Sherlett lake by Manitoba Basin Mines, Limited. The sedimentary gneiss here is locally complexly drag-folded and mineralized by pyrrhotite. Drift deposits are widespread and for this reason parts of this area are difficult to prospect by surface trenching. A sulphide body southwest of Threefinger lake was drilled during the winter of 1929 by Robert Jowsey and associates.

Camp Lake. Cold Lake Mines, Limited, completed Radiore surveys of several mining claims adjoining the Sherritt-Gordon property near the northwest end of Camp lake. In 1928 and 1929 this company drilled several deep holes and a number of shallow holes to explore the acidic footwall gneiss at the north end of the Sherritt-Gordon deposit. Several pyrrhotite bodies were intersected in this drilling.

Smith Pride Property. The Smith Pride deposit was explored extensively by surface trenching and some diamond drilling during 1928 and 1929. The preliminary work in 1928 was done by Callinan Flin Flon Syndicate and the property later was taken over by Smith Pride Mines,

Limited. Some fifty-five trenches were made to explore sulphide occurrences at three points on this group. The trenches expose sedimentary gneiss cut by pegmatite. The strike of the foliation of the gneiss is variable from north 30 to 60 degrees west and the dip from 30 to 65 degrees northeast. The abundant type of gneiss is a medium-grained, grey, quartz-mica-garnet type. Thin beds of quartzite and of black amphibole-rich gneiss are present at a few horizons within the micaceous gneiss. The black amphibole-bearing gneiss may represent recrystallized, calcareous, clayey beds. Some layers of the dark-coloured mica and amphibole-bearing gneiss between quartzite beds are highly schistose and the adjoining quartzite is jointed and brecciated. The sulphide mineralization is localized to the schistose mica and amphibole beds and the nearby brecciated quartzite. The sulphides occur both massive in small lenses and disseminated through the gneiss. The sulphides include pyrrhotite, pyrite, chalcopyrite, sphalerite, and some galena.

The main prospecting on the Smith Pride group has been done in the area from 700 to 1,800 feet northwest of No. 1 post of lot 1031, near the camps on the small bay of Kississing lake. Some work has also been done at points from 2,600 to 3,800 feet by road northwest of the camps.

The prospect trenches at the southeast end of the workings expose three small sulphide-bearing zones. A shaft was sunk 55 feet deep near the south end of the largest of these deposits. In the trenches across this deposit the rocks are quartzite and thin beds of black mica-rich gneiss. A mass of pegmatite with abundant greenish feldspar was cut in the shaft. Parts of this pegmatite are heavily mineralized with pyrrhotite and chalcopyrite. In the trenches the sulphides are for the most part in the micaceous rock and sections 10 feet thick of mica gneiss and thin beds of quartzite are heavily mineralized. Pyrrhotite is abundant and some lenses of massive, black sphalerite are also present. The chalcopyrite is localized to veinlets, lenses, and blebs through the pyrrhotite and sphalerite and in the quartzite gneiss. This deposit has been exposed at intervals for 350 feet along its strike and the drill holes also intersected at depth a similar body of sulphide-bearing gneiss.

Two zones of sulphide-bearing, brecciated gneiss are exposed in several trenches on the small hill across a depression and 300 feet south of the shaft. Gouge-like material is present along some of the joint planes, and the mineralization here appears to be along parallel faulted zones striking north 75 degrees west. The bodies of sulphide-bearing rock are each 6 feet wide, but they have not been traced far beyond the two main trenches. A mass of black amphibole-rich rock carries most of the sulphides along the zone farthest southwest. In addition to amphibole, the black rock contains diopside, some fibrous tremolitic material, biotite, and grains of andesine and calcite. The sulphides penetrate and replace the amphibole and pyroxene. Sphalerite and chalcopyrite occur only in small grains.

The prospect trenches along the hillside, commencing 375 feet west of the shaft and extending north 65 degrees west for 1,000 feet, expose quartzite and mica gneiss cut by pegmatite. A drag-folded and sheared bed of mica gneiss about 6 feet thick, and lying between beds of more massive quartzitic gneiss, extends most of this distance and the sulphide mineralization is localized at points along this horizon. At the west end a sill-like mass of pegmatite cuts this horizon. A prospect shaft was sunk

in the hanging-wall gneiss about midway between the end trenches. This shaft intersected a pegmatite body and the pegmatite and the adjoining gneiss were mineralized with pyrrhotite, pyrite, chalcopyrite, and vein quartz. Iron sulphides are disseminated through the bed of mica gneiss in most of the trenches, but chalcopyrite was noted only in three trenches. Channel samples of the sulphide deposit as crossed in the prospect shaft are reported to have assayed $5 to $8 in gold and nearly 2 per cent copper.

The prospect trenches at the locality farthest nor hwest expose beds of quartz-mica-garnet gneiss and quartzite. These rocks are cut by small dykes and sill-like masses of pegmatite. A bed of the quartz-mica gneiss carries pyrrhotite and some chalcopyrite at a few points across a thickness of from 1½ to 8 feet. Near the north prospect trenches, the beds of quartzite and quartz-mica gneiss appear to form a small anticlinal fold. Thick drift deposits cover the continuation of the sulphide bed and apparent anticlinal fold to the northwest.

Victor Group. Some trenching had also been done on the Victor group, owned by Mr. C. E. Johnson of Rosetown, Manitoba. The group was staked in September, 1927. The bedrock is quartz-mica gneiss with thin beds of black biotite-hornblende gneiss. The foliation of the sedimentary gneiss strikes north 45 degrees west and dips from 35 to 50 degrees northeast. The prospecting work has been done at two main localities to explore beds of gneiss carrying pyrrhotite. One of these beds lies about 110 feet southwest of the No. 2 post of the Victor No. 3 mineral claim. This bed has been exposed in three trenches along a distance of 800 feet. The trench farthest south crosses, from west to east, 12 feet of drift, 18 feet of quartz-mica gneiss and quartzite, 12 feet of massive pyrrhotite followed by black hornblende-bearing gneiss forming the hanging-wall. In fresh surfaces the pyrrhotite is white; it weathers bronze coloured. Chalcopyrite and sphalerite are present in the pyrrhotite near the hanging-wall. The massive sulphide is reported to assay low values in nickel, copper, zinc, and tin. Bodies of massive pyrrhotite were also found in the two trenches to the north. This sulphide body is heavily drift covered in the area between the prospect trenches and along its projected strike both to the northwest and southeast. The second sulphide-bearing zone is about 250 feet northeast of the one already described and is exposed by trenching at points 500 and 750 feet southeast of the No. 2 post of the Victor No. 3 mineral claim. The pyrrhotite here is disseminated across a wide, jointed zone of quartz-mica gneiss and quartzite. Chalcopyrite is only sparingly present with the pyrrhotite.

WELDON BAY AND FAY LAKES AREA

An area of andesitic lava and interbedded tuff and quartzite, lying between sedimentary gneiss on the north and granite on the south, extends from the east end of Kisseynew lake to and beyond Fay lake. This area of greenstone was prospected during the summers of 1928 and 1929 and several groups of mining claims were staked. Some assessment work has been done on a few of these claims. The mineral occurrences here were examined in June, 1930. The area is easily accessible from the Sherritt-Gordon branch of the Canadian National railway, which passes the east end of Fay lake.

Bar Group. Pyrrhotite bodies have been trenched at several points on the Bar group south of the creek from Syme lake to the small lake east of Weldon bay of Kisseynew lake. Andesite with interbedded quartzite outcrops south of the sulphide bodies, which are in a bed of quartzite. The bedding of the quartzite strikes north 55 degrees east and dips 75 degrees northwest. About 1,200 feet south of the sulphide bodies is the edge of a large body of granite intruding the lavas and sediments lying north of it.

Two long trenches on the north side of a hill south of the creek about 2,000 feet east of the lake, expose jointed and brecciated, grey quartzite and black, micaceous quartzite. Pyrrhotite is distributed in grains, veinlets, and masses up to 3 feet thick, across widths of 12 and 18 feet of the jointed and schistified sediment. The pyrrhotite is bronze coloured and the grains average 0·04 mm. in diameter. Small bits of chloritic material, bleached biotite, feldspar, quartz, epidote, and grey carbonate, occur in the bodies of massive pyrrhotite. This sulphide deposit has not been traced under the drift beyond the two trenches, which are about 350 feet apart. About 175 feet to the northwest across a depression, a large trench on the side of a low knoll exposes about 20 feet of jointed, bedded quartzite with disseminated pyrrhotite and one body of massive pyrrhotite 6 feet thick. A trench about 225 feet farther west, exposed 90 feet of jointed and schistified quartzite, some beds of which carry disseminated pyrrhotite. Chalcopyrite and sphalerite occur only in small quantities in a few specimens of pyrrhotite. A few veinlets of quartz cut the pyrrhotite and the schistose quartzite and some chalcopyrite is present within or near the quartz stringers.

B. C. Copper Group. Surface trenching of sulphide bodies has been done on four groups of mineral claims about Fay lake. The most extensive work in this area is on the B. C. Copper group, staked on the large point west of the east end of Fay lake. Figure 2 shows the location of the sulphide bodies as exposed by this work and also their position in respect to the contact of a large body of granite on the south and andesite lava on the north. A few small inclusions of andesite occur in the granite for at least 2,000 feet south of the contact between granite and andesite, as shown on the plan. The andesite north of the granite is penetrated by small dykes of granite, aplite, and pegmatite, and veins of quartz.

The pit farthest west exposes 4½ feet of jointed andesite and chlorite schist carrying white iron sulphide in grains and veinlets, some of which are 2½ inches thick. Only a few specks of chalcopyrite were noted near quartz stringers crossing the schistose andesite. The trenches at the middle locality are for the most part in a grey siliceous rock believed to be a fine-grained, marginal phase of the granite mass. In thin section this rock is mainly of irregular-shaped quartz grains with some kaolinized feldspar, flakes of biotite, chloritic material, cubes of pyrite, and grains of pyrrhotite. Where jointed this acidic rock is heavily mineralized with sulphides. The pyrite and pyrrhotite almost completely replace a body of this rock up to 20 feet wide, and chalcopyrite occurs along both margins of this sulphide mass. Some samples from the chalcopyrite-bearing sections assay 2 per cent copper. Veinlets of quartz cut the jointed rock and the sulphide body and a speck of free gold was found in one specimen of dark-coloured, vitreous quartz. Near the quartz veinlets chalcopyrite is more plentiful

than elsewhere and occurs in narrow streaks through the pyrrhotite. The pyrrhotite and pyrite are in small crystals and grains, some specimens from the areas of more massive sulphides being almost dense in appearance. The massive pyrrhotite contains spheres up to 1½ inches in diameter of crystals of pyrite. The sulphide body at the locality farthest east is very similar in general character to the middle deposit. Andesite is the wall-rock at the east locality. Veins of quartz are more abundant than at the other localities. One quartz vein in the north or hanging-wall side at the east end of this deposit is a foot wide, and the body of massive pyrrhotite close to the larger quartz vein carries abundant chalcopyrite. The quartz carries free gold, but the average combined gold and copper content of the large pyrrhotite and pyrite bodies is low.

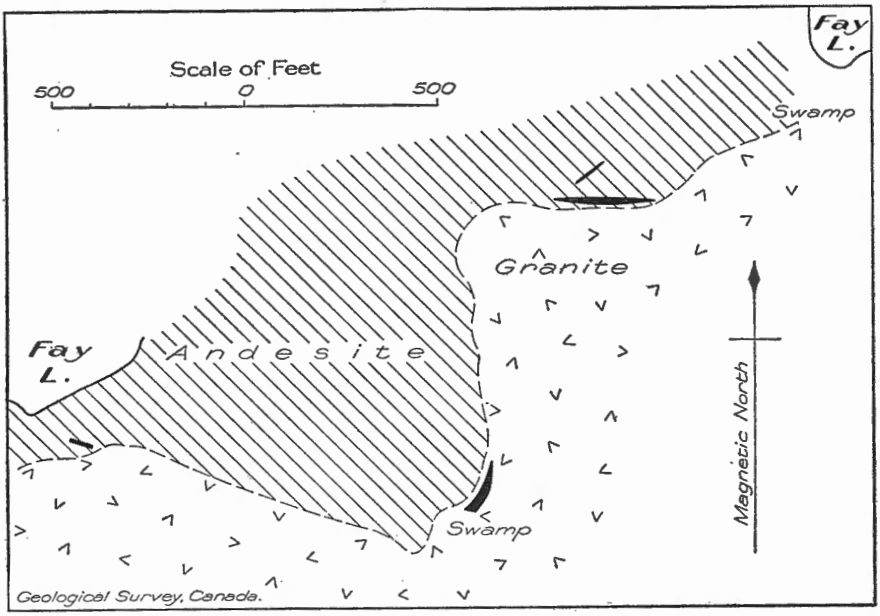

Figure 2. Location of bodies of sulphide (solid black) on B.C. Copper group, Fay lake, Manitoba.

Sundown Group. A pyrrhotite-pyrite body containing some chalcopyrite has been exposed by three trenches on the Sundown group at a point about 3,300 feet south of the west trench shown on the plan of the B. C. Copper deposits (Figure 2). The deposit on the Sundown group is in andesite a few hundred feet west of the main granite mass. The andesite near the trenches is cut by small bodies of granite. The sulphide body has been traced 300 feet along the side of a swamp, and at one point sulphides occur across a width of 10 feet. This deposit is very similar in its general features to the deposits on the B. C. Copper group.

Copper Chief. Two schist zones within the lavas on the Copper Chief group carry sulphides in small quantities. Several trenches have been dug along one of the schist zones on the north side of an island in the entrance

to the second bay south from the east end of Fay lake, and about 2,000 feet northwest of the west trench shown on the plan of the B. C. Copper group (Figure 2). Here parts of a bed of garnet-bearing schist about 100 feet thick, carry quartz in veinlets and small lenses and some pyrite, pyrrhotite, and chalcopyrite in scattered grains. The garnet-bearing rock exhibits bedding where it is not too highly schistified and may be a recrystallized, tuff-like layer within the lavas. Widths of 20 feet or more of the schistose rock carry sulphides, but at no point noted was chalcopyrite abundant enough, even across narrow sections, to make an ore of copper.

Pembroke Group. Some surface trenching has been done on the Pembroke group at the west end of Fay lake, to explore zones of schist. The bedrock is andesite cut by small dykes of granite. Most of the work has been done along the south shore of the lake where a wide zone of chloritic schist was followed 2,500 feet along the strike. No large mass of schist was uncovered wherein chalcopyrite was abundant.

Other Localities. Prospect trenches and pits have been sunk at a few points east of Fay lake close to the contact of granite on the east and andesite on the west. Two trenches about 500 feet east of the railway, at a point about 3,200 feet north of mileage 28·8, expose fine-grained, jointed, and gneissic grey granite containing a number of quartz veins and small areas wherein pyrite, chalcopyrite, and galena are abundant. Cubes of pyrite are scattered through most of the gneissic and slightly schistose granite crossed in the trenches. A number of small quartz veins are reported in the lavas north of Fay lake and the part of this area of volcanic rocks at a distance from the main granite mass to the south perhaps should be prospected carefully for gold-bearing quartz.

SNIPE LAKE AREA

In July, 1929, Messrs. Ray Tamlyn and M. Lavoie staked the Snipe group of mineral claims along the west side of Snipe lake, one-half mile south of Webb lake. This locality is accessible by canoe routes either from the railway at Fay lake or from Cranberry Portage by Elbow lake and Webb creek. Both routes are difficult except when travelling with light equipment. The route from Fay lake follows a series of small lakes and creeks with ten portages, several of which are across low, swampy country. There are only four portages on Webb creek from Elbow lake, but unless the water is high this creek is navigable with difficulty on account of the alder and willow bushes that overhang the banks.

Prospecting work has exposed sulphides at two localities along the strike and about 650 feet apart. The area between is covered by drift and, in part, by a shallow bay of Snipe lake. The sulphides are weathered to limonitic materials to depths varying from 6 inches to 4½ feet below the surface.

The main sulphide body on the Snipe group is exposed by seven trenches and pits along the west shore of Snipe lake 300 feet north of the outlet. The deposit is in andesite lava along the west side of a dyke of granite porphyry 150 feet wide. About 200 feet west of the deposit, the andesite is intruded by granite which is the country rock to the west for an unknown distance. The dyke of granite porphyry is probably an extension from the main granite body below.

The andesite is a black, fine-grained, schistose rock with needle-like crystals of hornblende arranged parallel with one another. In thin section the minerals are fresh and include hornblende, oligoclase-andesine, and some quartz. Titaniferous magnetite and leucoxene are abundant accessories. The lava along the margin of the granite is coarser grained than at the lake shore. North of the sulphide body the granite contact turns west and there the lava is recrystallized to a grey, foliated rock cut by many dykes of granite. The granite porphyry is grey with white, rectangular crystals of feldspar in a fine-grained, schistose matrix. In thin section the outline of the phenocrysts is still recognizable, though the feldspar is altered to calcite, quartz, zoisite, and chloritic materials. The groundmass is an aggregate of quartz, orthoclase, plagioclase, biotite, and hornblende. The granite of the large body to the west is grey, coarse grained, and massive. In thin section, the minerals of the granite are fresh, except for small areas of oligoclase which are altered to zoisite, calcite, and chloritic material along cracks. In addition to oligoclase, the granite contains orthoclase, quartz, hornblende, and biotite. The biotite flakes show frayed ends and contain crystals of hornblende.

The strike of the schistosity of the andesite and the sulphide body is north 30 degrees west and the dip 75 degrees east.

The south sulphide body is 38 feet wide in the middle trenches and narrows both north and south to form a lens about 260 feet long, which at both ends fingers into the schist. This central area of massive sulphides is 30 feet wide in one trench. Blocks and long, narrow masses of schistose andesite are abundant towards the margins and ends, and there chalcopyrite and sphalerite are sparingly present. At the south end, a few veinlets of massive chalcopyrite cut the schistose andesite and massive pyrrhotite. Short sections of the north and of the south trenches, wherein several veinlets and small patches of chalcopyrite are present, assay nearly 3 per cent copper. Only a small part of the whole mass, however, carries over 0·5 per cent copper. The central area of the lens is of fairly massive, fine-grained, bronze-coloured pyrrhotite containing cubes and grains of pyrite and blebs of quartz. The cubes of pyrite are veined by pyrrhotite. The succession of the mineralization at this locality appears to be as follows: (1) introduction of pyrite, which formed in cubes and irregular-shaped patches along a shattered and schistified zone in andesite; (2) introduction of pyrrhotite and quartz forming the main, large sulphide body; (3) introduction of quartz, chalcopyrite, and sphalerite in veinlets and disseminated grains in the sparingly mineralized schistose andesite around the ends and margins of the main sulphide body, and also replacing the main pyrrhotite mass for a few feet within its margin.

Two trenches along the lake shore at the northern sulphide occurrence, expose silicified, jointed, and schistified andesite cut by veinlets and irregular-shaped lenses of pyrite and pyrrhotite, and of quartz. A few grains of chalcopyrite occur near some of the quartz veinlets. One body of massive pyrrhotite is 10 feet wide.

A quartz vein, 5 feet wide and carrying cubes of pyrite, bits of chalcopyrite, and arsenopyrite, is exposed in a trench west of Webb creek and 400 feet south of the south sulphide body. The quartz vein is in the granite porphyry along its east side. No free gold has been found in this quartz and the quartz had not been assayed for gold.

ELBOW LAKE GOLD AREA

Three days near the end of June, 1930, were spent reviewing mineral developments about Elbow lake. The geology of the Elbow Lake gold field was mapped in 1915 by E. L. Bruce[1]. In 1921 Mr. Gordon Murray discovered gold in the area. During the following years many additional occurrences of gold were discovered by other prospectors. In 1922 preliminary work was undertaken on a number of these showings. In the summer of 1922, P. Armstrong[2] studied the gold prospects of the field. In the summer of 1930, Mr. Tom Hanna was developing a small gold vein on Gold Pan island north of reference mound *Z*15 on the east side of Elbow lake.

The bedrock in and about Elbow lake comprises a thick assemblage of volcanic rocks including flows of basalt, diabase, and andesite and intercalated beds of tuff-like materials. The volcanic rocks are massive only in the central parts of the thick flows. Hornblendic, chloritic, and sericitic schists, developed by shearing of the lavas and tuff-like beds, are widespread. The volcanic rocks are cut by granitic rocks in small bosses and dykes, and the area of lavas is almost surrounded by intrusive granite. The granitic rocks of the small masses within the lavas are schistified and for the most part altered to grey, quartz-sericite schist. As mapped by Bruce, the area of lavas and schists on and about Elbow lake is 6 miles wide and 12 miles long.

The gold prospects on Elbow lake that were examined hurriedly include the Sherlock, Webb-Garbutt, Mack, Hanna, and Murray. Many other deposits are known in the area.

Sherlock. The prospecting work on the Sherlock group was done on the side and top of a hill on the west shore of the bay of Elbow lake about one-quarter mile south of where Webb creek enters the lake. The property was staked by Messrs. Webb and Garbutt and Mr. Webb is reported to have panned about $800 of gold from a high-grade quartz lens during the preliminary prospecting of the deposit. In 1922, the Explorations Company of London, England, prospected the deposit extensively. The property is now controlled by a company organized by Mr. Wm. Garbutt of The Pas.

The rocks exposed in the workings are andesite lava and tuff-like sediments. The andesite is schistose and is in part altered to chloritic schist, some layers of which contain abundant carbonate. Veinlets of quartz and a few dykes of granite up to 2 inches wide are erratically distributed throughout the chloritic schist. The schist carries abundant quartz and epidote near the stringers of granite. The tuff-like beds outcrop near the top of the hill and form an horizon up to 45 feet thick. Some beds within this horizon are of laminated, cherty-magnetite layers, and others are of grey, fragmental materials alternating with black, chloritic schist and reddish-weathering, ashy-appearing types. The cherty-magnetite layers are intricately drag-folded at a few points, and the white tuff horizon appears to be folded into a small syncline within the lava. The general trend of the cherty layers is north 15 degrees west, and the pitch of the axis of the small folds appears to be about 70 degrees north. The general trend of the schistosity of the lavas is north 10 degrees west and the dip 75 degrees east.

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[1] "Amisk-Athapapuskow Lake District"; Geol. Surv., Canada, Mem. 105 (1918).

[2] "Geology and Ore Deposits of Elbow Lake area, Northern Manitoba"; Geol. Surv., Canada, Sum. Rept. 1922, pt. C, pp. 37–44.

The prospecting work includes an adit about 50 feet long running into the hill from just above lake-level, a prospect shaft near the top of the hill and at least 30 feet deep, and twelve trenches with an aggregate length of about 1,000 feet. This work exposes fairly thoroughly the quartz veins and rocks of an area approximately 125 feet wide and 400 feet long.

The adit intersects andesite with zones of chloritic and carbonate schists. The schistose zones carry a few quartz veinlets up to 2 inches thick and small, lenticular masses of quartz. A few of the quartz bodies in the tuff-like rock near the top of the hill are up to 3 feet wide and 20 feet long. The quartz is a white, sugary variety carrying small, dark-coloured areas. Pyrite and chalcopyrite are sparingly present in the quartz. Small crystals of pyrite are abundant in some of the chloritic schist. Small patches of calcite occur in the quartz of some of the larger lenses. Although small lenses and veinlets of quartz are distributed throughout most of the large area of rock exposed, no single body or group of closely spaced, small lenses of quartz was located that offered promise of being a large commercial ore-body. A few of the small lenses of quartz, however, are exceptionally rich in gold.

Webb-Garbutt Group. The Webb-Garbutt group includes some twenty mineral claims and fractions on the large island northeast of the bay into which Webb creek flows. The deposit on which most of the work has been done is on the Garbutt and Webb claims. Here a shaft was sunk 60 feet and some crosscutting completed at this level. The shaft is 45 feet southeast of the No. 6 post of lot 399 and No. 5 post of lot 402. The deposit was also trenched at intervals for 1,200 feet from the east to west sides of the island. Other veins are reported to occur to the west on the Bow, Ruby, and adjoining claims, but these deposits were not visited.

The bedrock on the island comprises thick flows of massive, medium-grained diabase and basalt porphyry, thinner flows of grey, more acidic lavas, and chloritic and sericitic schists derived from the lavas. The lavas are cut by small bosses and dykes of granite, in part altered to quartz-sericite schist. The quartz bodies are in zones of schist within the lavas, and in small dykes and stringers of schistose granite in the schist zones.

The schist zone and quartz bodies on the Webb-Garbutt claims strike north 30 degrees west and dip 78 degrees northeast. The deposit is exposed by trenches at four points within 1,200 feet, the intervening areas being heavily drift covered. At the southeast end of the deposit as exposed, quartz occurs in trenches for 200 feet along the strike. In the face of a low cliff at the north end of this stretch, the quartz-bearing, intermixed, aplitic granite and chloritic schist are 12 feet wide. To the southeast the quartz lenses become much smaller and the schist carries little quartz where the shear zone passes under drift. At the shaft the schistose zone is 20 feet wide, and the best defined vein is near the foot-wall, where the quartz with included schist is 8½ feet wide. Within 50 feet to the southeast this quartz body narrows to 3 feet, and at 105 feet farther along the strike it is only 6 inches wide. To the northwest of the shaft the schist belt has been trenched across a drift-covered area 225 feet wide, but here the clayey walls of the trenches have slumped so that little can be seen of what was found except that the lava throughout the distance was schistified and carries masses of granite, quartz, and carbonate. Northwest of this

depression the schist zone is exposed for 190 feet along the strike and across widths of 15 feet. The quartz here is in small stringers and the schist is cut by small masses of aplitic granite. The schist zone is again exposed 100 feet to the northwest for 125 feet to where it passes under the lake. The quartz lenses and stringers here are small and not closely spaced.

The quartz is white and some of it is well mineralized with pyrite, chalcopyrite, and galena. Iron carbonate is abundant in some of the quartz and also in the schists derived from the lava and granite. Free gold is reported in some of the quartz. No information is available regarding the average gold content of large bodies of schist carrying quartz. Some of the quartz from where the shaft was sunk is reported to be high grade.

Mack. The Mack deposit is at the foot of a small bay on the east shore of Elbow lake 1½ miles south of the north end of the lake. The rocks exposed near the deposit are andesite lava and derived chloritic schists. The lava is cut by dykes and bosses of granite and granite porphyry. The strike of the schistosity of the lava is north 25 degrees west and the dip 80 degrees east.

A schistose zone in andesite, trending north 25 degrees west for 600 feet from the foot of the bay, has been stripped at intervals. A prospect shaft near the south end of the deposit is 28 feet deep. At the shaft the schist zone is 5 feet wide. On the foot-wall side, the quartz is 21 inches wide; the remainder of the section is chloritic schist carrying veinlets of quartz and granite and some iron carbonate and pyrite. The quartz body widens north of the shaft and at 30 feet ends in a drag-fold where an irregular-shaped body of granite intrudes the zone. The granite, also, is schistified and carries quartz stringers. Sections across the bottom of the shaft are reported to assay nearly $10 a ton in gold. The trenches at the north end of the deposit cross from 5 to 9 feet of highly schistose lava and granite. The quartz here is distributed in small lenses and veinlets in the schistose granite and lava. The continuation of the shear zone both to the north and south is heavily drift covered.

Large Island in Elbow Lake. A wide zone of schists carrying quartz stringers and veins and small bodies of iron sulphides has been trenched at three points near the east shore of the large island and about three-quarters of a mile south of the Mack deposit. The rocks along the shore are andesitic lava altered to chloritic, sericitic, and carbonate schists. In the centre of the island the lava and schist are penetrated by dykes of medium-grained dioritic and granitic rocks.

The schist zone exposed by trenching, strikes about south and dips 78 to 80 degrees east. In the north trench, 40 feet of schistose lava is cut by quartz veinlets at a few points. A long trench 190 feet south of the north trench and beginning at the lake level, crosses 20 feet of highly schistose lava containing pyrite and pyrrhotite, both disseminated and in small bodies of massive sulphides. Narrow lenses of dark-coloured quartz are also present. A quartz vein 3 feet wide is exposed in a trench extending southwest from the west end of this trench. Four hundred feet south, across a bay, three trenches expose wide zones of schist cut by quartz veins. In one trench quartz is estimated to occupy one-third of the area across 9 feet of schist. One quartz vein here is 25 inches wide at its north end, but within 90 feet to the south narrows to 6 inches and continues with

this width for 125 feet. The quartz is white and carries a few crystals of white feldspar, and at some points small areas of siderite. Pyrite is abundant in the schist in the form of crystals and granular masses. Pyrrhotite was noted in the schist only where veinlets of dark-coloured quartz are present. No information is available regarding the gold content of the small bodies of quartz and iron sulphides.

Hanna. As already stated, only one gold deposit on Elbow lake was being explored during the summer of 1930. This is on a small island near the east shore of the lake and north of reference mound Z15. Here Mr. Tom Hanna was sinking a prospect shaft, using a small, portable, gasoline-driven compressor. The shaft was 20 feet deep at the end of June.

The bedrock on the island is black, massive, and schistose andesite. Quartz in veinlets and lenses is distributed along a zone of alternating layers of fairly massive and schistose lava, up to 125 feet wide and striking south 5 degrees west from a small bay at the north end of the island to the southwest point. The dip of the schistose zone appears to be about 80 degrees east. The zone has been exposed by a trench for 600 feet along its strike. The lenses and veinlets of quartz exposed are narrow and short, the largest one noted being 2½ feet across at one point and 22 feet long. Many of the quartz bodies are from 3 to 10 inches wide and 6 to 15 feet long. Some of the schist adjacent to the larger quartz masses carries seams of quartz and cubes of pyrite. Two veins about 5 feet apart and 12 and 18 inches wide, respectively, are exposed in the walls and bottom of the shaft. The quartz is white, fine grained, and contains some granular pyrite, chalcopyrite, and galena. A few specimens from the shaft veins carry abundant free gold.

Murray. The Murray deposit is on the east side of Grass river at the outlet of Elbow lake. Gold was discovered here by Messrs. Gordon and Kenneth Murray in 1920. The group of claims staked by the discoverers was taken over, in 1921, by a group of mining men closely associated with the Hollinger Gold Mines and the deposit was thoroughly explored by surface trenching before the option was dropped in 1922.

The trenching was done along the west side and top of a hill forming a point between Grass river on the west and a creek entering the river from the northeast (*See* Figure 3). Andesitic lava outcrops along the west side of the hill and on the west shore of the river. Gabbro, porphyritic and non-porphyritic quartz diorite, and granite outcrop southeast of the hill, a short distance east of the creek. The black, gabbroic, and dioritic masses appear to grade into the granitic rocks, and are considered to represent basic segregations along the margin of the intrusive mass. The trenching was done on a contact zone between the body of granitic rocks on the east and the lavas on the west.

The numerous trenches, run for the most part about east-west, have exposed in the contact zone three main areas and one minor area wherein gold-bearing quartz and iron sulphide are more abundant than in other parts (*See* Figure 3). The outlines of these areas of mineralized rock are not sharp, as the whole mass of rock on the hill between the river and creek is slightly jointed, schistified, and sparingly mineralized. The areas outlined on the accompanying figure are those wherein the rocks appeared to be more highly mineralized than elsewhere. The westernmost of these

areas is along the edge of the body of andesitic lavas. It is formed of dark-coloured, siliceous rock of the appearance of quartzite. The rock is highly jointed and veinlets of gold-bearing quartz follow some of the joint planes; the whole mass is sparingly mineralized with crystals and grains of pyrite. The dark-coloured rock has been considered to be an inclusion of quartzite in the granitic rocks. The contact of this siliceous rock against the granite is not sharp as is the case with the abundant andesite inclusions nearby. In a trench crossing this zone a few yards south of its north end, the fine-grained, siliceous rock becomes coarser grained to the east and

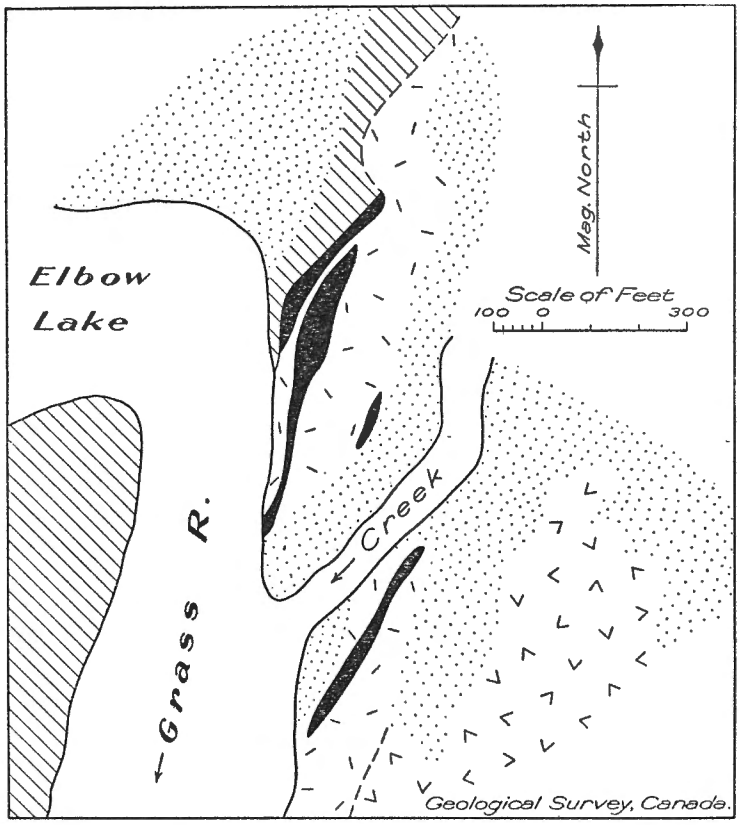

Figure 3. Murray gold deposit, Elbow lake, Manitoba. The outcropping part of the mineralized contact zone (pattern of dashes) lies between granite, diorite, and gabbro (pattern of angles) to the east, and andesite lava (pattern of ruling) to the west; the more richly mineralized areas are in solid black. Drift is shown by a pattern of dots.

passes into porphyritic granite. Patches of green schist that may be included bits of lava were noted at one point in the siliceous rock toward the south end of the zone. Because of these facts and the further fact that no beds of quartzite are known in the nearby area from which a quartzite inclusion could be derived, it is concluded that the siliceous rock is probably a fine-grained border phase of the granitic intrusion that has been silicified, jointed, and impregnated with gold-bearing quartz and pyrite.

The next mineralized area to the east (*See* Figure 3) is of jointed and schistified granitic rocks containing many inclusions of andesite lava, veinlets of quartz, and also pyrite. The inclusions of black, chloritic schist derived from the lava exhibit sharp contacts against the granite and at a few points are crossed by veinlets of granite. Two inclusions of andesite are from 6 to 18 inches in width and 110 and 190 feet long, respectively. Both these masses of lava are bordered by numerous, small quartz veins and lenses. Only a few of the quartz bodies are a foot thick.

The next mineralized area to the east lies on the edge of a drift-covered area. It is small and poorly defined. The fourth area is to the southeast, across the creek. Both areas consist of schistose, granitic rock and andesitic inclusions cut by small quartz veins and lenses.

Some of the small quartz stringers carry abundant free gold. The exposed part of the contact zone northwest of the creek was trenched extensively to determine if a large body of the mineralized rock carried enough gold to warrant a large operation. Two prospect shafts were sunk 25 and 60 feet deep, respectively, and a tunnel was run from near the foot of the hill for 50 feet across the mineralized zones. The trenches and workings were all carefully sampled. The results of this investigation were not encouraging enough to warrant further developments in 1922.

CRANBERRY, COPPER, AND BRUNNE LAKES AREAS

Prospecting has been in progress at intervals during the past 15 years near Cranberry lakes and to the north on Copper, Brunne, and a number of nearby small lakes. This district was not visited in 1930 except to pass across Cranberry lakes en route from Elbow lake to Cranberry Portage. A number of deposits in these areas were investigated in 1928 and 1929 by various mining companies. The available information regarding the geology and mineral deposits of these areas is summarized in the following paragraphs.

The geology of the areas surrounding Cranberry lakes and Brunne and Copper lakes was mapped by E. L. Bruce.[1] The bedrock consists of Amisk lavas cut by granite, granite porphyry, and pegmatite. The areas of lavas are not large, the widest is north of the narrows between Second and Third Cranberry lakes and is 3 miles across in the widest part. The areas of lavas near Brunne and Copper lakes are large inclusions within a large body of granite.

In the autumn of 1928, Cold Lake Mines did some diamond drilling on a sulphide body on an island near the northeast end of Second Cranberry lake. This deposit was discovered in 1928 by the Thompson brothers of Cranberry Portage. Some chalcopyrite is distributed through part of a pegmatitic mass and in the lava adjoining the pegmatite.

In the spring of 1928, Dixon Mines did surface work and some diamond drilling to explore a copper deposit north of the portage between the east arm of Athapapuskow lake and First Cranberry lake. The bedrock near this deposit consists of small areas of lavas within granite. Chalcopyrite is present sparingly along small shear zones in one area of the lava. The group was surveyed by the Radiore method of prospecting. Exploratory work was discontinued late in 1928.

[1] "Athapapuskow Lake Region"; Geol. Surv., Canada, Map. No. 1726.

In the autumn of 1928 Ventures Limited optioned a large area near Copper and Brunne lakes, and in 1929 completed considerable surface work on several sulphide bodies. No information is available of the results of this work. The following information regarding the deposits of this area is from a paper by R. C. Wallace.[1]

"Copper and Brunne lakes lie in a somewhat restricted band of sheared greenstone and fine-grained porphyry flanked on the east and west by a reddish granite which on the western contact is fairly basic. The strike of the rock is 40 degrees east and the belt is elongated in the direction of the strike. Within the belt lie Copper and Brunne lakes, and the mineral discoveries have been made on the east, but mainly on the west, side of these lakes. The intrusions from the granite into the belt consist of irregular veins and masses of a very fine-grained, pinkish granite which is apparently identical mineralogically with the main granite."

A rich shoot of gold on the Red Rose mineral claim is described as follows:

"The shoot appears on the west wall of a vertical quartz vein 18 inches wide and occupies 3 inches in that wall.....The highly sheared and somewhat decomposed greenstone on the east wall shows very coarse gold in panning across 2½ feet at the bottom of the pit. The vein has been stripped for 200 feet and varies in width from 18 inches to 6 inches.

The importance in itself of the gold shoot on the Red Rose claim cannot at the present moment be accurately estimated owing to the fact that no considerable body of quartz has been uncovered in the line of strike in which this shoot appears. It is, however, significant as indicating the presence of gold in quantity at one place in a district where quartz and iron sulphide bodies are so extensively developed....."

A deposit near the Red Rose is described as follows:

"Less than a claim's width west of this vein [on the Red Rose] a parallel quartz lode has been prospected over five claims by J. P. Gordon, who later staked the Red Rose. This lode is well exposed over 2,000 feet on the two most northerly claims, with cross trenches varying in width from 15 to 30 feet. The other claims have not yet been sufficiently prospected to determine the extension of lode, but on the fourth claim a large vein of quartz and country rock, less than half of which is quartz, is exposed for a width of 100 feet.....To the north, three-quarters of a mile beyond a beaver dam lake, on the projection of the line of strike of the lode (42 degrees east) a vein has been cross-trenched by Peterson to a width of 18 feet, showing much heavier galena mineralization than on the properties to the south. Galena is, however, a characteristic mineral in all the quartz outcrops along the line of strike, fine-grained except in the more northerly showings, associated with a little pyrite and occasionally chalcopyrite. In places the quartz has a rather peculiar, cherty aspect, and owing to cross-strains breaks with a cleavage not unlike that of calcite."

The Dominion group lies south of, and slightly farther east than, Gordon's claims, extending from the south shore of Copper lake, southwest along the west shore of Brunne lake.

".....On the more northerly claims of the group molybdenite and pyrite are the chief sulphides in a vein up to 3½ feet in width, while on claims 4 and 5 west of Brunne lake, somewhat irregular masses of quartz carry abundant pyrite, some galena and chalcopyrite, and no molybdenite."

The results of an "Examination of and Experimental Tests on Gold Ore from Dominion Claims, Copper lake, Northwest Manitoba", are given by W. B. Timm and J. S. Godard in a report of the Mines Branch, Ottawa.[2] The shipment was made by A. L. Stewart in 1924, and consisted of four small samples, the largest weighing 6½ pounds, and a

[1] "The Gold Discovery at Copper Lake, Northern Manitoba"; Can. Min. Jour., vol. 40, pp. 731–33 (1919).
[2] Investigations in Ore Dressing and Metallurgy, 1924, pp. 62–67.

composite sample of 198 pounds. "The samples consisted of mineralized quartz, the chief minerals being iron pyrites and small amounts of galena." No free gold was visible in the samples, but in grinding one sample free gold was detected. The samples assayed as follows:

—	Gold	Silver	Tellurium
	Oz. a ton	Oz. a ton	Per cent
Shipment No. 1	13·92	45·56	0·09
Shipment No. 2, large sample	4·91	16·37	.....
Shipment No. 2, small sample	7·50	23·47	.....
Composite sample	2·88	11·14	.....

The conclusions from the study of the samples submitted are:

"The ore submitted for examination and test contains free gold. It also contains tellurium, indicating the presence of gold tellurides. The silver is present as ruby silver, a small portion may be present associated with the small amount of galena in the ore, and a portion may be present as silver sulphide, argentite, although this mineral was not detected by microscopic examination..... The ore is amenable to treatment by cyanidation with high recoveries of the gold and silver values....."

Several large bodies of iron sulphides have also been prospected and diamond drilled in Copper and Brunne Lakes areas.

Dr. Wallace states in the paper referred to in the foregoing paragraphs that:

"Still farther east (of the Dominion) on a parallel line of strike a carbonaceous schist has been impregnated with pyrite and pyrrhotite.....Some idea of the extent of this iron sulphide mineralization may be obtained from the fact that on the Caribou claim west of Brunne lake a rounded hill is well exposed on the line of strike of the iron formation at least 75 feet wide and is mineralized throughout with practically solid pyrite and pyrrhotite. In places, as at the south end of Copper lake, the iron sulphide bands are associated with bands of quartz only sparsely mineralized with pyrite. It would appear that this type of mineralization has affected a series of parallel bands of schist, between which lie bands of unmineralized massive greenstone."

Samples from the bodies of iron sulphides of this area are reported to carry gold, copper, nickel, and platinum in traces.

ATHAPAPUSKOW LAKE AREA

The country surrounding Athapapuskow lake was prospected carefully from 1915 to 1920, and many sulphide bodies were discovered. A few of these deposits have been trenched and investigated in a preliminary way, and some underground work has been done on the Baker-Patton deposit. Of the deposits of this area, only the Baker-Patton, Don Jon, and Billy Boy were examined during the summer of 1930.

The sulphide deposits of the area are in Amisk volcanic rocks or associated tuff-like beds. The volcanic rocks include black and green andesitic, and grey rhyolitic types. Some of the lavas are porphyritic. Agglomerates and coarse pyroclastic beds are present locally. Over large areas the minerals of these rocks are altered to an aggregate of chlorite, sericite, epidote, and carbonates. The dip of the schistosity of the lavas is nearly vertical, and apparently this group of rocks is folded complexly.

The Amisk volcanics are overlain unconformably by the Missian sediments, including conglomerate, arkose, and greywacke. The Missian sediments lie in synclinal basins and fault blocks within the Amisk volcanics. Both the Amisk lavas and the Missian sediments are cut by granite and granodiorite.

Baker-Patton. The Baker-Patton deposit is on top of a hill about 800 feet east of the north end of Sourdough bay at the north end of the northeast arm of Athapapuskow lake. The deposit was discovered by Messrs. H. L. Baker and Wm. Patton and was optioned to the London Exploration Company. Surface trenching of the deposit was done by this company in 1922 and later the option was dropped. Additional surface work, and an electrical survey and some diamond drilling were completed on the deposit prior to 1927. In 1928 the group was taken over by Callinan Flin Flon Mines and a small mining plant was installed. This work was under the direction of Mr. E. F. Elliott. It is reported that a shaft was sunk to 415 feet, stations cut at the 150, 275, and 400-foot horizons, and some crosscutting and drifting done at the 150, 275, and 400-foot levels. This development program was discontinued in January, 1929. Late in 1929, Mandy Mines, Limited, optioned the property and did much diamond drilling in 1929 and 1930. No work was in progress during the summer of 1930, and in August the mining plant and surface building were burned by a forest fire that swept the surrounding country.

The rocks near the Baker-Patton deposit are schistose, basic, and acidic lavas with interlayered tuff-like and cherty beds. Large areas of the rock are stained brownish and reddish by iron oxide formed from the weathering of finely disseminated pyrites. In some specimens small, subangular grains of quartz and feldspar are visible in a chloritic and sericitic matrix. The outlines of angular and subangular fragments of porphyritic lava in a schistose matrix are well shown on the weathered surfaces of areas of the large outcrop in the low ridge of rock west of the deposit. Such rocks are probably agglomeratic phases of the lava. Some outcrops of grey, acidic rock north of the deposit have the texture and appearance of a fine-grained, porphyritic granite. Bands of lava on the west side of the hill west of the deposit are of a black, more basic type, probably andesite or dacite in composition. The various types of volcanic rocks outcrop in alternating bands trending north 10 degrees west. The dip of the schistosity is from 70 to 80 degrees east.

The Baker-Patton deposit is in a belt of cherty, and of tuff-like rocks lying between thick flows of schistose, acidic lava. On the surface the rocks along and adjoining the sulphide-bearing zone are highly schistose and so stained with iron rust that it is difficult to determine the extent of the belt of cherty and tuff-like rocks. Specimens from the underground workings in the foot-wall (west) side of the deposit are of a bedded, cherty rock. To the east the cherty beds are followed by black, slaty, ash-like beds and black, chloritic schist. The chert and slaty beds are mineralized with pyrite and quartz in small grains and in veinlets along joint planes in the brittle chert. The main sulphide body is in the black, slaty rocks and the chloritic schists. On the surface the heavily mineralized schist belt is 225 feet wide at a point 150 feet north of the shaft. Here a swampy area lies east of the deposit and this swampy depression continues both north and south for 1,500 feet or more. The sulphide-bearing zone has been traced by trenching for 600 feet north from a point about 100 feet

east of the shaft. To the north the body of heavily mineralized rock gradually narrows and appears to end. The southward continuation is drift covered. The underground workings across the zone of sulphide-bearing rock cut a few lenses and dyke-like masses of nearly massive pyrite carrying a little chalcopyrite and quartz. At the surface the more massive lenses of sulphides are completely weathered, their outcrops being a mass of friable, spongy, siliceous rock. The pyrite is light coloured and fine grained. The chalcopyrite is for the most part in the schist adjacent to the bodies of massive pyrite or just within the margins of these bodies. Quartz occurs as veinlets and small, irregular patches in the schist and massive pyrite. The quartz and chalcopyrite seem to have been deposited at the same time and both are later than the pyrite. The large body of pyrite-bearing schist and one body of massive pyrite have been explored at a few points along their margins by diamond drill intersections and underground drifts and crosscuts. On the 400-foot level a narrow body of sulphides is reported to carry 3 per cent copper, and on all levels a few narrow sections of similar grade copper ore were cut, and larger bodies of low-grade copper and gold ore were also encountered. This pyrite deposit was explored at depth in the hope that at some point a large body would carry enough chalcopyrite and gold to be an ore.

Don Jon. Outcrops of schist carrying disseminated and massive pyrite and some chalcopyrite were discovered on Thompson lake, and in 1922 several groups of mining claims were staked on them. Some surface trenching was done on several of these deposits.

A deposit on the east side of a small island near the east shore of the lake one-half mile from the south end was discovered by David Collins late in the summer of 1929. This deposit, the Don Jon, was optioned in the same year by Consolidated Mining and Smelting Company, who did much surface trenching and some diamond drilling.

The rocks exposed west of the Don Jon deposit are grey to black lavas, in part highly schistified and drag-folded. Poorly defined pillow structures show on the weathered surfaces of a few outcrops near the northwest corner of the island. Some of the trenches at the south end of the island cross quartzose sericite schists and quartzose, chloritic-carbonate schists which probably represent beds of quartzose and limy sediments within the lavas. Some beds contain fragments of lava and probably are of pyroclastic origin.

Bodies of massive sulphides occur along the limy beds between the thicker, more massive quartzose beds. The sulphide bodies are exposed by seven trenches distributed at intervals for 400 feet along a direction of north 25 degrees east. The dip of the deposits appears to be nearly 80 degrees northwest. In the two south trenches the sulphide-bearing zone is at least 50 feet wide and may extend farther east under the water of the lake. In these trenches beds of slightly schistose, quartzose rock sparingly mineralized with pyrite alternate with bands up to 10 feet wide of fairly massive, light-coloured pyrite carrying some chalcopyrite. In the trenches to the north the zone of highly schistified and mineralized rock is about 20 feet wide and it appears to narrow northward. The southward continuation of the wide sulphide bodies is under the lake. Acidic lava only sparingly mineralized with pyrite outcrops on a small island 300 feet to the south along the projected strike of the deposit.

Thin sections of the more massive sulphides show cubes, grains, and irregular-shaped patches of pyrite replacing grains of quartz and areas of calcite and chlorite. The pyrite cubes in some narrow seams of chloritic schist are up to one-half inch across. In one specimen the gangue is almost entirely calcite, quartz being only sparingly present. The pyrite is cut by veinlets of chalcopyrite, quartz, and iron carbonate. The larger masses of chalcopyrite are near the quartz veinlets and lenses.

No information is available regarding the results of the diamond drilling. Sections of the deposit carry enough chalcopyrite to make a copper ore of medium grade. Small areas of this sulphide body are very similar in appearance to parts of the Mandy and Flin Flon deposits.

Surface trenching has been done on islands and along the west shore of Thompson lake, to explore schist zones carrying sulphides. Several trenches on the west shore of the northwest bay of the lake cross wide zones of quartz-sericite schist carrying pyrite. Two trenches on the west side of an island near the west shore, about a mile from the south end of the lake, expose cherty and ashy, tuff-like beds that across 30 feet carry pyrite and some chalcopyrite. On the east side of this island the andesitic lava contains round patches of quartz up to one-half inch across, and this may represent an amygdaloidal lava. The lavas here are schistified and some layers contain fragments and perhaps are pyroclastic beds.

Billy Boy. The first claims of the Billy Boy were staked in 1925, by Mr. William Baker, on the farthest south, large island of the group south of Bakers narrows and near the east shore of the large, central bay of Athapapuskow lake. In the autumn of 1929, Manitoba Basin Mines optioned the group and staked additional ground nearby. The property was thoroughly prospected by this company during 1929 and 1930. The main trenching was done at two localities, one on top of the hill back from the shore on the southeast side of the island and the other near the west corner of the island. At the first-mentioned locality, the bedrock is granodiorite intruding lavas and the prospect trenches are within granodiorite about 100 feet east of the lavas. The granodiorite is a black, medium-grained, jointed rock which is slightly schistified along narrow seams. In some areas parallel joint planes are closely spaced and the slightly sheared granodiorite is silicified and carries pyrite and a little chalcopyrite. Quartz stringers up to 4 inches wide follow a few of the joint planes and some specimens of the quartz contain free gold. No continuous, large body of jointed and mineralized granodiorite was found that carried enough gold and copper to be an ore.

The trenches at the locality near the southwest corner of the island are in basaltic and andesitic lava and schistose granite. The farthest west group of trenches, fourteen in number, expose highly jointed and slightly schistified, black, fine-grained andesite and porphyritic basalt mineralized with pyrite, and at some points exhibiting stringers of quartz and calcite and a few bits of chalcopyrite. The areas of mineralized rock that have been trenched are up to 20 feet wide, but chalcopyrite is present only sparingly. About 200 feet east of this group of trenches, seven pits and trenches expose quartz-sericite schist sparsely mineralized with pyrite and chalcopyrite. At one point the zone of schistose rock is over 100 feet wide. To the southwest the granitic rock is more massive and of medium grain. The quartz-sericite schist apparently represents highly sheared rock in the northeast end of a small, intrusive body of granite.

Var Group. Some work was in progress in the summer of 1930 on the Var group, staked by Mr. Alex. D. Moody on the shore of Athapapuskow lake southeast of the Billy Boy group. Here several outcrops of sulphide-bearing schist were trenched at the edge of the lake, and small sections of this deposit are reported to assay up to 2 per cent copper. The continuation of this sulphide body under the lake can be determined best by diamond drilling in winter.

East Arm of Athapapuskow Lake. The country about the east arm of Athapapuskow lake, and especially the north shore, has been prospected carefully. Several groups of mineral claims were staked here previous to 1920. This area was not visited during the summer of 1930 and the following information regarding the results of the development of the deposits discovered is taken from a report by R. C. Wallace.[1]

The deposits are along soft, schistose bands in the greenstone (Amisk lavas) which have in part been changed into an epidote rock and mineralized with chalcopyrite and in places with bornite,

"the copper sulphides appearing in close proximity to, but as a rule not in, the stringers of epidote. Three parallel bands of this type have been prospected, striking in a northeasterly direction. On the most westerly are staked the Ross group, on the next the Robertson group and the Vedo claims, and on the most easterly the Cameron and Stewart groups."

One trench on the Cameron property is 50 feet wide and 7 feet deep. Here

"the chalcopyrite and bornite are closely associated with veinlets of quartz and calcite which crisscross the epidotized greenstone; but the bornite is subordinate in amount to chalcopyrite. There is no indication of defined walls to the mineralized zone on any property, though on the Stewart the mineralization is more definitely restricted than elsewhere. On the Vedo claims and Robertson group several pits have been sunk on a mineralized band which probably extends for 3,000 feet in length. On all the properties on the north shore of the east arm of the lake the percentage values of copper in cross-channelling over any considerable width are low, and underground work should not be undertaken unless surface values are sufficiently high to permit of operation over widths of at least 50 feet.

South of the Ross group, on the 'Don' claim, a quartz vein has been uncovered for 45 feet, with a width of from 12 to 24 inches. Eastwards it breaks up into stringers on a fault plane. It is mineralized with pyrite and chalcopyrite. From this property some very rich samples of native gold and telluride had previously been taken."

Payuk and Twin Lakes. Near Payuk and Twin lakes, north of the east arm of Athapapuskow lake, sulphide bodies have been discovered. Some trenching was done in this locality previous to 1920 and in 1928 and 1929 a number of the deposits were reinvestigated. These lakes were not visited in 1930. The lakes lie in a small area of Amisk lavas included within a large granite mass. R. C. Wallace, on page 28 of the paper referred to above, describes the Twin Lake deposits as follows:

"A good deal of drifting and some trenching have been done on claims 'E' and 'F' in a group of claims staked on the east side of Twin lake. The work has been done on two, fine-grained, reddish, felsite intrusions, each approximately 20 feet wide, and carrying a little pyrite. On the more easterly claims narrow veinlets of quartz cross the felsite and carry sphalerite and galena at the bottom of a cross-trench 20 feet wide and 9 feet deep. A good deal of unnecessary tunnelling has been done on these properties, as by surface stripping and sampling the necessary preliminary evaluation could have been obtained at a much smaller expenditure. The felsite veins are typical intrusions from the granite. Here and there quartz veins proceed from the felsite dykes."

[1] "Mining and Mineral Prospects in Northern Manitoba"; Northern Manitoba Bull. 1919, p. 28.

Chica Claim. Sulphide bodies have been discovered along the west shore of the north arm of Athapapuskow lake from Pineroot river north through Mikanagan, Aimée, and Wabishkok lakes. Time did not permit in 1930 to visit the deposits of this large area. Apparently the deposits are large bodies of schistose lavas mineralized with pyrite and some pyrrhotite, chalcopyrite, and sphalerite. R. C. Wallace has described a deposit on the Chica claim as follows[1]:

"Near the mouth of the Pineroot river, immediately west of the rapids, a narrow zone of sheared porphyry intruded on the west side by granite and flanked on the east by conglomerate, has been impregnated by sulphides. Some cross-trenching was done in 1917 and during the summers of 1918 and 1919 a diamond drill has been continuously at work on the property. In these cross-trenches the rock is mineralized with pyrite and scattered crystals of chalcopyrite. The dip of the rock is 70 degrees towards the west. Eight holes have been drilled on the property, the later holes having been put down from the west at an angle of 65 degrees. It is understood that a lens of chalcopyrite has been reached at depth on the contact between the conglomerate and porphyry. The average length of drill hole is 400 feet.

Eastwards from Pineroot river and along the shore of the lake (Athapapuskow), work has been done on a series of claims in the greenstone at the margin of the granite. The mineralization is similar to that on the Chica property, but on the more northerly claims there is pyrrhotite as well as pyrite and some chalcopyrite. Work has been confined to surface trenching and some tunnelling."

SCHIST LAKE AREA

A number of sulphide bodies have been discovered near Schist lake and some surface work has been done on a few of these deposits. The Mandy deposit is on the west side of the northwest arm of this lake near its north end. The rocks exposed in the long, narrow arms of this lake are Amisk volcanics carrying thin beds of sediments and cut by small bodies of gabbro, granodiorite, granite, and granite porphyry. All the volcanic rocks are slightly schistose and some beds are now chloritic schists. Many such schist zones contain iron sulphides and at some localities chalcopyrite occurs with the iron sulphides. The available information regarding a few of the deposits near Schist lake is summarized below.

Thompson Group. The sulphide deposit on this group was visited in July, 1930. The deposit is about three-quarters of a mile by trail west from a cabin on the west shore of the northeast arm of the lake about 1½ miles south of its north end. Several of the mineral claims of the group have been surveyed. The surface work has been done just south of the No. 6 post of lot 392 and No. 3 posts of lots 394 and 396 of group 421. The group is controlled by Mr. Thompson, D.L.S., of Cranberry Portage, H. M. Paull, and associates.

Bedrock is not well exposed near the workings, as a deep, wet swamp lies east of the deposit and along its projected strike to the north. Fine to medium-grained, basaltic-appearing lava outcrops at a few points south and west of the deposit. In thin section the minerals of the more massive-appearing basaltic rock are seen to be largely altered and the rock consists of bits of feldspar scattered through grey to green, chloritic materials. Some of the chloritic materials shows traces of amphibole cleavage. Small grains of zoisite, epidote, calcite, and leucoxene are abundant. The strike of the schistosity of the lava is from south 10 to 15 degrees east and the dip 70 degrees west.

[1] "Mining and Mineral Prospects in Northern Manitoba"; Northern Manitoba Bull. 1920, p. 27.

The sulphide body is exposed in seven prospect pits sunk at intervals over a length of 475 feet along a strike of north 15 degrees west. The deep pits were nearly full of water at the time the deposit was examined and the sides of trenches in deep drift had slumped. The west wall of the deposit is sheared basalt carrying some pyrite. To the east this is followed by black, fine-grained rock showing slaty cleavage and small drag-folds. With the slaty rock are seams of chloritic and sericitic schist carrying abundant pyrite and chalcopyrite. A few layers up to 4 inches wide are of massive pyrite carrying chalcopyrite and quartz. The slaty rock is about 16 feet thick in one trench and on the east is bordered by chloritic schist carrying disseminated pyrite and chalcopyrite. The maximum width of the zone of schistose rock carrying sulphides is not known, for it was impossible to trench farther east on account of water from the swamp. The fourth trench from the south end exposed a width of 30 feet of schistose, sulphide-bearing rock. Channel samples taken from the bottom of a prospect shaft 200 feet north of the trench, at the south end of the deposit, are reported to have assayed 3·60 per cent copper across 3 feet, with adjoining sections of 6 feet on both sides assaying from 1·2 to 1·5 per cent copper. The gold content is reported to be from 40 cents to $2 a ton. The location of this sulphide body along the margin of a large, wet swamp makes it difficult to expose the deposit by surface trenching.

Le Vasseur Claim. The deposit on this claim is at the north end of the northeast arm of Schist lake and has been described by R. C. Wallace[1] as follows:

"This showing of mixed copper sulphide ore has been uncovered at the north end of the lake and is exposed for a distance of 60 feet into the lake. At the time of examination a pit had been sunk to a depth of 6 feet in a shear zone 6 feet in width on two stringers of mixed chalcopyrite and pyrite, respectively 3 inches and 6 inches wide. At the bottom of the pit the sulphide had widened out to a vein of 30 inches, with a higher percentage of chalcopyrite than on the surface. The dip is towards the west, and the foot-wall seems to dip into the hanging-wall in the pit. The zone widens, however, southwards and there is a possibility that the ore pitches southwards underneath the lake. On the claim to the north (Moosehorn) the overburden of clay has been removed in a crosscut, but no indication of shear zone or ore was obtained. An option has been taken on both properties by Guenlees, who is sinking on the sulphide vein with the intention of drifting southwards underneath the lake from the 35-foot level in order to intercept the ore-body."

Sunbeam Group. Dr. Wallace describes the deposit in the report referred to above as follows:

"On the Sunbeam group, on the west side of Hook lake, which lies west of the Inlet arm of Schist lake, and Big Island lake, some work has been done by the Creighton-Mosher-Dion group on copper sulphide stringers in a contact acid rock near granite, striking north 22 degrees west. A pit has been sunk 12 feet deep on four stringers of mixed pyrite and chalcopyrite, the greatest width of any individual stringer being 3 inches. At the bottom of the pit, on the northeast corner, one of the stringers flattens out into more massive ore, and chalcocite occurs in considerable quantity mixed with the chalcopyrite. The stringers have been traced on the surface on a somewhat indefinite shear line for a distance of approximately 70 feet, the copper sulphides being weathered into the green and blue carbonates. The dip of the rock is 80 degrees west. Some indications of copper have been found farther north immediately east of the north end of Hook lake."

[1]"Mining and Mineral Prospects in Northern Manitoba"; Northern Manitoba Bull., 1920, pp. 26-27.

Mandy Deposit. The Mandy deposit was discovered by Messrs. S. Jackson and Fred Reynolds in the autumn of 1915 and was at once optioned by J. E. Spurr on behalf of the Tonapah Mining Company. By the summer of 1916, some 25,000 tons of massive chalcopyrite and 180,000 tons of mixed copper and zinc ore were outlined in one body above the 225-foot level. Between 1917 and 1920 the massive copper ore was mined by open-cut and underground stoping, shipped to the Trail smelter, and yielded nearly 9,900,000 pounds of copper and $5 a ton in gold. This ore was hauled by barges and teams nearly 170 miles to The Pas from where it was shipped by rail. The 180,000 tons of lower grade ore remains in the original lens and it and ore on the lower levels will probably be shipped to the Flin Flon plant, 3½ miles to the northwest, for treatment.

In the spring of 1928, Mandy Mines, Limited, was organized to explore the deposit at depth. A small mining plant was installed and in 1928 and 1929 underground work was carried to the 1,025-foot level. In all, nearly 8,000 feet of lateral work was done on and below the 325-foot level and extensive lateral diamond drilling was completed at the 1,000-foot horizon.

The Mandy deposit has been described in detail by E. L. Bruce[1], R. C. Wallace[2], J. E. Spurr[3], and F. J. Alcock[4]. The following description of the deposit is from the report by F. J. Alcock, based on his field work in this area in 1922.

"The rocks on the peninsula on which the Mandy ore-body occurs are greenstone, pyroclastics, and chlorite schists. The ore lens is in a band of schist with massive greenstone on either side. The lens is 225 feet long and has a maximum width of 40 feet. It is rather irregular in shape, and its longer axis parallels the strike of the schist and greenstone bands. At either end a narrow vein of sulphides branches off from the lens, following the strike of the schist. The ore at the south end is dominantly chalcopyrite, and at the north end is composed chiefly of pyrite.....The lens dips from 75 to 80 degrees to the east and pitches at a high angle to the south.....The central part consisted of high-grade chalcopyrite surrounded by sphalerite and chalcopyrite. This central lens of chalcopyrite had a maximum width of 12 feet on the surface and a length of 100 feet. On the 100-foot level it widened to over 18 feet. Its strike is not quite the same as that of the whole sulphide deposit. The zones of the various sulphides are not sharply demarcated, but merge into each other. The zone of sphalerite ore shows a well-banded structure, and a rough banding is to be seen also in the pyrite zone.

The metallic sulphides in the ore-body were deposited in the following order: pyrite and arsenopyrite; sphalerite and chalcopyrite; galena. Pyrite is the most abundant mineral and is the chief mineral of the outer zone of the ore-body. The pyrite zone grades from the massive sulphide type into country rock impregnated with sulphides.....In places there is a rough banded appearance due to the parallel arrangement of zones of pyrite, zones of pyrite with chalcopyrite, and zones of pyrite with sphalerite as the chief constituents between the pyrite grains.

.....Locally, chalcopyrite and sphalerite form a well-banded variety of ore, but in this type chalcopyrite is present in the sphalerite bands, and sphalerite in the chalcopyrite bands with no evidence of fracturing or subsequent introduction of one mineral into the other. These bands vary in width from a quarter of an inch or so to extreme narrow bands.

The chalcopyrite is massive and on the freshly broken surface is rather paler in colour than is common for that mineral. An analysis of the purest ore that could be selected gave 28·96 per cent copper.

The sphalerite is massive and shows no signs of cleavage or crystal faces. It is dark in colour, with a metallic lustre quite different from that of ordinary blackjack. An analysis of the purest sphalerite ore that could be selected gave 46·21 per cent zinc.

The gangue minerals include quartz and carbonates. They are found filling fractures in the pyrite and between pyrite grains.....The quartz is later than the pyrite, but most of it is earlier than, or of the same age as, the chalcopyrite and sphalerite."

[1]Geol. Surv., Canada, Mem. 105, pp. 72–77 (1918).
[2]Northern Manitoba Bull., 1920, pp. 24–26.
[3]"The Ore Magmas"; vol. I, pp. 110–23 (1923).
[4]Geol. Surv., Canada, Sum. Rept. 1922, pt. C, pp. 26–29.

In the autumn of 1928, the underground workings on the 300, 400, and 500-foot levels were examined by the writer. In July, 1930, the workings were full of water and Mr. Frank Smith, mining engineer in charge, kindly briefly outlined the work completed. The drifts and crosscuts on the various levels followed small shear zones in andesitic lava, in greenish, tuff-like, and other pyroclastic beds. No evidence was seen of complex drag-folding along these shear zones. In places the schistose lava is silicified slightly and impregnated with veinlets of quartz and small crystals of white feldspar. Large bodies of the schist carried disseminated pyrite and in sections of the workings chalcopyrite is sparsely associated with the pyrite. Small lenses of fairly massive chalcopyrite, and of chalcopyrite and sphalerite, have been outlined on the different levels, but there does not appear to be any large body of high-grade copper ore extending downward from level to level. Although no raises have been made between the levels, the several sulphide lenses appear to be small and not connected either vertically or horizontally. On the 400-foot level, one body of massive ore is 3 feet wide and 100 feet long. In general character the small lenses are like the large, high-grade lens described by Alcock. At about the 225-foot horizon, the high-grade lens at the surface ended abruptly, the lava under the lens being crossed by a series of parallel, nearly horizontal joints. No indications could be recognized along the workings of a channel by which the sulphide-bearing materials moved upward to form such a large, unusually high-grade deposit as that from the 225-foot horizon to the surface, and which was estimated by Spurr[1] to have originally been at least 400 feet high, about half of it having been eroded away. The recent extensive campaign of underground work and diamond drilling was undertaken in the hope of locating another such deposit in depth. Some exploration work has also been done south of the deposit along the projected strike of the shear zone, and diamond drilling has been under the lake both north and south of the deposit. The 180,000 tons of ore remaining in the original lens is estimated to average: copper 6 per cent, zinc 20 per cent, and gold and silver 0·10 and 2·5 ounces a ton respectively.

Flin Flon Mine. In 1915 Messrs. Creighton, Mosher, and Dion and associates were prospecting near the lake now known as Flinflon, and, so it is reported, Mr. Thomas Creighton noticed sulphide-stained rock on the east shore of the lake. As these men were prospecting for gold-bearing quartz, little or no attention was paid this body of iron-stained rock. Later in the summer, an Indian named David Collins, whose trapping ground was about Flinflon lake, showed these prospectors specimens of copper ore, and later accompanied them to Flinflon lake and showed them the spot from which the specimens had been collected. The ground was then staked and surface trenching was commenced. The sulphides, however, were so completely leached from the outcrops that little could be learned of the grade or extent of the ore from surface work.

Mr. Jack Hammel interested financiers in New York and Boston in the possibilities of the discovery and in March, 1916, diamond drilling was commenced. About 6,000 feet were drilled and then work ceased. In 1917, Toronto interests continued the drilling and by July, 1918, 25,664 feet of drilling had been completed in forty-four holes. In 1920, the deposit was optioned to Toronto and New York interests and underground work

[1] "The Ore Magmas", vol. I, p. 110 (1923).

was commenced to check the results of diamond drilling. In 1921, Mining Corporation of Canada bought a controlling interest in the property, and this company and Faskens of Toronto became joint owners. Mining Corporation did considerable exploration work in the area surrounding the deposit and assembled all available data regarding the character and size of the deposit and the geology of the surrounding area. In 1922, F. J. Alcock studied the geology of the deposit and the surrounding country in some detail[1]. According to this investigation,

"the total length of the ore-body on the surface is 2,593 feet; at a depth of 900 feet it has a length of over 1,000 feet. It has a greatest width of 400 feet, but this includes some bands of unmineralized greenstone which occur in the ore-body. The largest of these masses forms the prominent ridge along the strike of the ore-body between the two shafts. At a depth of 900 feet the ore-body has narrowed to 35 feet. It has been calculated that there are over 16,600,000 tons of ore without including the unmineralized horses of country rock or the ore below the 900-foot level."

The investigations leading to the present large-scale development of the deposit and the metallurgical treatment of the ore have been described in recent papers by Mr. W. A. Green[2], superintendent, and S. P. Lowe[3], mill superintendent. According to the paper by Mr. Green, the present organization became interested in the property in the summer of 1925, when the deposit was examined for the Whitney interests by Messrs. R. E. Phelan, A. S. Winther, and W. A. Green. The grade and size of the ore-body were checked and found to be as stated by the owners. The questions of transportation, source of electrical power, and metallurgical treatment of the complex, low-grade, copper-zinc-gold-silver ore were next investigated. These problems were solved and in November, 1927, the Hudson Bay Mining and Smelting Company was organized to develop the deposit. In 1928, the Canadian National railways built a branch line, 85 miles long, to the property, and in 1928 and 1929, a hydroelectric plant of 44,000 horsepower capacity was built for the Hudson Bay Mining and Smelting Company at Island falls on Churchill river, 65 miles north of the deposit. In the late summer of 1930, a concentrating and metallurgical plant, to treat 3,000 tons of ore daily, was completed and in the autumn of 1930 the first large shipment of copper was made.

The geology and general character of the Flin Flon ore-body is described as follows by F. J. Alcock[4];

"The ore-body lies in greenstone. To the northeast of the deposit the greenstone is massive and amygdaloidal, showing its flow origin. The ore-body strikes north 30 degrees west. Some banded tuffs associated with flow rocks on the summit of Flinflon hill east of the wagon road strike north 12 degrees west. The deposit dips from 60 to 70 degrees to the northeast and the boring records show that it pitches at a low angle to the south. Dykes of quartz porphyry were encountered by the drill; one of these dykes forms the hanging-wall of the ore-body for some distance. The ore-body is a fairly regularly shaped lens, tapering gradually to the northeast and ending rather bluntly to the southwest."

Small bodies of both acidic and basic intrusive are especially abundant along the projected strike of the ore zone both north and south of the deposit. Although similar intrusives are widespread in the volcanic rocks, at no other locality are the intrusives known to be localized so definitely along a particular zone as they are north and south from Flinflon ore-body[5].

[1] "Flinflon Map-area, Manitoba and Saskatchewan"; Geol. Surv., Canada, Sum. Rept. 1922, pt. C, pp. 1-36.
[2] "History of Development and Organization at Flinflon Mine, Manitoba"; Can. Min. and Met. Bull., Sept., 1930, pp. 1175-82.
[3] "Concentration and Cyanidation at Flin Flon Pilot Mill"; Can. Min. and Met. Bull., Sept., 1930, pp. 1183-1205.
[4] Geol. Surv., Canada, Sum. Rept. 1922, pt. C, pp. 30-33, and Maps Nos. 1978 and 1994.
[5] *See* geological map of Flinflon Lake area, by F. J. Alcock, Pub. No. 1994, Geol. Surv., Canada.

Quoting Alcock:

"The principal minerals in the ore-body are pyrite, sphalerite, and chalcopyrite. Assays show that gold and silver are present. Arsenopyrite, galena, and magnetite have also been recorded, and small amounts of native copper have been found in the upper part of the deposit. Quartz is present in places between grains of pyrite, and as local veinlets traversing the sulphides. Calcite is rare but occurs in places with the quartz.

The ore consists of two fairly distinct types, known respectively as the solid sulphide variety and the disseminated ore. The solid sulphide variety consists chiefly of very fine-grained, pale-coloured pyrite, containing sphalerite, chalcopyrite with some rare fragments of schist, and some quartz and calcite. In places there is a distinctly banded effect where the sphalerite and chalcopyrite form narrow bands in the pyrite.....The disseminated ore consists of country rock, chiefly chlorite schist, impregnated with sulphides. The solid sulphide variety forms the central part of the lens, though in places it extends to the hanging-wall, whereas the disseminated ore is largely confined to a zone along the foot-wall. Disseminated ore is also found on the hanging-wall in the upper part of the deposit, but the copper content is here less than in the disseminated ore on the foot-wall. In places, ...disseminated ore forms a zone on either side of the central solid sulphide type. Boundaries between the disseminated and solid sulphide types are, as a rule, fairly distinct, though in places a gradation between the two varieties is found. Contacts between the solid sulphides and the horses of unmineralized rocks are also, as a rule, quite sharp .....The sphalerite is more abundant on the hanging-wall side than elsewhere in the deposit.....Galena is rare in the ore-body, but it has been found lining vugs in the country rock."

According to Lowe[1]:

"Average assays of the two types of ore of the deposit are as follows:

—	Heavy sulphide ore	Disseminated ore
Au	0·095 oz. a ton	0·018 oz. a ton
Ag	1·4 "	0·29 "
Cu	1·57 per cent	2·05 per cent
Pb	0·5 "	0·0 "
Zn	4·4 "	1·12 "
SiO_2	4·0 "	29·1 "
S	37·0 "	12·9 "
Fe	35·0 "	19·3 "
MgO	1·0 "	8·0 "
Specific gravity	4·2	2·9

It has been estimated that about 7,000,000 tons of ore will be mined by open-cut methods at a low cost per ton. To do this a dam has been built between the islands across the entrance of the bay of Flinflon lake adjoining the deposit, and the water has been pumped from the bay. Cheap electrical power and low mining costs will help materially in the treatment of the Flinflon complex ore.

AREA BETWEEN KISSISSING LAKE AREA AND THE NORTHWEST CORNER OF REED-WEKUSKO LAKES REGION

In July, 1930, the canoe route leading east from the northeast corner of Kississing lake through Walton lake, Limestone Point lake, and south along File river to Loonhead lake was followed, to study the mineral prospects in this area and the eastward extension of the Kisseynew sedimentary gneisses. This canoe route is difficult eastward from Kississing lake,

[1]Lowe, S. P.: "Concentration and Cyanidation at Flin Flon Pilot Mill"; Can. Min. and Met. Bull., Sept., 1930, p. 1183.

as between Sing Sing, Jungle, and Walton lakes there are six portages, three of which are a mile or more in length and, for a part of their length, follow swamps. These portages connect a series of small lakes. From Walton lake to Loonhead lake, the route follows Limestone Point and File rivers and the portages past the rapids and falls on these rivers are short. Bedrock is fairly well exposed for most of the distance along the shores of the lakes and river or inland a short distance back from the water on ridges from which the moss and timber have been burned.

The bedrock observed along this canoe route consists of highly metamorphosed sediments cut by granite and pegmatite and the geology of this area is very similar to that about Kississing lake as described in some detail in Part B of the Summary Report for 1928. The Kisseynew sedimentary gneisses as exposed eastward from Kississing lake are grey to black, fine to medium-grained, bedded, and foliated rocks. The most widespread type is a grey, quartz-biotite-garnet gneiss, with local interbeds of more quartzose types, such as micaceous quartzite, some beds of which carry abundant calcite and are impure crystalline limestone. At other horizons beds of black hornblende and biotite-rich types occur which, probably, are recrystallized clayey and limy sediments of the original series of sandstones, clayey and limy sandstone. The sedimentary gneisses lie in a series of open folds, the strike and dip of bedding and foliation varying from point to point, though the general trend of the beds is from northwest to west.

The Kisseynew sedimentary gneisses are cut by elongated masses and small dykes of granite and of pegmatite. In some places the gneisses are intimately intermixed with thin bands of granite giving rise to lit par lit gneisses. In other large areas no granite was seen, though the rocks are recrystallized to the same extent as in the areas where granite is developed.

From Sing Sing lake east to Jungle lake, the rocks are grey and black, gneissic, quartzose, and micaceous types. On the south shore of Jungle lake, some beds are a black, hornblende-plagioclase gneiss. The strike and dip of the foliation of the gneisses on Jungle lake and eastward are variable. Within one-half mile the strike may change from north 40 degrees west to south 70 degrees west and the angle of dip from 10 to 50 degrees. Numerous drag-folded horizons and a few very prominent joint or fault planes were seen and these features, together with the marked change in direction of strike and angle of dip, suggest complex folding and perhaps faulting of the strata at this locality. South of Jungle lake and east to Star lake, several bosses of granite cut the gneisses. The granite is pink to grey and massive or slightly foliated. The granite is cut by small dykes of pegmatite, and the gneiss surrounding the granite bodies is cut by many small dykes of granite and pegmatite. The contact of granite and pegmatite with gneiss is sharp. Some pegmatite dykes exhibit a saw-toothed margin due to large crystals of feldspar extending from one-quarter to one-half inch into the gneiss beyond the edge of the dykes.

Some prospecting has been done along a few of the dark hornblendic gneisses south of Jungle lake. So far as could be seen during a hurried visit, chalcopyrite is scarce or absent, pyrrhotite being the abundant sulphide along the schistose zones examined.

The sedimentary gneisses on and about Walton lake are quartzose and micaceous types whose bedding and foliation strike north 35 to 70 degrees west and dip 30 to 40 degrees northeast. Some bands in the gneisses east of the inlet of the lake are black, fine-grained, hornblendic types that may be either altered lava or recrystallized greywacke-like sediments. The gneisses are cut by narrow, sill-like bodies of granite, aplite, and pegmatite. The area about Walton lake was prospected in a preliminary way by several parties during the summers of 1928 and 1929. A number of groups of mining claims have been staked, and of these the Carmen, Peace River, Bing, and Douglas groups were visited in 1930.

Carmen Group. The Carmen group is north of Walton lake about a mile east of the west end. The few rock outcrops on this group are on small hills projecting above the clay. Black, hornblendic and quartzose gneisses are presented. The dip and strike are variable, some beds being nearly horizontal, whereas nearby beds dip at angles of 35 degrees. Prospect pits at several points on the group expose schistose and jointed gneiss carrying pyrrhotite. A few bits of chalcopyrite and sphalerite were seen in some specimens on the dumps near the pits.

Bing and Peace River Groups. The Bing and Peace River groups lie about 2 miles northeast of the east end of Walton lake. The prospect trenches on these groups are reached by a trail from the camps on the north side of the river at the first portage east of Walton lake. The rocks on these groups are exposed on long, narrow ridges and scattered, small outcrops with intervening large areas of drift and swamp. The rock types noted include: bedded quartzite, quartz-mica gneiss, and dark grey to black, micaceous and hornblendic gneisses. Some quartzite beds are nearly white and almost pure quartz. All the gneisses contain a few red garnets. Dykes and sill-like bodies of granite, aplite, and pegmatite are abundant at a few points. The trend of the bedding and foliation of the sedimentary gneisses is from north 5 degrees to north 35 degrees west, and the dip 40 to 80 degrees northeast.

Some prospecting work has been done on the Bing group near the Nos. 1 and 2 posts of the Bing Nos. 5, 6, 7, and 8 mineral claims. Here five trenches, up to 90 feet long and 12 feet deep, expose highly jointed and schistified, quartzose gneiss stained with limonite. A few thin beds of micaceous and hornblendic gneiss are interbedded with the quartzite. Some of the micaceous gneiss contains disseminated graphite. Quartz veinlets and narrow pegmatite dykes cut the gneiss exposed in the trenches. Some specimens of gneiss on the dumps contain pyrrhotite and a few bits of chalcopyrite. The sulphides are localized in small lenses and veinlets near pegmatite and quartz veinlets and within beds of garnetiferous mica gneiss.

The Peace River group lies immediately north and northwest of the Bing group. On Nos. 5 and 6 mineral claims beds of black, coarse-grained, mica-hornblende-garnet gneiss are exposed. Garnet is estimated to form about half of some beds and some of the garnet crystals are an inch across. Beds of quartzite are interlayered with the black gneiss. A few small dykes and lenses of pegmatite cut the gneiss. Small crystals of black tourmaline and abundant needles of green actinolite lie in the gneiss along the margins of the pegmatite bodies. The black gneiss contains disseminated pyrrhotite and chalcopyrite across widths of 10 to 15 feet.

Mr. P. J. Jennings of Calgary, who controls an interest in these groups, reports to the writer that a channel sample from one of the trenches on the Peace River group was assayed at Trail, B.C., and gave 0·2 per cent tin; 0·10 per cent copper; 1·7 ounces of silver; and a trace of gold and lead. As stated above, black tourmaline is abundant in the gneiss adjacent to some pegmatites, and it is possible that the pegmatites that introduced the tourmaline also carried some cassiterite.

Douglas Group. The Douglas group lies south of the river leading east from Walton lake and about one-half mile from the southeast corner of the lake. The bedrock here is black and grey, sedimentary gneiss with interlayered, long, narrow bodies of black, medium-grained rock that may represent either basic lava flows or intrusive masses. The sedimentary gneisses are cut by sill-like bodies of granite, aplite, and pegmatite.

The prospecting work on this group has been done at two localities. At the locality farthest northwest, near the No. 2 post of lot 1554, three long trenches cross a schistose zone, up to 50 feet wide, in gneiss. Some of the highly schistose beds carry some chalcopyrite and pyrrhotite. The schistose zone strikes north 15 degrees west and dips 40 degrees east. A sill-like mass of granite forms the foot-wall. This zone has been traced 400 feet by trenches. To the north it passes under a swamp and to the south it gradually ends.

At the second locality, about 1,300 feet to the south, two long trenches expose a zone of schistose, black gneiss trending about west and heavily mineralized with pyrrhotite and some chalcopyrite. The black schist is cut by a granite dyke about 15 feet thick and, south of the granite, carries stringers of white quartz and cubes of pyrite. North of the granite the schist is cut by pegmatite and lenses and veinlets of massive pyrrhotite and disseminated chalcopyrite occur across a width of 12 feet. The pegmatite carries pyrrhotite in small grains. The outcrops north of the trenches are of interbanded black gneiss and quartzite. This sulphide body is heavily drift covered along its strike both to the east and west. The strike of the deposit appears to be nearly at right angles to the trend of the foliation of the gneiss both to the north and south, and the deposit may be along a small fold developed at this point. A thin section of the black gneiss carries some augite, in addition to abundant hornblende and actinolite; the feldspar is basic andesine and only a few clusters of quartz grains are present. The minerals are fresh with the exception of a few areas of hornblende which in part have been altered to chloritic material.

Walton to Limestone Point Lakes. Grey and black, quartz-mica gneisses outcrop along the river eastward from Walton lake to the first lake east of Walton lake. Some thick beds of the gneiss are medium-grained, granitic-appearing rocks composed of quartz and flakes of white and black mica and a few red garnets. Other interbeds are grey to black gneisses rich in mica and hornblende, and in some cases carrying abundant red garnet. Many small masses of granite and pegmatite cut the gneisses, especially in the area south of the river and south of the first lake east of Walton lake. The general trend of the foliation of the gneiss along the river is northwest and the dip is to the northeast to near the west end of the first lake east of Walton lake where the dip is southwest. At the east end of this lake the dip is north and northeast. A small syncline and anticline are developed here within

4 miles across the strike of the gneisses. The axes of these folds trend southeast. Along the projected strike of these folds to the southeast, the strata are folded into a small anticline and syncline, respectively, situated near the east and the west end of Batty lake.

Thick-bedded, granitic-appearing, quartzose gneiss with many thinner beds of grey and black, micaceous and garnet-rich gneisses outcrop at intervals along the river from the lake east of Walton lake to Limestone Paint lake, and the course of the river closely follows the strike of the beds. The dip of the bedding and foliation is northeast. Grey and black, sedimentary gneisses are also exposed along the branch river entering the main river from the southwest, about 2½ miles northwest of Limestone Point lake, and on Batty and Moody lakes on this branch river. The dip of the bedding and foliation of the sedimentary gneisses is nearly horizontal at some points on Batty lake. Grey and black, quartzose and micaceous, garnet-bearing, sedimentary gneisses outcrop on the shore of Limestone Point lake, at intervals along File river from Limestone Point lake south to Loonhead lake, and on the large lake that lies northwest of Loonhead lake and drains north by a small river entering File river from the west about 2½ miles south of Limestone Point lake. In all these areas the sedimentary gneisses are cut by sill-like bodies of granite, and by dykes of granite, aplite, and pegmatite. North from Limestone Point lake, along File river, the granite bodies increase in size and number until at about 6 miles north of the lake, outcrops of granite greatly predominate over those of sedimentary gneiss and in the next 6 miles the sedimentary gneisses are limited to numerous small bodies in the granite. Farther north, towards Burntwood lake, the areas of sedimentary gneisses included in the granite become smaller and more widely spaced.

The observations made along the route eastward from Kississing lake via Limestone Point lake to Loonhead lake, thus indicate that in this district sedimentary gneisses are widespread and of one general character. The sedimentary gneisses mapped by F. J. Alcock[1] about Loonhead lake extend northwest along the strike of their bedding and foliation through Limestone Point, Batty, and Moody lakes to Walton lake, and sedimentary gneisses are continuous in the area between Walton and Kississing lakes. It is believed, therefore, that the Kisseynew sedimentary gneisses as developed about Kississing lake and the gneisses on Loonhead lake belong to the same group. The relations of the sedimentary gneisses and volcanic rocks about Loonhead lake are not specifically mentioned by Alcock, but he concluded that similar sedimentary gneisses occurring farther east, near Wekusko lake, are interbanded with the volcanics.[2] The sedimentary gneisses about Loonhead lake appear to lie on volcanic rocks. Neither lava flows nor conglomerate beds have been recognized amongst the Kisseynew gneisses as developed near Loonhead lake and northwest to and about Kississing lake. The Kisseynew gneisses, as developed near Loonhead lake, are separated by an area of granite from the similar gneisses with their associated conglomerates of the district to the east about Wekusko lake and where, as already stated, Alcock states the sediments (Wekusko series) are interbanded with volcanics (Kiski volcanics). For these reasons the Kisseynew gneisses are correlated only with that part of the Wekusko series developed about Loonhead lake.

[1] "Reed-Wekusko Lakes Region"; Geol. Surv., Canada, Map. No. 1301.
[2] Geol. Surv., Canada, Mem. 119, p. 24.

The large area of sedimentary gneisses northwest of Loonhead lake has been prospected only in a general way and no mineral deposits of importance are known in this district. Many beds of the black, micaceous gneiss weather rusty and a few small prospect pits in them were noted. Pyrrhotite was the only sulphide seen in the fresh rock under the rusty cappings. Several large bodies of disseminated pyrrhotite occur near the west end of Batty lake and along the river for a mile south of the lake.

Early Palæozoic Limestone on Limestone Point Lake. An interesting feature of the geology of Limestone Point lake is an outlier of Palæozoic limestone on the point extending northwest from near the middle of the south shore, east of the narrows between the large east bay running northwest and the smaller west bay of the lake. The name Limestone Point has been given this lake on account of this unusual feature. Elsewhere in the region, outliers of Palæozoic rocks have not been found more than 5 miles north of the main area of Palæozoic strata, whose north boundary is 50 miles south of Limestone Point lake, along the south shore of Reed lake.

In the summer of 1899, D. B. Dowling crossed Limestone Point lake and he has described this area of limestone as follows.[1]

"At a lake about 8 miles below Loonhead lake where the river makes a jog to the east for 3 miles, the central island and a long point reaching out from the southeast are both found to be composed of light, fine-grained, dolomitic limestone, dipping along the eastern edge, towards the northeast. As the beds are not all standing in this position but are more nearly horizontal at the southwest side, it is possible that beneath these are sandstones of a friable nature which have been denuded so that the beds have fallen down. There appear to be no fossils in the beds with the exception of a few broken crinoid stems, so the exact age could not be decided, but in their general appearance they resemble the beds exposed on Cumberland lake which are of Niagara age. The limestone is fine-grained but pitted by numerous small cavities, possibly impressions of salt crystals. This outlier of limestone is the only one known in this district at any great distance from the general outcrop of the Silurian and Cambro-Silurian rocks. The lake in which they are found is generally called Limestone Point lake."

The limestone outlier is somewhat more than 2 miles long and is ½ mile across at the widest point. The limestone is fine grained. Specimens from some beds exhibit glistening faces of small crystals of calcite. The usual colour is white, but some beds are buff, pinkish, or brownish. The magnesium content is unknown. Some beds are siliceous and these weather with a rough, pitted surface. The beds were searched carefully for fossils, but only a few poorly preserved casts of unidentifiable fossils could be found. The dip of the beds on the east side of the point is from 40 to 85 degrees northeast, whereas the bedding of the few outcrops in the central area and along the west shore of the point is horizontal or dips eastward at from 5 to 10 degrees. Where the beds stand nearly vertically, the limestone is much jointed and exhibits poorly developed fracture cleavage. These features and the localization of the steep dips to a narrow zone along the east margin of the limestone area indicate a dragging movement of the beds along a fault plane rather than the effects of slumping, as suggested by Dowling. The outlier of Palæozoic limestone, therefore, probably owes to faulting its present position in a basin below

[1] "Geological Explorations in Athabaska, Saskatchewan, and Keewatin Districts"; Geol. Surv., Canada, Ann. Rept., vol. XIII, pt. FF, p. 28 (1902).

the general level of the surface of the Precambrian rocks. The fault probably extends northwest through the long arm of Limestone Point lake, paralleling the strike of the foliation of the sedimentary gneisses. The exact age of the limestone is unknown, but the beds probably belong to the same series as the limestone and dolomite south of Reed lake, which have been referred to the Trenton.[1] The date of the faulting is unknown.

LOONHEAD LAKE AREA

General prospecting has been in progress over 10 years in the area surrounding Loonhead lake and a few shallow prospect pits expose schistose rock carrying pyrrhotite, pyrite, and some chalcopyrite. The area is reached by canoe from Reed lake up Morton lake, across File lake, and down a crooked small river between File and Loonhead lakes. This river is fairly navigable for canoe when the water is high. A good wagon road has been cut across the 4-mile portage from Reed to Morton lakes.

The rocks exposed on and about Loonhead lake are grey and black, quartz-mica gneiss and quartzite cut by dykes, sill-like and other larger bodies of pegmatite, granite, and granite-gneiss. The beds of quartz-mica gneiss are nearly horizontal in some outcrops and apparently the axis of an anticlinal fold passes northwest across the lake, for the strata on the north side of the lake, and those on the south side, dip in opposite directions. Andesitic lava outcrops south of the middle of Loonhead lake. A long point extending south from the north shore of the lake east of the outlet, is underlain by a foliated, bedded-like, fine-grained granite carrying red garnet and holding inclusions of grey, sedimentary gneiss. The other granites of the area are massive, coarse-grained types markedly different in appearance from this foliated, stratiform granite.

Five trenches expose sulphide-bearing gneiss just north of Loonhead lake at a locality a mile east of the east side of the long point extending south from the north shore. A pit near the shore exposes 20 feet of sheared quartzite and mica gneiss carrying disseminated pyrrhotite, pyrite, and some chalcopyrite. The sheared quartzite and mica-gneiss are cut by a narrow dyke of pegmatite containing crystals of pyrite and veinlets of pyrrhotite. At another pit, about 450 feet farther east, nearly flat-lying, jointed, and schistified quartzite is cut by pegmatite, and along the edge of the pegmatite body is heavily mineralized with pyrrhotite and pyrite across a maximum breadth of one foot. Nearby a shallow shaft has been sunk on a drag-folded and faulted zone 12 feet wide of schistose quartzose sediments holding pyrrhotite, pyrite, and a little chalcopyrite. These sulphide-bearing zones have not been traced more than 100 feet along their strike under the drift.

The Majestic group of mineral claims was staked west of Loonhead lake in 1928 by Messrs. Charles Foss, Thomas Hendricks, and associates. The claims are largely drift covered. The few rock outcrops noted are of coarse pegmatitic granite. A prospect pit through drift exposes micaceous gneiss carrying fine-grained pyrrhotite and white iron sulphide.

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[1]Alcock, F. J.: "The Reed-Wekusko Map-area, Northern Manitoba"; Geol. Surv., Canada, Mem. 119, p. 30 (1920).

The H. M. group was staked in June, 1929, by Messrs. R. Kerr, Peterson and Dickison, on both sides of the 18th base line east of a creek entering a deep bay on the south shore of Loonhead lake. This locality was not visited. Specimens reported to come from this locality are of schistose andesitic lava carrying pyrrhotite, chalcopyrite, and some vein quartz.

Trenching has been done to the east of the H. M. group, about 1,500 feet south of B.M. 199 on the 18th base line. Several zones of schistose andesitic lava exposed here, carry some pyrrhotite, pyrite, chalcopyrite, and vein quartz.

No deposit of sulphides seen near Loonhead lake carries enough chalcopyrite to be a copper ore. The rocks, however, are widely mineralized with sulphides. The thick overburden handicaps prospecting.

MORTON LAKE AREA

Morton lake is easily accessible by a good wagon road from Reed lake, and the area immediately surrounding Morton lake has been prospected carefully. The Copper Valley sulphide deposit has been explored by two diamond drill holes and the North Star gold prospect was trenched during the summer of 1930. A number of quartz bodies near the shore of Morton lake have been opened by prospect pits.

A large area of volcanic rocks lies west of Morton lake. The lavas include black, basaltic and andesitic types outcropping as a series of ridges trending nearly north or parallel the long direction of Morton lake. The depressions between the ridges are floored with drift and are swampy. Beds of stratified, tuff-like materials occur within the lavas at some horizons. Wide zones of chloritic schist have been developed and contain the sulphide deposits and gold-bearing quartz. Dykes of pegmatite, granite, granite porphyry, gabbro, and black lamprophyre cut the lavas.

Copper Valley Sulphide Deposit. This deposit is one-half mile north and one-quarter mile west of the north end of Morton lake. The deposit was exploded by trenching and two diamond drill holes, in the winter of 1930, by Messrs. Bartlett and C. E. Herman. This work was done on the Copper Valley No. 1 mineral claim. Near the south side of this claim a trench on the east side of a hill exposes 18 feet of jointed and schistified andesite carrying fine-grained, light-coloured pyrrhotite and small bits of chalcopyrite. The sulphides occur disseminated through the rock and in small veins and lenses, in some of which dark-coloured layers of chloritic material and pyrrhotite alternate with lighter-coloured layers of more massive pyrrhotite. In thin section the grains of pyrrhotite vary in diameter from 0·15 mm. to 1·2 mm. and are distributed evenly throughout the area of the thin sections, filling the interstices between the gangue minerals and penetrating these minerals in small veinlets. The gangue minerals are hornblende, biotite, oligoclase, and quartz, the characteristic minerals of the enclosing andesitic lava. The silicates are fresh except that the margins of a few grains of biotite and hornblende have altered to chloritic materials. The strike of the schistosity of the lava is south 55 degrees east and the dip 68 degrees northeast. The continuation of the deposit north and south is covered by swamp which also extends for 250 feet east

of the trench. The first drill hole was put down in the swamp 160 feet east of the trench. The second drill hole was put down 4,000 feet northeast, supposedly along the continuation of the deposit in this direction. The pyrrhotite is reported to carry nickel.

Gordon Lake Sulphide Deposits. This deposit is about 500 feet south of Gordon lake, and is reached by a trail, about 1½ miles long, leading from the west shore of Morton lake about ½ mile south of the north end of this lake. A syndicate of residents of The Pas did some surface work on the property during the summer of 1929. A shaft was sunk about 50 feet and trenching was done at several points south and east of Gordon lake. The bedrock is slightly schistose andesite. The shaft is sunk on a zone of chloritic schist about 4 feet wide. Some of the schist on the dump contains abundant light-coloured pyrrhotite, specks of chalcopyrite, quartz veinlets, and iron carbonates. The schist zone was not traced more than 500 feet south of the shaft. North of the shaft the drift is thick. Other nearby zones of schist carry only small quantities of sulphides and vein quartz.

North Star Gold Deposit. The North Star gold-bearing quartz deposit was discovered by Mr. Lambert Nelson in the spring of 1927. The deposit was staked in December, 1927, and in succeeding months several additional groups of ten mining claims were staked north and south of the original location. The North Star deposit can be reached in half a day by canoe from the northwest corner of Reed lake, the route following Krug, Sewell, and Paterson lakes. A rough trail 4½ miles long leads from the west shore of Paterson lake to the property.

Consolidated Mining and Smelting Company held the property under option during the summer of 1930. At the time the locality was visited, near the end of July, 1930, this company had just commenced surface work. The showing later was completely stripped, trenched, and systematically sampled. Late in 1930 the option was dropped.

The bedrock from Paterson lake west to a point one mile west of the deposit consists of massive and schistose andesite and basalt cut by bosses and dykes of granite and by dykes of granite porphyry and of black, hornblende lamprophyre. About a mile west of the North Star deposit, the lavas are cut off by a large body of granite. The schistosity of the lavas strikes south and dips from 78 to 84 degrees east.

The mineral deposit is on the North Star No. 2 mineral claim and consists of a series of lenses, veins, and stringers of quartz in a belt of chloritic schist. Massive, black, medium-grained andesite outcrops immediately east and west of the deposit, and the chloritic schist is for the most part a schistified and altered lava. The outlines of poorly developed pillows are recognizable on the weathered surface of some outcrops of black lava both south and west of the deposit. In the area just west of the deposit, massive, medium-grained andesite is followed to the east by fine-grained lava with, in places, markings resembling the outlines of pillows and in other places exhibiting fragments of lava surrounded by schistose andesite. Thin layers present wavy lines resembling flow structure. Schistose phases carry small lenses and irregular-shaped bits of white quartz up to one-quarter inch across that, perhaps, are fillings of amygdaloidal cavities in the lava. The lava showing these structures may be the top portion of a flow, and if so, the tops of the flows face east at this locality.

The belt of schist forming the mineral deposit is exposed over a length of 1,000 feet along a north-south direction and in the north passes beneath drift. The north part for a length of about 400 feet consists of two belts separated by 30 to 50 feet of massive lava. To the south the two belts unite to form a single belt 90 feet broad, but which in a distance of about 100 feet narrows to 25 feet *(See* Figure 4). To the south of this, quartz in very small lenses and stringers is only sparingly present at a few points, and the schist zone varies in width from a seam to 8 feet. The schist zone appears to be along or near the contact between two lava flows, and the strike is north 10 degrees east and the dip from 78 to 84 degrees east. Within the belt of schist some narrow areas are of chloritic ribbon schist and other intervening areas are of much less schistose lava. Some of the greyish to greenish ribbon schist may represent thin beds of highly altered tuffaceous materials, as some lava flows of the district are separated by thin deposits of bedded materials. A grey, massive, fine-grained rock associated with the eastern fork of the shear zone has the appearance of a fine-grained, slightly porphyritic, aplitic granite, but is probably a recrystallized clayey and limy tuff.

The lava west of the north end of the west fork of the schist zone is cut by a crooked dyke of granite porphyry up to 6 feet wide, the average width being about 2 feet. The average trend of the dyke is nearly north-east and it cuts across the western fork of the schist zone and continues a short distance beyond in massive lava. The western fork of the schist zone is also cut by a short dyke of black lamprophyre from 6 inches to 3 feet wide. The lamprophyre is of similar texture and mineral content to the hornblende lamprophyre outcropping near some of the gold-bearing quartz deposits in Wekusko Lake area. The porphyry and lamprophyre dykes appear to be younger than the shearing which produced the zone of schist and older than the quartz veins.

The distribution and size of the gold-bearing quartz bodies are shown approximately in Figure 4. The quartz is white and coarsely crystalline. The surface of some of it is weathered and pitted, and iron oxide in the cavities carries abundant free gold. Small bits of iron carbonate occur in some of the unweathered quartz. In a thin section, subangular, crenated quartz grains interlock. The quartz is but little granulated and does not show wavy extinction. The average size of the grains is about 0·9 mm., some grains are up to 1·5 mm. across, and a few are as small as 0·1 mm. No feldspar was recognized; shreds of chlorite, biotite, bits of pyrite, and red iron oxide are sparingly present. No free gold occurs in the specimen examined microscopically. Free gold, however, is abundant in some of the quartz of a mass near the south end of the area represented in Figure 4. Pyrite, chalcopyrite, sphalerite, galena, native copper, malachite, and azurite occur sparingly in the quartz. The chloritic schist adjoining the larger quartz bodies is mineralized with grains and veinlets of quartz and carries pyrite in cubes and grains. The free gold appears to be erratically distributed through the quartz. The value of the deposit perhaps depends upon whether the mineralized schist adjacent to the quartz bodies carries sufficient gold so that schist and quartz could be profitably treated together.

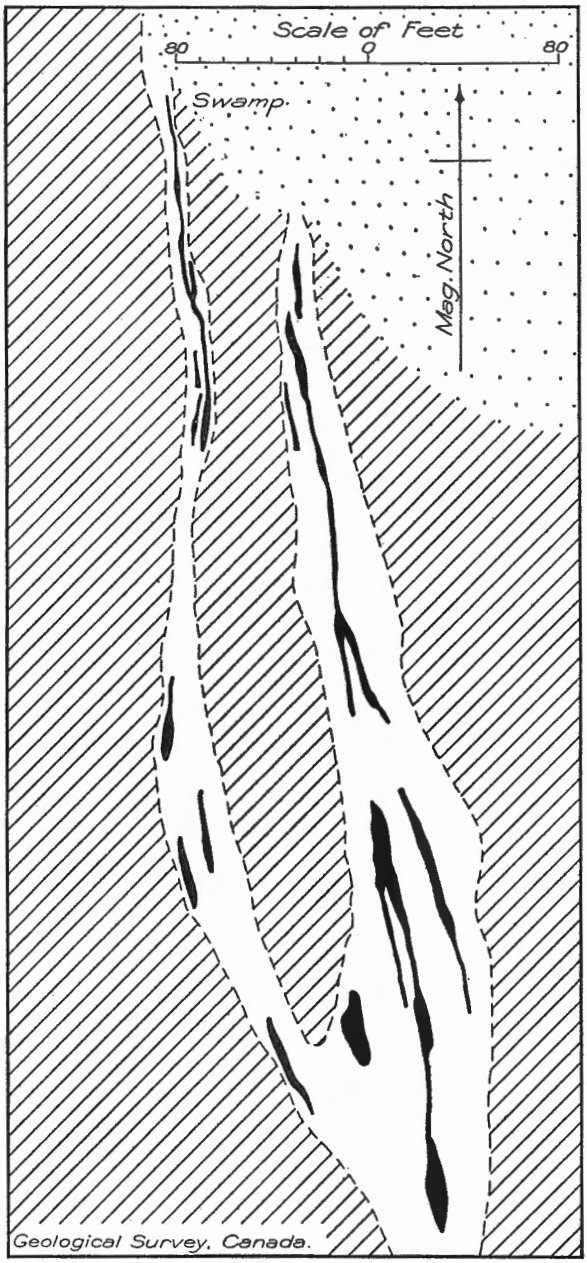

Figure 4. Northern part of schist zone on North Star gold prospect, Morton Lake area, Manitoba, showing position of quartz veins, etc. (solid black), in schist zone (blank) in massive andesite (pattern of ruling). Drift is shown by a pattern of dots.

Snow Mineral Claim. Some work has been done on deposits of gold-bearing quartz on several mineral claims in the neighbourhood of the North Star property, but only one of these deposits was visited. On the Snow mineral claim, adjoining the North Star No. 2 on the west, chloritic schist and vein quartz are exposed in a prospect trench across a width of 10 feet. The strike of the schistosity of the lava is south 5 degrees east and the dip 83 degrees east. The quartz is white, sugary-appearing, and apparently does not carry a promising gold content. Cubes and grains of pyrite are abundant both in the quartz and schist. In one specimen quartz and pyrite are crossed by cracks along which veinlets of chalcopyrite have formed. The wide belt of volcanic rocks surrounding the North Star deposit and extending northward from the west end of Reed lake appears to be a promising area wherein to prospect intensively for gold-bearing deposits.

REED LAKE AREA

Ordovician limestone outcrops along most of the south shore of Reed lake; lavas are exposed on the west shore and continue along the north shore to near the east end where intrusive granite is the country rock.[1] The lavas include rhyolite, andesite, and basalt with intercalated tuff, chert, and carbonate beds. Some outcrops show pillow structure and others carry quartz-epidote lumps which are a characteristic feature of lavas of some areas. The volcanic rocks are for the most part schistose and the dip of the schistosity and the cleavage and bedding of the tuffs is nearly vertical at the localities visited en route across the lake. The details of the structure of the volcanic rocks are unknown. Bruce[2] states that the crest of an anticline lies in Reed Lake district, but no details of the structure are given. Dykes and other small masses of schistose granite porphyry cut the volcanic rocks.

Considerable prospecting has been done in Reed Lake district, but time did not permit of visiting all the localities where work had been done. The observations made at the few localities visited are briefly summarized below. Free gold has been discovered in quartz on a number of mineral claims in addition to those visited.

On a point on the south shore of Reed lake, near reference mound Z 23 and about 4 miles west of the inlet of Grass river, two prospect pits expose quartz-chlorite-sericite schist carrying veinlets of coarsely crystalline, white quartz. The bedrock is greenish grey lava overlain, about 300 feet west of the pits, by nearly flat Ordovician limestone and dolomite. The schist zone on the south side of the point is 75 feet wide and a schist belt is exposed across 20 feet at the water's edge on the north side of the point. The quartz contains iron carbonate and cubes of pyrites. The quartz cuts the carbonate, which apparently formed earlier. Shreds of chlorite and sericite are included within the quartz. Vein quartz is estimated to form nearly one-tenth of the material crossed in the trenches. The average gold content of the zones is not known. These deposits can be prospected to advantage at a time of low water in the lake. Large blocks of white quartz are visible under the water just west of the trench exposing the northern shear zone.

[1] *See* Map, Pub. No. 1801, Reed-Wekusko Lakes Region, Geol. Surv., Canada.
[2] Geol. Surv., Canada, Sum. Rept. 1918, pt. D, pp. 2-5.

From the bay south of the point referred to above, a trail one-quarter mile long leads south to the Big Ben, Diamond, and other mineral claims staked in January, 1928, and February, 1929, by Frank Allison, Charles Foss, and associates. The bedrock on these claims is andesite lava cut by small bosses and dykes of granite and granite porphyry. The intrusives are both massive and schistose, light to dark grey rocks showing rounded phenocrysts of smoky quartz and lath-shaped crystals of white feldspar. The granitic masses are from 25 to 75 feet wide and of irregular outline. Their longer axes trend south 85 degrees west and parallel the schistosity of the lava. One dyke of granite porphyry is exposed by some fifteen trenches for 650 feet and across widths of from 10 to 50 feet. Small masses of black, schistose lava lie in this dyke and quartz in small lenses and veinlets parallels the schistosity and lies along joint planes cutting the schistosity. The deposit has been channel sampled, but the average gold content is not known to the writer. One other nearby but smaller granite body has been prospected and the quartz of some of the stringers is reported to carry free gold.

On the south side of a point near the east end of the large island north of Bartlett point on the south shore of Reed lake a shallow pit exposes a schistose zone along the contact between a granite mass and lava. The granite body is about 400 feet wide and it was followed 900 feet along a strike of south 65 degrees west. The rock is of variable texture, aplitic, pegmatitic, evenly granular, and porphyritic phases being represented in different outcrops. The pegmatitic phases are localized along the south margin of the body. A narrow zone of schistose lava adjoining the south side of the granite contains stringers of quartz. No free gold was seen in the quartz and no assay results are available. Areas wherein schistose lava is cut by small bodies of granite and granite porphyry are regarded as being favourable for the occurrence of gold deposits, and the district bordering the southern part of Reed lake perhaps should be prospected carefully.

New Colony Group. An outcrop of sulphide-bearing rock on the east side of Jackfish lake had been known for a number of years and in July, 1928, the New Colony group of mineral claims were staked at this locality. The group was at once optioned to Manitoba Basin Mines, Limited, and considerable surface work was done there by that company during 1928 and 1929. This prospecting work was done on the east and west shores of the lake near its outlet and farther north along the east shore. Jackfish lake is reached by canoe by following a small, crooked river about 2 miles long entering the north shore of Reed lake, 3 miles directly west of where Grass river leaves Reed lake.

Andesite lava and quartz gabbro are exposed on Jackfish lake. These rocks apparently form a narrow belt extending north from Reed lake along the river draining Jackfish lake. They lie between granite on the east and west. The margin of a quartz gabbro body exposed in a trench just northwest of the outlet of Jackfish lake is chilled against andesite, thus suggesting an intrusive relationship of the quartz gabbro to the andesite at this point. The sulphide bodies are in the quartz gabbro or in the andesite adjacent to the quartz gabbro.

The gabbro is a grey-weathering, black rock of medium to coarse grain. Smoky quartz, hornblende, mica, feldspar, pyrrhotite, and magnetite are recognizable in most specimens. The size of grain varies in different outcrops, and in some outcrops areas up to a foot or more in diameter, of a fine-grained type, are distributed through the coarsely granular rock. The contact of the coarser, normal gabbro with the areas of fine-grained rocks is sharp. Fine, granular pyrrhotite and pyrite are present in an unusually large percentage in the quartz gabbro surrounding the areas of rock of fine texture. Small, rounded areas of grey, quartzitic-appearing rock are abundant in the gabbro near some of the prospect pits.

The following is the approximate percentages by volume of the minerals in a thin section of a specimen of quartz gabbro from near the prospect pits on the east side of Jackfish lake just north of the outlet, as determined by using a Wentworth micrometer: plagioclase (Ab 55) 33·7; hornblende 42·5; biotite 3·8; orthoclase 5·1; quartz 7·6; and accessories 1·7. The minerals are only slightly altered, the feldspars to zoisite and the hornblende to chloritic materials. The altered amphibole carries grains of pyrrhotite and pyrite.

A prospect trench on the east side of Jackfish lake, just north of the outlet, crosses a depression 45 feet wide between two small outcrops of quartz gabbro. Veinlets and lenses of pyrite and pyrrhotite are present along joint planes in the quartz gabbro throughout the length of the trench. In a section about 7 feet wide near the east end of the trench, the rock is brecciated, slightly schistose, and carries wider and more closely spaced sulphide veinlets than elsewhere. The walls of many of the joint planes in this section are slickensided. The continuation of this brecciated zone under the drift along the strike is unknown. Pyrite is the abundant sulphide and some of it weathers with a copper stain. No chalcopyrite or sphalerite was seen at this locality. The sulphides are for the most part oxidized for at least 6 feet below the drift.

Two pits on the west side of the lake, just north of the outlet, expose quartz gabbro in contact with andesite. The fine-grained gabbro across widths of from 1 to 4 feet from the contact is jointed and schistified and carries some pyrrhotite and chalcopyrite. The adjoining andesite also is schistose and the resultant chloritic schist is cut by quartz veinlets and carries pyrite, pyrrhotite, and chalcopyrite in small grains and lenses. The contact of the quartz gabbro and andesite apparently follows an irregular course. Small bodies of schist and sulphides are reported to occur at a number of points along the contact north of the prospect pits examined.

On the east side of Jackfish lake, one-half mile north of the outlet, three large pits cross the contact zone between quartz gabbro on the east and andesite on the west and southwest. Jointed and schistose andesite and quartz gabbro carry sulphides disseminated and in small lenses. Pyrrhotite is the abundant sulphide, pyrite, chalcopyrite, and sphalerite are present only sparingly. In a polished surface, the sulphides penetrate the slightly altered crystals of plagioclase, hornblende, and brown biotite of the quartz gabbro. Pyrrhotite includes rounded bits of fresh silicates. The chalcopyrite is within the pyrrhotite as rounded and subangular areas with straight or gently curved contacts against pyrrhotite. No pentlandite was recognized in the specimens examined although the massive sulphides probably carry some nickel.

WEKUSKO LAKE AREA

The location of the more important mineral deposits about Wekusko lake is shown on the accompanying figure (Figure 5). Many of the deposits of this area were located in 1914 and 1915 during the early prospecting of the field. A few deposits are well exposed by surface trenching, and underground work has been done on the Rex, Bingo, and Northern Manitoba.

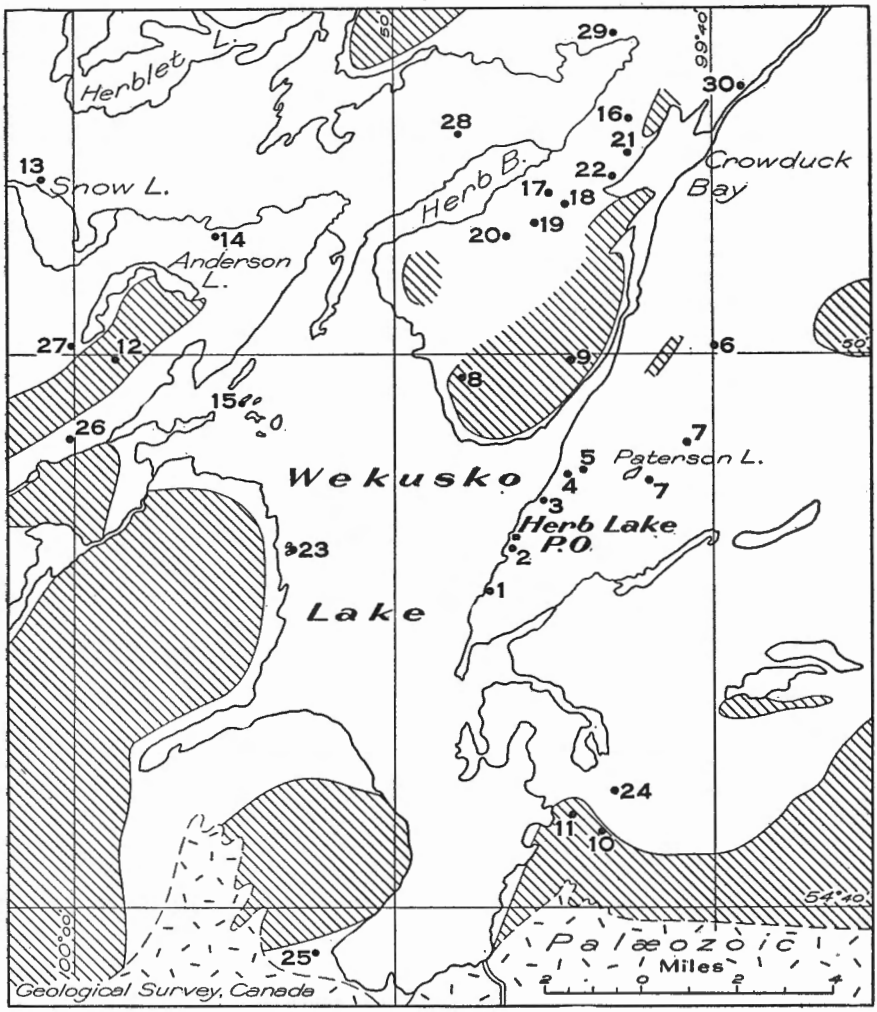

Figure 5. Index map of Wekusko Lake area, showing positions of mineral deposits and main bodies of granite (pattern of ruling).
Mineral deposits: 1, Kiski; 2, Northern Manitoba; 3, Rex; 4, Bingo; 5, Elizabeth-Dauphin; 6, McCafferty; 7, Paterson Lake group; 8, Apex; 9, Dion; 10, Wekusko; 11, Lucky Jack; 12, Taylor; 13, Penas; 14, Gold Hill; 15, Rice-Woosey; 16, Copper Dome; 17, Arctic; 18, Arctic Extension; 19, West; 20, Chalco; 21, Mundic; 22, Waldron; 23, Eureka; 24, Puella Bay; 25, Manitoba Basin; 26, Maple; 27, Eagle; 28, Polo; 29, Ruby; 30, Bengal.

The bedrock about Wekusko lake is a complex of sediments and lavas, cut by large and small bodies of various types of intrusives. Some lavas are grey, porphyritic, and non-porphyritic rhyolite; others are black andesite and basalt. Locally the lavas are schistose. Interbedded with the lavas are slate, greywacke, arkose, conglomerate, and quartz-mica gneiss, many beds of which contain red garnet and a few, staurolite and cyanite. Some conglomerate beds contain well-rounded pebbles and boulders of granite. The sediments and lavas are intruded by bodies of quartz gabbro, quartz porphyry, and granite. Dykes and small bosses of mica and hornblende lamprophyre are abundant in the rhyolitic lavas east of Wekusko lake.

The mineral deposits include gold-bearing quartz bodies, sulphide bodies, and pegmatitic quartz bodies carrying molybdenite.

Kiski (1).[1] A vein on the Kiski was the first to be discovered in the area, and was located in 1914 by Messrs. Richard Woosey and M. Hackett. Boulders of quartz carrying abundant free gold were found on the beach just south of the south end of a vein that, later on, was uncovered on the hillside and became known as No. 1 vein. Soon after the discovery, the Kiski Mining and Development Company was organized to develop the deposit. Some time before 1926, this company amalgamated with the Northern Manitoba Development Company, holding the ground to the north, and a new company known as the Kiskoba Mining and Development Company was formed. During the summer of 1930, Consolidated Mining and Smelting Company of Canada held a sampling option of the property of this company. Surface stripping was done and all the quartz and schist bodies were systematically sampled under the direction of Mr. Wm. J. Dean. The option was dropped in the autumn of 1930.

The general features of the bedrock geology of the area in the vicinity of the Kiski veins is shown on the accompanying figure (Figure 6). The lavas consist of rhyolite and darker, more basic varieties, probably dacite and andesite. Some outcrops show pillow structure. The grey, rhyolitic varieties are locally a volcanic breccia. Both the acidic and more basic lavas are schistose, and, in places, quartz-sericite and quartz-chlorite schists have developed. A few, narrow, discontinuous dykes of black lamprophyre cut the lavas.

The veins do not extend far into the lavas, but lie for the most part within but close to the southern margin of an intrusive body of quartz-mica diorite. The diorite is a black, medium-grained rock, most outcrops of which are schistose. In a few outcrops the diorite carries feldspar crystals up to half an inch in length. In most outcrops the only minerals recognizable are large flakes of black biotite, shreds of chlorite, and feldspar of an epidotite-green colour. In thin section the feldspar is seen to be largely altered to zoisite and calcite; only a few small grains are determinable as oligoclase-andesine. Some kaolinized feldspar is also present and may be orthoclase. Most of the area of the thin section is an aggregate of small grains of quartz, untwinned feldspar, biotite, actinolite, epidote, and chlorite. Needles of black tourmaline are present in both the more massive and the schistose diorite adjacent to the quartz bodies. Some of the shreds and flakes of greenish biotite are distributed in zones, perhaps representing

[1]The numbers following the names of the mineral properties are the symbols used on Figure 5 to indicate the approximate situation of the properties.

planes of schistosity. Veinlets of calcite cross the minerals, and small grains and cubes of pyrite, pyrrhotite, arsenopyrite, and magnetite are present. The intrusive nature of the diorite is well shown near the south end of No. 3 vein where fragments of rhyolite are included in the fine-grained marginal phase of the intrusive body.

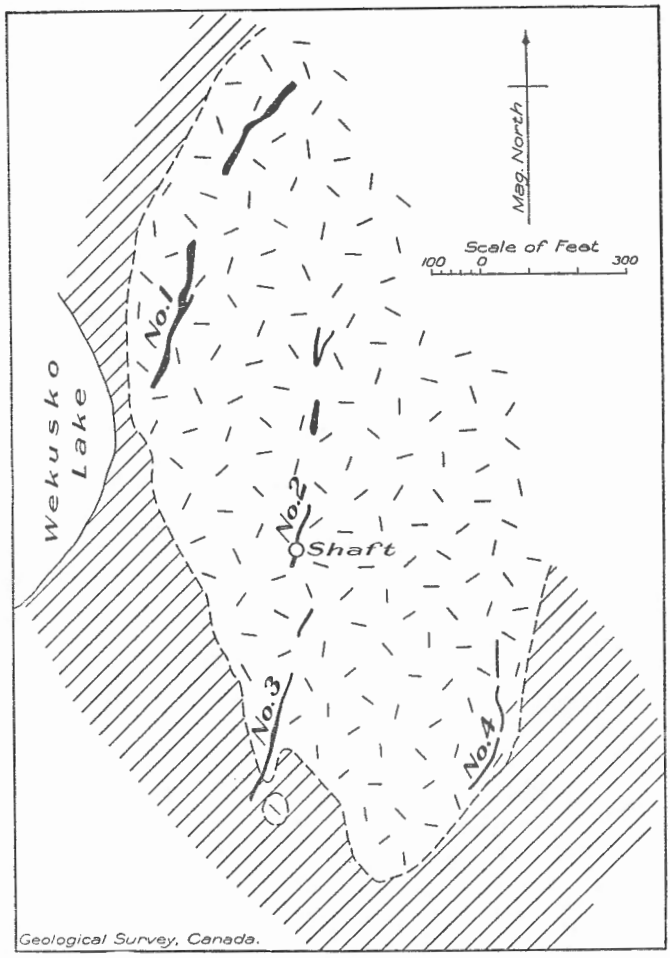

Figure 6. Outcropping veins on the Kiski location, Wekusko lake, Manitoba. The veins (solid black) lie mainly in a body of quartz-mica diorite (pattern of dashes) bordered by lavas (pattern of ruling).

Most of the work on the property has been done on four veins (*See* Figure 6). Several lenses of quartz outcrop in the lavas for a quarter of a mile to the south, but the quartz is white and does not appear promising as a gold carrier. The average trend of the schistose zones carrying quartz in the diorite is from north to north 15 degrees east and their dip varies from vertical to 75 degrees east. The quartz bodies and the enclosing masses of highly schistose diorite are lenticular. The general shape and

length of the deposits are shown on Figure 6. Vein No. 1 has been stripped almost continuously along two sections, with a combined length of 600 feet; the average width is 4 feet, and the maximum, 12 feet. No. 2 vein has been stripped, over several sections, for a combined length of 300 feet; it varies in width from 1 foot to 12 feet. The shaft near the south end of No. 2 vein is 53 feet deep. No. 3 vein has been exposed for 350 feet and averages about 2 feet in width. Some of the quartz of No. 3 vein carries abundant free gold. No. 4 vein is more irregular in shape and has been exposed for about 300 feet along the strike; the quartz of this vein is in narrow lenses and stringers.

The greenish, chloritic schist forming the walls of the quartz bodies carries pyrite and arsenopyrite in crystals and aggregates of grains. Black tourmaline is abundant locally in the quartz. Small veinlets of quartz are distributed through some parts of the schist up to several feet away from the main quartz vein. This mineralized schist apparently does not carry more than a trace of gold. The quartz is white and granular and, apparently, the gold is erratically distributed through the quartz masses. The four deposits taken together offer possibilities of developing a considerable tonnage of quartz and mineralized schist, but, apparently, the quantity of gold present is not great enough to make large bodies of commercial grade and the lenses carrying abundant gold are so erratically distributed as to make it difficult or impossible to develop the property in a small way for the extraction of high-grade ore.

Northern Manitoba (2). This property includes the Moosehorn and Ballast mineral claims, Nos. 12 and 21, respectively, of group 422. Soon after the discovery of the property in 1915, the Northern Manitoba Mining and Development Company was organized to develop it. A shaft was sunk 100 feet and 50 feet of drifting was completed at this level. A car-load of ore was shipped from the property to Trail, B.C., and, according to Alcock,[1] yielded $2,323, or an average of $81.53 a ton in gold. During the summer of 1918, Makeever Brothers held an option on the group and in 1919-20 Northern Canada Exploration Company was interested in the property. Both these options were dropped. Prior to 1926, the Northern Manitoba Mining and Development Company holdings were amalgamated with the Kiski property to the south, forming the Kiskoba Mining and Development Company.

The bedrock exposed on the property is grey to greenish, rhyolitic, and dacitic lava, in part altered to sericite and chlorite schists. The strike of the schistosity is south 20 to 25 degrees west and the dip is from 70 to 85 degrees east. Thin beds of pyroclastic and conglomeratic materials are present among the lavas and thin lenses of volcanic breccia are locally developed. Some of the grey lava is porphyritic, carrying small crystals of pinkish-weathering feldspar. The lavas and associated beds are cut by small dykes of grey granite porphyry and black lamprophyre. In thin section the lamprophyre dyke rock is described by Alcock[1] as being "highly altered, consisting of brown biotite, largely altered to chlorite, small amounts of muscovite, feldspar largely changed to carbonate and sericite, a little iron ore and apatite, and quartz. The vein lies in the largest of these lamprophyre dykes." The lamprophyre is considered to be of the same age as the larger mass of quartz-mica diorite containing the Kiski deposit.

[1]Geol. Surv., Canada, Mem. 119, p. 36 (1920).

The vein on which most of the prospecting work has been done is just north of a small bay on Wekusko lake and is well exposed for 150 feet north of the shaft. The zone of schist carrying quartz is probably 300 to 400 feet long. The strike of the deposit is south 35 degrees west and the dip 65 degrees east. The schist zone is crooked and varies in width from 2 to 8 feet. The quartz bodies are lenticular. A quartz body just north of the shaft averages 29 inches in width for 11 feet. North of the shaft the average width of the quartz in the schist zone is 15 inches for 150 feet. The quartz is white and coarsely granular. Free gold is abundant along some cracks in this quartz. Black tourmaline and arsenopyrite are abundant locally. Pyrite, chalcopyrite, galena, and sphalerite are sparingly present. Alcock[1] states that "In one specimen a telluride determined by R. A. A. Johnston to be probably petzite (carrying silver and gold in ratio of 3 to 1) was found surrounding some of the gold particles." The schist adjacent to the quartz carries needles of black tourmaline and crystalline and granular arsenopyrite. On the surface the quartz south and north of the main lens at the shaft is in small stringers, whereas along the short drift on the 100-foot level the quartz body is reported to be more continuous. On the surface the schist zone passes from black lamprophyre into rhyolitic schist both to the north and to the south of the shaft and the quartz in the rhyolite schist occurs only in small lenses and stringers.

Two wide shear zones along the trail leading from the shaft on the northern Manitoba property to Herb Lake village have been prospected. These are in the volcanic rocks. White, coarsely granular quartz carrying a yellowish carbonate (siderite?) and specks of pyrite and arsenopyrite is present in, for the most part, scattered lenses and stringers.

So far as can be determined from a surface examination all the quartz bodies on this property are small. The results of the test shipment indicate, however, that some of the quartz is high-grade ore. The small shipment suggests that by mining on a small scale this deposit and, probably, a number of others in the same general locality, could, perhaps, profitably produce considerable gold if a mill to treat the ore were located nearby.

Rex (3). The Rex is the only gold deposit in northwest Manitoba that has been extensively explored underground. Nearly $150,000 in gold is reported to have been recovered up to the time work ceased in 1925. Alcock[2] summarizes the history and development of the deposit prior to November, 1918, as follows:

"The Herb Lake Gold Mines, Limited, controls a group of seven claims on the east shore of Wekusko lake, on which is located a vein generally known as the Rex. The company was promoted by the Makeever Brothers, brokers of New York, and was incorporated in Manitoba in 1918 with a capitalization of $1,000,000, divided into dollar shares. A total of $38,000 has been spent in developing work on the property. The equipment, valued at $104,590, consists of a mill with a capacity of 30 tons a day,.....and other essential tools. Up to the end of November, 1918, the production in gold, not including concentrates, was in excess of $27,000. The shaft is 127 feet deep, and drifts have been run at the 100-foot level 250 feet south and 90 feet north."

So far as known, no work was done on the Rex deposit from the end of 1918 to the spring of 1924. In the autumn of 1923, the vein was carefully sampled by engineers representing the Mining Corporation of Canada,

[1]Geol. Surv., Canada, Mem. 119, p. 36.
[2]Geol. Surv., Canada, Mem. 119, pp. 33-34.

and in March, 1924, this company commenced work on the property, and continued until October, 1925. The group of mining claims is now controlled by Manitoba Metals Mining Company, a subsidiary of the Mining Corporation of Canada.

According to Mr. A. Miller of Herb Lake, a shaft was sunk to a depth of 422 feet and lateral work was done on the 250- and 350-foot levels. All the ore milled was taken from stopes above the 350-foot level. No work was done south of the shaft on the 350-foot level. The mill, mining machinery, assay plant, and camps on the property are still in fairly good shape.

The geology in the vicinity of the Rex vein is represented in considerable detail on a map[1] prepared by Alcock. Bedrock is well exposed adjacent to the vein and consists of bands of slate, arkose, and conglomerate alternating with others of acidic lavas. The bands strike northeasterly and are nearly parallel with the lake shore. A sedimentary band occurs along the shore. Inland a few hundred feet is the edge of a band of lavas and along or close to this edge the Rex vein has developed. Both the lavas and sediments are cut by small dykes and more irregular bodies of mica lamprophyre and hornblende lamprophyre.

Alcock has described the lithological features of the rocks on the Rex property in some detail and his description is here quoted:[2]

"The sediments consist of a band of slate (outcropping on the lake shore and succeeded eastward by arkose, and of a second band of arkose farther inland beyond a band of lavas) .....The arkose stands on edge or with steep dips to the east.....Conglomeratic bands are numerous in the arkose but do not form definite continuous horizons. The pebbles consist of quartz, volcanic rocks of both light and dark colours, porphyry, and more rarely granite. Locally, masses of breccia composed largely of angular fragments of rhyolite are associated with water-sorted fine material. In places, bedding and cross-bedding are well shown on weathered surfaces.

In hand specimens the arkose is a grey, fine-grained rock, hard and fairly massive. In thin section it is seen to consist largely of quartz and biotite. Muscovite is present in varying amounts. Orthoclase, albite, and graphic intergrowths of quartz and orthoclase are also present. The quartz crystals show an interlocking arrangement throughout, pointing to a recrystallization of the rock. Garnets are abundant locally and in places the rock resembles somewhat the typical garnet gneiss of the region.

The volcanic bands consist of a dense, hard rock which weathers to a light pinkish grey colour; freshly broken surfaces, however, are usually much darker. Small phenocrysts of feldspar and quartz can be observed in most hand specimens. Along the hanging-wall of the vein the rock is dark in colour and slightly schistose. In thin sections phenocrysts are locally abundant and in others are absent altogether. When present, they consist of quartz and feldspar, including both orthoclase and plagioclase. The latter in one section consisted largely of andesine with an average of 70 per cent albite. The quartz phenocrysts have rounded and corroded borders and nearly all are broken and exhibit undulating extinction. The groundmass is.....a fine-grained mixture of quartz and feldspar. Small flakes of both biotite and muscovite are numerous in some sections, the biotite being the more abundant. In specimens which have been more or less sheared considerable quantities of fine sericite occur concentrated to a large extent in narrow bands. Iron ore, carbonate, and chlorite are present in varying amounts in the sections.

One hundred feet east of the shaft-house is a band of dark rock 40 feet wide which cuts across an horizon of rhyolite and then follows its contact with a quartzite band to the west. The rock is dark in colour, is dense and massive, and locally contains small, red garnets. Since in its field relations it is a long, narrow band with approximately parallel sides cutting across a rhyolite band, it is classed as a dyke rock. In thin section the most

[1]Geol. Surv., Canada, Pub. No. 1763.
[2]Geol. Surv., Canada, Mem. 119, pp. 34-35 (1920).

prominent mineral is brown biotite, which is present in both large masses and small flakes .....Part of the biotite has altered into chlorite. Iron and apatite are present and a few long crystals of tourmaline. Carbonate is abundant. The finer-grained portion consists of feldspar with subordinate amounts of quartz. The feldspar is unstriated .....much of it is plagioclase of composition approximately 85 per cent albite.....

Another variety of lamprophyre intrudes the rhyolite and forms sills and dykes in the quartzite. In hand specimen the rock is dense and massive and of a dark greenish grey colour. In thin section much the most prominent mineral is a light green hornblende .....Brown biotite is common in most of the sections studied. The remainder of the rock consists of orthoclase, a little plagioclase, and a considerable amount of quartz .....This rock forms a number of dykes in the property and three narrow sills 300 feet north of the mill."

The Rex vein follows closely the contact between beds of massive arkose and conglomerate to the west and rhyolitic lava flows to the east. Quartz lenses are exposed fairly continuously for 1,800 feet along a strike of south 20 degrees west. In width the quartz varies from less than a foot to 7 feet, the average being nearly 3½ feet. The quartz bodies are bordered for most of this length by a narrow fringe of schist; only at a few points is quartz in contact with massive wall-rock. The dip of the schist zone and the quartz bodies is variable, the average being nearly 70 degrees east. At a point 500 feet south of the shaft, where a stope reaches the surface, the dip of the quartz is only 5 degrees east. Due to this flat dip the vein here appeared to be 15 feet wide. Several such rolls or abrupt changes in dip of the vein are reported in the underground workings. Small stringers of quartz are distributed along zones of quartz-sericite schist adjacent to the arkose-rhyolite contact for one-half mile south beyond the trench farthest south on the deposit. This suggests that the deposit is along a fairly long shear or fault zone. Some of the arkose and conglomerate beds continue a mile or more south, gradually thinning in this direction and fingering in between lava flows and beds of pyroclastic material.

The quartz of the Rex deposit is white and of medium grain. It carries a few small bunches of crystals and grains of white and brownish carbonate. Sulphides are not abundant. Arsenopyrite and pyrite are present in the quartz near the walls as individual crystals and granular aggregates. Free gold is abundant in a few specimens of quartz. Small needles of black tourmaline are abundant in narrow veinlets of quartz in schist adjacent to some of larger bodies. The relation of the gold-bearing quartz bodies to the lamprophyre dykes is not known and the age relation of the mica lamprophyre to the hornblende lamprophyre is also unknown, but the two lamprophyres are believed to be of about the same age and to be older than the gold-bearing quartz. At the Kiski and Northern Manitoba to the south, the quartz veins are later than the mica lamprophyre or quartz-mica diorite. A mica lamprophyre just north of the Rex shaft is cut by veinlets of quartz up to half an inch wide. These carry black tourmaline and biotite.

Little definite information is available regarding the geology along the underground workings. In a drift extending 400 feet north from the shaft on the 350-foot level, the vein is reported to be the full width of the drift. This suggests that the quartz lenses plunge northward, for, whereas on the surface a large quartz body lies 200 feet south of the shaft, the vein is very small north of the shaft. From the 250 to 350-foot level the vein

is reported to be more regular in dip and more nearly uniform in size than above the 100-foot horizon and at the surface. R. C. Wallace examined the workings above the 100-foot level and reports among other details as follows:[1]

"The hanging-wall is sheared while the foot-wall is as a rule frozen. Ore has been removed by overhead stoping both from the north and south drifts, the average widths of ore on the north stopes being 30 inches. The values are found in the fissures, more particularly near the hanging-wall. In the quartz there is considerable arsenopyrite, a little calcite, and here and there lenses of pyrite."

In 1924 a shipment of 142 pounds of Rex ore was tested at the Mines Branch Metallurgical Laboratory, Ottawa[2]. The assays of the samples received run from 0·90 to 1·096 ounces a ton in gold and 0·17 ounce a ton silver. The tests show a recovery of 85 per cent of the gold by amalgamation. The ore should be ground to 30 mesh for high recovery by amalgamation and the remaining gold of amalgamation tailing is easily recovered by cyanidation.

Bingo (*4*). At intervals between 1919 and 1927, an extensive program of surface prospecting, underground work, and diamond drilling was completed on the Bingo deposit. The main workings are on the Bingo mineral claim, lot 62, group 422, a small, irregular-shaped fraction. A number of surrounding mineral claims are included in the group. The most extensive developments of the deposit were carried out between 1922 and the end of 1924 by Bingo Mines, Limited. The foundations and frame of a large mill were completed during the summer of 1924, but the results of investigations of the deposit, made independently by two consulting engineers, proved that the ore developed was not of commercial grade; work was stopped and a series of court actions followed. Bingo Mines, Limited, was liquidated and the assets purchased by a new company, known as Bingo Gold Mines, Limited. At present the Northern Trust Company of Winnipeg represents the interests of shareholders in the property.

Following the closing of the court actions, the property was reopened in 1927, and a 10-ton mill was built to make mill-tests of the ore. Underground work had reached the 400-foot level and diamond drilling was done from the underground workings and from the surface of the mineral claims to the west and north of the Bingo fractional mineral claim. No work has been done on the property during the last 3 years. A good set of camps were built and these and the mining machinery are in good condition.

The bedrock exposed on the property comprises flows of evenly granular and porphyritic rhyolite, beds of arkose and conglomerate, and dykes of mica lamprophyre. The sediments and lavas are conformably interbedded, as on the Rex property to the south. The rhyolitic lava is schistose and a number of small zones of quartz-sericite schist in the rhyolite or along the contact between rhyolite and arkose, or between these rocks and mica lamprophyre, contain quartz stringers. The schistosity of the lavas and the bedding of the sediments trend nearly south 15 degrees west and the dip is vertical or steeply west. The general trend of the schist zones near the Bingo shaft is south 17 degrees west and their dip 80 degrees west.

[1] "Mining and Mineral Prospects in Northern Manitoba"; Northern Manitoba Bull. 1919, p. 33.
[2] Parsons, C. S.: "Investigations in Ore Dressing and Metallurgy, 1924," pp. 58-61.

Many long trenches and a few prospect pits in the overburden explore the Bingo veins, expecially in an area extending 300 feet south of the shaft. A large muskeg lies just north of the shaft. The clay walls of the trenches have now slumped and, therefore, little can be seen of what was found. Rhyolitic lava outcrops at a few points south of the shaft and narrow quartz veins and stringers are present along a series of narrow parallel schist zones in these rocks. Dykes of black, mica lamprophyre cut the lava 90 feet east of the shaft. The dykes are crooked and of irregular width. Apparently no large, continuous quartz vein was uncovered. The trenches and pits on the Bingo were examined by R. C. Wallace shortly after they were made and the surface showing is described as follows:[1]

".....four parallel veins have been stripped within a width of 60 feet. These veins are narrow, the main vein on which stripping and pitting has been done showing widths varying from 8 inches to 24 inches. This vein has unusually numerous showings of gold on the surface, with a fair amount of galena in narrow parallel fissures."

Bingo Mines, Limited, also did considerable surface work to explore schist zones carrying quartz veins on the LeRoy, Vanguard, Gold Eagle, Pine, and other mineral claims to the west and north of the Bingo fractional mineral claim. The quartz veins exposed on some of these mineral claims are larger than the veins at the locality where the underground work was done. The quartz bodies northwest of the Bingo are for the most part along depressions between ridges of rhyolite and arkose, and some of the trenches cut 20 feet or more of stratified clay and gravel before reaching bedrock. At 125 feet west of the No. 3 post of the Pine mineral claim, a zone of quartz-sericite schist, 12 feet wide, is exposed for 180 feet along the edge of a drift depression and throughout the schist are stringers of white quartz. At the main pit, in a breadth of 8 feet of schist, the total width of quartz is 3 feet. The quartz and schist carry some pyrite. A deposit on the line between the LeRoy and Vanguard mineral claims is exposed by trenching for 280 feet. Here a zone of greenish grey, quartz-sericite schist, from 2 to 8 feet in width, carries quartz stringers and cubes of pyrite. At 250 feet southeast of the No. 1 post of the LeRoy mineral claim, lot 9, group 422, a zone of quartz-sericite schist carrying stringers and narrow veins of white quartz is exposed for 100 feet along a strike of north 20 degrees east. Just north of the No. 1 post of the LeRoy mineral claim, six trenches have been dug through deep overburden to expose two schist zones. The walls of the trenches and pits have caved so that little can be seen. At the north end of the workings, the zone of schist, carrying quartz stringers, is 6 feet wide; it narrows northward in less than 100 feet to 1 foot. Some of the quartz at this locality is reported to carry free gold and to have been intersected in depth by one or two diamond drill holes located along the ridge to the west.

Little information is available regarding the geology along the underground workings on the Bingo veins. R. C. Wallace[2] described the work in progress in 1923 as follows:

"The shaft had reached a depth of 225 feet at the beginning of August, and sinking was to be continued to 400 feet. Approximately 310 feet of drifting has been done on the 200-foot level north and south of the shaft, and a crosscut has been run (50 feet) from the north drift, and another (80 feet) from the south drift, crosscutting on both sides of the drift. The underground work to date shows the vein on which the shaft was sunk and the parallel vein to the east, continuing downward in well-marked fissures.. On both walls in each vein considerable movement has taken place.....The quartz shows more

[1] "Mining and Mineral Prospects in Northern Manitoba"; Northern Manitoba Bull. 1919, p. 35.
[2] "The Pas Mineral Belt in 1923"; Can. Min. Jour., vol. 44, p. 758 (1923).

volume than at the surface, with considerable widening between the 50-foot and 100-foot depths, and carries a good deal of galena with pyrite. The country rock, which dips with the veins approximately 80 degrees east, is a sheared, fine-grained, acidic lava, well sheared on the foot-wall, and cut by numerous stringers of quartz. In the free gold showings in the vein-stuff, as for instance below the 200-foot level, the gold appears to be associated mainly with the galena, but is very clean and is presumably almost completely free milling."

The deposit was carefully studied by Mr. J. A. Reid in October and November, 1924, and the following information is extracted from Mr. Reid's report[1].

"All values of importance are confined to the veins, and, furthermore, the vein is only rich where it is narrow, 2 to 8 inches, and wider lenses are very low grade. The better values are concentrated around the shaft and diminish with distance therefrom.

Three hundred and sixty-seven channel samples were taken. In sampling the drifts, when possible the vein and country rock were sampled separately.....The channels were cut completely across the area exposed, including the part occupied by the drifts, and were divided into 5-foot sections. The channels in all cases averaged at least 3 inches wide and half an inch deep, and were made as even as possible, which was difficult in view of the splintery nature of the rock.

The samples were assayed by the Temiskaming Testing Laboratories at Cobalt, Ontario, an ore sampling plant and assay office operated by the Government of Ontario."

The results of the sampling are given as follows:

"100-foot level—The average value for the whole level over a distance of 606 feet is $2.20 over a width of 60 inches.

200-foot level—The average value of all the workings on this level exclusive of crosscuts, for the length of the level, a distance of 604 feet, is $1.57 over a width of 63 inches.

300-foot level—The average value for the whole level over a distance of 602 feet, the length of the drift, is $1.71 over 62 inches.

400-foot level—The average value of the workings on this level, exclusive of crosscuts, is $1.26 over 60 inches for the length of the drift, 622 feet.

The average of all drifts in the mine is $1.69 over an average width of 61 inches, that being over the total footage, 2,434 feet.

The average of the 203 north crosscut is 68 cents for the distance traversed, 59 feet, and the average of the 204 south crosscut is 64 cents for 80 feet. The average of the 400 south crosscut, 200 feet south of the shaft, is 96 cents over 54 feet, the distance traversed, including the face of the 402 south drift.

The best drift in the mine is the 102 drift, which averages $4.62 over its length, 206 feet. This drift has also the best patch of ore in the mine, namely 80 feet, from a point 55 feet south to 135 feet south it averages $8.87 over a width of 49 inches.....The country rock is far too low grade to be of any value, averaging as it does below $1.

In view of the results shown above it is obvious that the mine as developed does not contain a workable grade of ore. The vein itself undoubtedly carries gold, and in places assays quite high. The shoots, however, are small and scattered, and the values not sufficient in view of the narrow widths to allow it to be worked profitably."

In December, 1924, the property was again systematically sampled under the direction of Mr. J. A. Dresser, and the following is quoted from Mr. Dresser's report in the paper cited above:

".....In all, 884 feet of rock channels were cut and the material assayed in 305 samples.

No commercial ore was found. Gold occurs in numerous places in the property but was found in no place in quantity large enough to be profitably recovered.

.....The total length of drifts on each level as shown by the measurement of the sample sections is slightly more than 600 feet. The average width and value per ton where sampled are as follows:

	Width Inches	Value $ cts.
1st level	55·7	1.66
2nd "	56·7	1.15
3rd "	55·9	1.06
4th "	57·8	1.00
Mean total	56·5	1.22

[1] "Sampling of the Bingo Mine by Reid and Dresser"; Can. Min. Jour., vol. 46, p. 472 (1925).

The crosscuts show no significant values save where they disclose small quartz veins. The only one of these that is worthy of note appears in crosscuts 203 and 204 at a distance of 22 feet east of the foot-wall in the second level. Here a width of 7 inches gave values of $8 in the south crosscut, 204, and of $15.50 in the north crosscut, 203. The distance between these crosscuts is 200 feet."

In 1926 a 10-ton mill was built near the Bingo shaft under the direction of Professor E. R. Shorey, of the University of Wisconsin. It is reported that nearly 530 tons of ore taken from the different workings of the property was run through the mill. The average gold recovery from this ore was reported as $10.80 a ton. No information is available regarding the amount of waste cobbled from the material hoisted. Following this test, a contract was let to drill a number of holes to a depth of 1,000 feet vertically, starting from near the west side of the LeRoy mineral claim. The cores of this drilling are stored in one of the camps, and are in good shape for examination. No additional work has been done on the property since the drilling was completed.

Dauphin-Elizabeth (5). A gold-bearing quartz vein on the Dauphin and Elizabeth mineral claims, Nos. 66 and 67, respectively, of group 422, has been prospected by surface pits and a shaft 50 feet deep. The property is controlled by Pas Consolidated Mines and includes six mineral claims adjacent to the Dauphin and Elizabeth.

A variety of rocks are exposed near the Dauphin-Elizabeth vein. The most abundant type is a grey, rhyolitic lava showing fragmental phases and poorly developed pillow structure. Beds of conglomerate and arkose up to 20 feet thick are interlayered with the rhyolitic lava. The lava and sediments are cut by small, irregular masses of granite porphyry and dykes of mica lamprophyre. All the rocks examined are slightly schistose. The mica lamprophyre in thin section shows the same texture and minerals as the rocks of similar dykes near the Rex and Kiski veins.

The quartz vein on the Dauphin-Elizabeth property is exposed at intervals for 800 feet along a strike of north 35 degrees east. The dip is from 80 degrees east to vertical. The wall-rock is schistose rhyolite, the schistose zone varying in width from 1 foot to 12 feet. Throughout the length of the deposit the vein is continuous. At the south prospect pits it is 3 feet wide, at other points it is 5 feet wide, and at others less than a foot. The average width, perhaps, is nearly 2½ feet. The quartz is white and carries small quantities of pyrite, arsenopyrite, chalcopyrite, and galena. Some of the quartz carries particles of free gold.

McCafferty (6). The McCafferty property may be reached by a trail about 2 miles long, from the east shore of the northeast bay of Wekusko lake. The trail commences at a camping site about 1,000 feet north of the farthest north island in the bay and just south of the narrows leading north to Crowduck bay. Among the mineral claims of the group are the Prince Edward, King George, Lawson, and Palmer, Nos. 57, 58, 59, and 60, respectively, of group 422. The work on the group has been done on the King George mineral claim and consists of numerous trenches and a shaft, near the south end of a deposit 27 feet deep, and a second shaft 90 feet deep, 250 feet northeast of the south shaft. About 75 feet of drifting has been done at the 90-foot horizon in the northern shaft, this shaft is about midway between the north and south ends of the exposed schist zone

carrying the quartz bodies. This work is reported to have been financed by directors of the Bingo Gold Mining Company. In the summer of 1930, Consolidated Mining and Smelting Company held a sampling option on the deposit and did considerable more trenching, thereby uncovering the quartz for 200 or more feet north from where it had been previously uncovered. The option was dropped in the autumn of 1930.

The country surrounding the McCafferty deposit is a nearly flat brûlé area with scattered outcrops. The bedrock exposed is interpreted as being rhyolitic and dacitic lavas. They are grey to greenish grey and of much finer average grain than the lavas near the Rex deposit. The rock of most outcrops is slightly schistose, and of some it is very fine grained. Some pinkish-weathering outcrops have the appearance of a slightly schistose aplitic granite. The rock of other outcrops is dark grey and of medium grain, and in these crystals and grains of quartz, feldspar, and biotite are recognizable on the weathered surface. A thin section of a specimen from an outcrop of grey, supposedly rhyolitic lava of medium grain exhibits subangular to angular grains of quartz, oligoclase, orthoclase, biotite, calcite, and magnetite. The minerals are fresh or only slightly changed to chloritic and kaolinitic materials. Except for minor variations in colour and texture, the rock exposed appears to be uniform, hence the general structure of the formations surrounding the deposit could not be readily determined. No sign of pillow or brecciated structures was noted in the outcrops studied. At nearly 2,800 feet along the trail west from the main shaft, the grey, apparently structureless, volcanic rocks are followed to the west by dark grey, fine-grained, bedded quartz-mica gneiss carrying small red garnets. A quarter of a mile farther west along the trail, the quartz mica gneiss is intruded by a sill-shaped mass of granite about 550 feet wide. At the main shaft, the rhyolitic rock is intruded by an irregular-shaped, branching body of mica lamprophyre 15 feet across at the widest point.

The quartz lenses of the McCafferty deposit are exposed fairly continuously for 1,000 feet along a strike of north 31 degrees east. Their dip is 76 degrees east. The zone of chloritic and sericitic schist containing the quartz varies in width from 1 foot to 15 feet. The southern quartz body, exposed north and south of the south shaft, is 125 feet long, and from 9 inches to 3 feet in width. The largest quartz body exposed is 450 feet long. It pinches and swells within 5 feet along the strike from widths of 8 inches to 5 feet, the average size being nearly 3¼ feet. The northern shaft is near the south end of this quartz mass, which here is between mica lamprophyre as a foot-wall and quartz-sericite schist derived from the rhyolitic lava as a hanging-wall. To the north two other quartz lenses are exposed at a few points by deep trenching along the projected strike of the schist zone.

The quartz is white and of medium grain. Pyrite, arsenopyrite, chalcopyrite, and galena are only sparingly present in most specimens. Galena was noted to be most abundant near the northern shaft, in the vicinity of the lamprophyre dyke, and here the gold content is reported to be higher than elsewhere. Free gold is abundant along some cracks in the quartz; others with slickensided surfaces carry only granular pyrite. The quartz along the drift on the 90-foot level is reported to be from 4 to 5 feet wide and in it free gold is said to be fairly abundant. Judging

from the abundant mica lamprophyre on the rock dump, the underground workings were mostly in this rock. It is chloritic and carries crystals of pyrite and arsenopyrite, and needles of black tourmaline. So far as could be determined, both the sulphide and gold mineralization are localized to small areas along the margin of the large quartz bodies, and for this reason average assay results of the whole mass are likely to be disappointingly low.

Deposits East of Paterson Lake (7). A half dozen or more gold-bearing quartz veins are known in an area east of Paterson lake and from 2½ to 3¾ miles northeast of the Rex. They can be reached by a trail leading from the Bingo camps and passing by the northeast corner of the Ballard and the southeast corner of the Trapper mineral claims, Nos. 7 and 8, respectively, of group 422. By trail from this point, it is about 3¼ miles east and north to the Rainbow or farthest east deposit of the group to be described. The trail crosses several muskegs that are wet during the early summer or late autumn months. Another trail to the properties leads directly east from a small bay on the east shore of Wekusko lake, just north of Durand island, northwest from the Rex mill. Five of the deposits were examined, these are the Rainbow, Ferro, Pocahontas, Paterson, and Orcadian. The Rainbow deposit is on the Lingo and Rainbow surveyed mineral claims, Nos. 216 and 217, respectively, of group 422, and the Ferro is on No. 218 of group 422. The three other deposits are on unsurveyed mineral claims. The Rainbow is at the northeast end and the Orcadian at the southwest end of the group visited. A number of other gold-bearing quartz bodies are known in this locality.

The bedrock exposed in the vicinity of the gold-bearing quartz veins is a black, fine-grained, andesite lava showing pillow structure at a few points. Lumps of green epidote are present in some of the lava. Small grains of quartz, needles of greenish black hornblende or actinolite, and phenocrysts of feldspar are recognizable on the weathered surfaces of some outcrops. The black lava in some localities is massive and in others is schistose, the strike of the schistosity being north 20 degrees east and the dip from vertical to 75 degrees east.

The andesite on the Orcadian mineral claim and on the Wizard adjoining it to the southeast, is cut by dyke-like masses of granite porphyry, exposed at intervals for 550 feet along a trend of north 40 degrees west. The porphyry is not well exposed, but apparently there are two or more, separate, small masses varying in width from 4 to 11 feet or more. The more massive outcrops are pinkish and carry oval phenocrysts of quartz. The porphyry is schistose in the prospect trenches and is cut by veinlets of quartz carrying chalcopyrite and magnetite. No dykes of black lamprophyre were recognized cutting the andesite, although along the trail 3,000 feet west of the Orcadian, lamprophyre dykes cut rhyolitic and dacitic lavas that border the andesite on the west and form the outcrops from there along the trail to the Bingo camp.

Rainbow. The work on this deposit has been done along a schist zone in andesite. The strike of the zone is south 23 degrees west and the dip from 70 to 80 degrees east. The deposit has been stripped for 1,800 feet along the strike by trenches and pits spaced at intervals of about 50 feet. For lengths of 200 feet the thin mantle of overburden has been completely

stripped from the zone of schistose rock. Little work has been done on the property since 1924-5. No information is available regarding the ownership of the group, although it is reported the deposit was prospected under the direction of officials of the Rex.

The zone of schistose andesite and chloritic schist carrying the quartz varies from 1 foot to 18 feet in width, the average being about 4 feet. The quartz is distributed as stringers, lenses, and narrow veins. No wide, well-defined vein is exposed. At a deep pit near the south end of the deposit, the chlorite schist is 10 feet wide and veinlets of white quartz are estimated to form about a quarter of the area exposed. Near the north end of the workings, a number of quartz veins a foot or thereabout in width and 200 to 300 feet long are exposed. The quartz is white, fine to medium grained, and only sparsely mineralized with pyrite and arsenopyrite. Free gold has been found in some of the quartz.

Ferro. The northeast deposit on this mineral claim is about one-quarter mile southwest of the Rainbow. Here, four small schist zones containing quartz have been prospected. Two of these are near the northeast side and two are near the southwest side of the claim. The two deposits farthest northeast are exposed at the foot of a hill just south of the margin of a muskeg to the north. The easterly of the two is exposed 30 feet along the strike, passing under swamp to the north and to the south into jointed andesite carrying quartz stringers. The schist zone is up to 7 feet wide, and there is about 3 feet of quartz. The strike of the deposit is south 30 degrees west and the dip 80 degrees east. The quartz is white to reddish weathering and carries some pyrite and chalcopyrite.

The second of the two northerly deposits is 135 feet west of the one described above, and the two are parallel in strike. The deposit has been stripped for 25 feet along the strike. The schist zone is 11 feet wide where it passes under muskeg to the north. Quartz and schist are about equally abundant in the exposed sections. The quartz carries grains of sulphides and some free gold. The quantity of quartz decreases southward. A partly drift-filled, narrow depression between steep-walled ridges of andesite continues to the southwest for 370 feet from the outcrop of the deposit.

The second group of two deposits on the Ferro mineral claim, along which some work has been done, is 800 feet southwest of the last deposit described, but the deposits are not along the projected southwest strike of the northern two parallel schist zones. The eastern of the two southern deposits is a quartz vein 350 feet long and averaging 9 inches in width. The schist zone is from 1 foot to 3 feet wide. The white quartz carries free gold at a few points. The second deposit is a vein, 55 feet to the west, and is exposed at intervals for 425 feet along the strike. The schist zone is up to 6 feet wide and the quartz vein up to 14 inches thick.

Other small quartz lenses are exposed on the property, but on them little work has been done. A number of the small veins were sampled in September, 1930, by the Consolidated Mining and Smelting Company.

Pocahontas. This deposit is about one-eighth of a mile southwest of the Ferro. A schist zone in andesite, up to 12 feet wide and exposed for 200 feet along the strike, carries white quartz. At the south end the quartz body and schist zone pass under a swamp. The strike of the

deposit is south 17 degrees west and the dip 85 degrees east. At the north end, the quartz is in two stringers, 2 and 4 inches wide, respectively. To the south, 20 feet, these unite and the vein is here 14 inches wide. At the south exposure the quartz is 3½ feet wide. The quartz is coarse-grained and carries a few grains of pyrite along the margins. No free gold was seen in the quartz, although some has been reported to have been found at the time the prospecting work was done.

Orcadian. Two schist zones carrying some quartz are exposed on the Orcadian mineral claim owned by Mr. John Dickson. While stripping the northern of the two zones, a block of quartz carrying abundant free gold was found, but the source of this quartz has not yet been discovered. The northern zone is just north of a body of granite porphyry. The trenches on the southern zone cross quartz-sericite and chloritic schist developed along the granite porphyry-andesite contact. This schist zone is exposed for a length of 80 feet and varies in width from 2 to 8 feet. In it quartz occurs in lenses and stringers; pyrite, chalcopyrite, and calcite are present in the schist and in the quartz. At the north workings 225 feet to the north of the south deposit, mica-chlorite schist with quartz veinlets is exposed 90 feet along the strike and across widths up to 10 feet. To the north this zone passes under drift and swamp. One quartz vein is 2 feet wide in the trench farthest north. Most of the quartz is distributed in stringers. Veinlets of calcite and grains and crystals of pyrite occur in the schist. Some trenching has been done on the Wizard mineral claim adjoining the Orcadian to the southeast. Here, the overburden of stratified clay carrying granite boulders is thick. The prospect trenches expose granite porphyry in contact with schistose andesite, but no promising quartz vein was uncovered.

Paterson. This deposit is one-quarter mile northeast of the Orcadian. The deposit was discovered and prospected by Mr. Andy Paterson and associates. It is exposed by trenching for 350 feet along a strike of south 16 degrees west. The dip is 70 degrees east. The schist zone passes under swamp at both the north and south ends; only a little quartz is present at these points. The wall-rock is black andesite. For 100 feet from the north end, the zone of schistose andesite averages 4 feet across and carries only stringers of quartz. Twenty feet farther south, just north of a big prospect pit, the quartz is 4 feet wide and a quartz vein 1½ feet wide branches to the west nearly at right angles to the main deposit. Free gold is abundant in the branch vein at and just beyond its junction with the main quartz body. The quartz here carries cubes of pyrite and in specimens from which the pyrite is weathered, free gold is abundant along the walls of the rusty-coated cavities. For 50 feet south from the large prospect pit, the quartz veins average 3½ feet in width. The schist zone continues 180 feet farther south, but in this section the quartz is in stringers only.

Apex (8). The Apex group was staked in 1918 by Mr. Paul Gasse and associates. The group includes the Apex, Dawson, Victoria, Discovery, Pine Ridge, and other adjoining unsurveyed mineral claims. The main worki gs are along the line between the Apex and Dawson mineral claims. Some work has been done on four other small deposits on the group situated from 1,500 to 4,500 feet southeast of the main deposit. Preliminary sampling of the main deposit was done by Mr. J. A. Reid prior to 1925.

This work indicated that possibly there was present a large tonnage of gold ore averaging $2 or thereabouts a ton. In the early summer of 1930, the deposit was stripped and thoroughly sampled by the Consolidated Mining and Smelting Company under the direction of Mr. Wm. J. Dean. In all over 540 channel samples were cut. The property is held by the Mammoth Mining Company.

The prospect trenches on the Apex group expose grey and pink granodiorite and granite. These rocks weather light to dark grey and pinkish and the surface of some outcrops is slightly rough due to numerous, projecting, subangular grains of dark quartz up to one-eighth inch in diameter. Crystals of grey feldspar, flakes of black biotite, and specks of white arsenopyrite are recognizable in most specimens of the grey phase of the granite from near the prospect pits. The grey granite is of medium to coarse grain, whereas the pinkish rock is either fine grained or coarse pegmatitic in texture. The grey and pink types of granite are intermixed. Near the main deposit, the grey and pink granite form part of the same outcrop with no apparent sharp line of division between the two types. To the east and southeast of the deposit, however, pink granite is the abundant type for at least half a mile.

The following is the approximate mineral content by area of specimens of the granite as determined from measurements of thin sections, using a Wentworth micrometer:

—	74	75
Quartz	25·7	18·6
Plagioclase	26·4 (Ab 75 about)	43·1 (Ab 70 about)
Orthoclase	23·8	13·9
Microperthite	3·2	....
Hornblende	15·8	3·7
Biotite	4·2	14·1
Calcite	....	4·3
Arsenopyrite	....	0·6
Accessories	0·8	1·1
	99·9	99·4

No. 74. Pink granite from south end of outcrop of main deposit.
No. 75. Grey granite or granodiorite from north end of same outcrop.

In thin section the minerals are fresh or only slightly altered. Biotite and chloritic materials are present along the cleavage lines of some of the hornblende. The biotite is highly pleochroic in brown shades. Some of the plagioclase is zonally grown. A few grains of feldspar in No. 74 shows the microcline grating structure and this has been included with orthoclase in the table of mineral percentages. No microcline was recognized in No. 75. Some of the plagioclase crystals contain bits of epidote, zoisite, calcite, white mica, quartz, and biotite.

The main deposit is just east of the west margin of the granite body. Long, narrow, included masses of black schist, probably originally andesite or quartz gabbro, are exposed in trenches of the group exposing the northwest section of the deposit. Round fragments of this black rock from ½ to 4 inches in diameter give some of the rock at this locality the appearance of an orbicular granite. From 300 to 700 feet northwest of the deposit, included blocks of quartz gabbro are abundant in the granite. An out-

crop 400 feet northwest of the north end of the deposit is estimated to be one-tenth quartz gabbro in angular blocks, many of which are 2 feet or more long and 1 foot wide. Some of the quartz gabbro blocks are up to 50 feet long. In some outcrops of the granite a few blocks of black lava and garnet-bearing gneiss are also present with quartz gabbro. Granite carrying blocks of quartz gabbro and schist is exposed along the trail leading west from the deposit to the camps at the sandy beach on the lake. The zone wherein inclusions are abundant is from 1,000 to 2,000 feet wide and is followed to the northwest by quartz gabbro cut by dykes of granite. The fairly wide contact zone between the granite and quartz gabbro suggests that the granite contact dips northwest at a low angle, perhaps nearly 40 degrees. At 4,500 feet north of the deposit, a band of lava and sedimentary gneiss, nearly 1,000 feet wide, lies between the quartz gabbro on the west and granite on the east.

The numerous prospect trenches expose granite that has been jointed to an unusual degree. The rock between some of the joint planes has been altered in part to a quartz-sericite schist, and much of the granite or granodiorite exposed by the prospect trenches is slightly schistose. The jointed and slightly schistose granite is cut by quartz veinlets following joint planes and also carries small lenses of quartz and grains of arsenopyrite. Pyrite and chalcopyrite are sparingly present in some of the altered granite. The strike of the more prominent, more persistent joints varies, but in general lies between north 45 degrees east and south 45 degrees east. The dip of the more prominent joints is in most cases northerly and the angle 30 to 50 degrees. In places the granite is crossed by a series of parallel joint planes spaced at intervals of from 4 to 18 inches, thus giving the rock a platy or bedded appearance.

No large and continuous quartz body is exposed in the trenches, for, as already stated, the quartz occurs in stringers. These vary in thickness from ½ to 4 inches, but one, at the 12-foot shaft, is 18 inches wide at one point. In a few trenches a number of closely spaced quartz stringers are exposed and narrow widths of some such zones assay from $8 to $25 in gold a ton. Some of this quartz carries free gold. No large, continuous body of ore of this grade, however, is present. The usual condition is that along a trench one sample across 2 or 3 feet may assay $8 or $10 in gold a ton, whereas 5 feet along the projected strike in either direction the rock carries less than $1 in gold a ton. Furthermore, samples from each side of the commercial grade material will show only a trace, or a dollar or so in gold a ton. A channel sample from almost any of the trenches exposing slightly altered granite containing vein quartz and grains of sulphides, will assay some gold. The outline of the areas of jointed and altered granite carrying an unusually high content of vein quartz and sulphides is roughly indicated on Figure 7. The average gold content of these large bodies is perhaps slightly over $2 a ton. Over half the gold apparently is carried in the arsenopyrite. No information is available regarding the continuation in depth of the body of jointed, altered, and mineralized granite. It may follow the dip of the joint planes, and, if so, the dip would be from 40 to 50 degrees northwest. If the deposit is workable commercially, the operations will have to be on a large scale. Such operations can not be undertaken to advantage until cheap electric power and better transportation facilities are provided.

The four small deposits southeast of the main Apex workings are along shear zones in granite. The first of these deposits, crossed on the trail at 1,500 feet south of the main workings, is exposed for 80 feet along the strike. At one point the quartz vein is 26 inches wide. The deposit strikes south 20 degrees west and dips 45 degrees west. Fragments of granite and of quartz-sericite schist derived from granite lie in the white quartz, which is only sparingly mineralized with arsenopyrite and chalcopyrite.

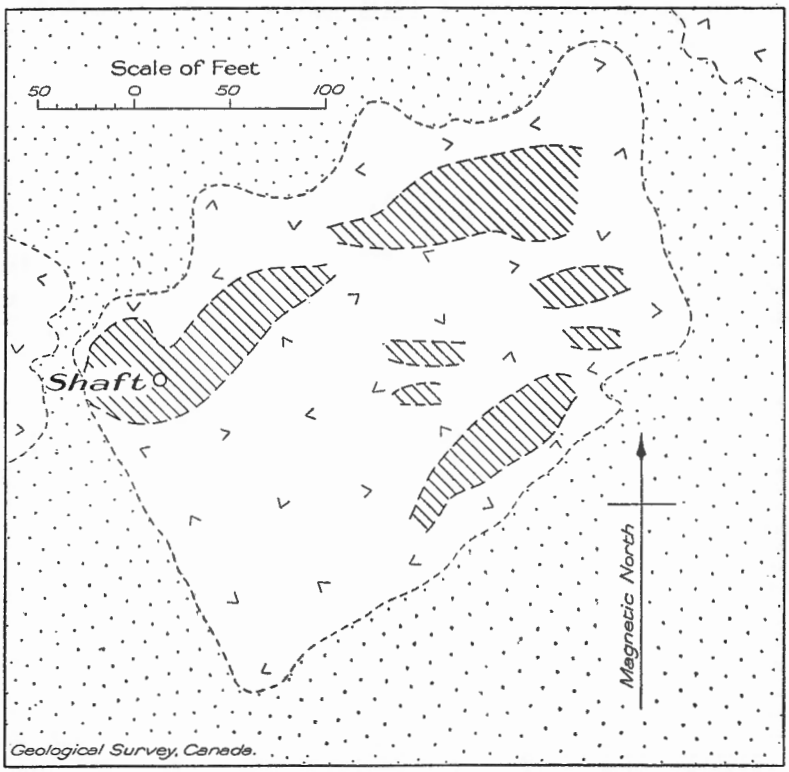

Figure 7. Plan of Apex gold deposit, Wekusko Lake area, Manitoba, showing positions of more highly jointed, schistified, and mineralized areas (pattern of ruling) within granite outcrop (pattern of angles). Drift is shown by a pattern of dots.

At the second locality, 500 feet farther south along the trail, several large pits expose two, closely situated, jointed and slightly schistified zones in granite carrying quartz stringers and sulphides. The largest quartz vein here is a foot across and extends only 10 feet along the strike. The granite weathers rusty and fresh specimens carry small grains of pyrite and arsenopyrite. The trend of the two rusty zones of schistose granite is south 40 degrees west.

The third deposit, 750 feet southeast of the second, is exposed for 175 feet along a strike of south 20 degrees west. The schist zone here is 4 feet thick at one point, the average width being about 18 inches. The

dip of the deposit is 75 degrees west. Quartz is distributed through the quartz-sericite schist derived from the granite, in parallel lenticular stringers and veinlets from 1 inch to 3 or 4 inches wide. Free gold is present in some of the quartz. A shaft has been sunk 12 feet on the deposit.

The fourth deposit is 2,000 feet southeast of the third. It has been trenched for 230 feet along the strike, which is south 5 degrees west. The deposit dips 75 degrees west. The quartz vein is lenticular, averaging 11 inches in width and widening at one point to 3 feet. The wide sections of the vein are bordered by massive granite. Where the schist zone is narrow, it contains only stringers of quartz. The quartz is partly white, partly dark grey; the dark quartz carries specks of arsenopyrite, chalcopyrite, and free gold.

Dion (9). Mr. Dion and associates have done some trenching to explore three deposits of gold-bearing quartz on a group of mineral claims on top of the hill west of the south end of the narrows from Wekusko lake to Crowduck bay. The bedrock in the vicinity of the prospect is grey granodiorite with areas of pinkish granite. The granitic rocks are schistified and some of the schistose areas contain specks of arsenopyrite and veins and stringers of gold-bearing quartz. These deposits are near the east side of the granite body that extends west to the Apex deposit. To the east greywacke and other quartzose sediments outcrop at the lake shore and inland for from 200 to 800 feet.

One deposit has been exposed by trenching for about 400 feet along a strike of south 25 degrees west. This schistose zone is 6 feet wide in one pit. Quartz veins and stringers are distributed throughout the schistose granite, and both the quartz and schist contain some arsenopyrite. The deposit dips 75 degrees east. Some sections of the schistose rock and quartz are reported to assay $10 or more in gold a ton, and specimens assay much higher. About 400 feet west of this deposit another area of slightly schistose granite is mineralized with veinlets of quartz and specks of arsenopyrite. This zone is up to 20 feet wide, but has not been followed along the strike. The average gold content is reported to be low. A shallow shaft has been sunk along a vein northeast of the first deposit described. The quartz is 33 inches wide at the shaft. Schistose granite and quartz have been traced 300 feet north and 30 feet south of the shaft. Some sheared granite adjoining the quartz veinlets is silicified and contains arsenopyrite. Some quartz carries free gold and flakes of molybdenite. The free gold appears to be distributed in the quartz near the molybdenite.

Wekusko (10). Wekusko Mines, Limited, did trenching to expose deposits of gold-bearing quartz at two localities, respectively, 4,000 and 5,000 feet east by trail from the south set of cabins on Broad bay, Wekusko lake. The main workings are on the Royal mineral claim, No. 136, group 422.

The bedrock exposed near the prospect workings is grey granite. Quartz-mica gneiss outcrops 200 feet northeast of the east workings. This rock is highly altered and injected with granite. Originally it perhaps was a quartzose sediment. The granite is partly massive, partly slightly foliated. It is grey to pinkish weathering and is of medium grain. The trenches cross zones within the granite that are more highly foliated than the average rock, and the foliated, slightly schistose zones carry quartz stringers. The granite is traversed by joints striking north 55 degrees

east and north 80 degrees east. The quartz-bearing, foliated zones trend south 10 degrees east and south 35 degrees east. No large quartz vein was seen on the property. At the west locality, where a shaft has been sunk, the foliated zone carrying quartz stringers is 4½ feet wide. This zone has been exposed by trenching for 800 feet along its strike. The quartz is reported to carry free gold. Some of the white quartz and schistose grey granite contains grains of pyrite and arsenopyrite.

Lucky Jack (11). This property is reported to be controlled by the Sask-Mani Precious Metals Mining Company. The deposit is in granite, probably a part of the same mass extending northward from the Wekusko deposit some 4,000 feet to the southeast. The surface work is reported to have been done previous to 1926, and the main workings are on the Lucky Jack mineral claim.

The prospect pits expose granite crossed by a band of chloritic schist. The black chloritic schist band is about 2 feet wide and is exposed for 100 feet along a strike of south 40 degrees east. This narrow mass of chloritic schist may be an inclusion of older volcanic rock in the granite. The granite is medium grained and weathers pinkish. It is crossed by joint planes and quartz veinlets from one-quarter to one-half inch wide. The quartz veinlets trend in various directions and are not continuous nor closely enough spaced to make the whole mass ore even if individual veinlets were high grade. Some of the quartz is pegmatitic and contains flakes of muscovite and biotite up to three-quarters inch across. Pyrite, some of which tarnishes with a copper stain, is fairly abundant in some of the quartz. The prospect shaft, at 220 feet north of No. 5 post of lot 418 and No. 3 posts of lots 419 and 420, was sunk near the northwest end of the mass of dark schist. Here, stringers and lenses of quartz are more numerous than elsewhere and the quartz-bearing zone is 4 feet wide. This zone did not appear to continue with this size for over 12 feet northwest of the shaft.

Taylor (12). The Taylor, Joe, and adjoining mineral claims of this group are reported to be controlled by the Sask-Mani Precious Metals Company of Saskatoon. The bedrock in the vicinity of the prospect pits is granite with inclusions of andesite. From the No. 1 post of lot 199, group 422, a schistose zone has been traced at intervals for about 540 feet along a strike of south 20 degrees east. At the mineral claim post, the zone is 3 feet wide and the quartz in it 2 feet wide. A large muskeg covers the deposit along its continuation to the north. At 200 feet south of the mineral claim post one body of quartz is 3½ feet wide for a length of 90 feet. The schistose zone here is 14 feet wide. Small fragments of granite are abundant in some of the quartz. The outlines of the quartz bodies are irregular. To the south the schistose zone becomes narrower and the quartz lenses become smaller and more widely spaced. Some of the quartz bodies are along the contact between black chloritic schist and schistose granite. The quartz is finely crystalline and contains some pyrite, chalcopyrite, and galena. A few small vugs in the quartz have calcite crystals on their walls. The average gold content of the deposit is unknown.

Perras (13). In 1928, Mr. C. R. Perras and associates staked a group of mineral claims north of Snow lake, just east of the narrows joining the bays forming the east and west ends, respectively, of the lake. Snow lake may be reached by canoe from Wekusko lake, by following Snow river.

Parres?

At a time of high water the canoe trip takes about 6 hours, there being five short portages along Snow river. A small cabin has been built on the north shore of Snow lake at a point about midway between the east and west sides of the group.

Bedrock is exposed at only a few points on the Perras group of mineral claims, boulder clay and gravel being widespread. A fragmental rock, apparently a brecciated acidic lava, outcrops on the islets in front of the cabin and 100 feet from the north shore of the lake. On the mainland, about 300 feet east of the cabin, an acidic, gneissic rock with no sign of bedding or other structural features to indicate its origin, outcrops at the water's edge. A few small masses of quartz-mica gneiss, some with staurolite crystals up to 1 inch in length, are exposed at intervals along the north shore of Snow lake for 3 miles west of the cabin. About 200 feet along the trail leading north from the cabin, greywacke-like schist outcrops to the west, and 800 feet farther north there are a number of outcrops of a black, medium to coarse-grained, basic rock. Thin sections of this rock show it to be mainly amphibole and biotite; accompanied by very small amounts of oligoclase (Ab 75), quartz, tourmaline, calcite, and magnetite. The amphibole is highly pleochroic in yellowish to bluish green shades; some of it is common hornblende, some actinolite and uralite. The biotite is brown and highly pleochroic. The minerals are for the most part unaltered and show no evidence of having been deformed. The rock has not completely lost its igneous structure. In outcrop the rocks have the appearance of being slightly schistose, coarse-grained gabbro unusually rich in ferromagnesian minerals. The original minerals have in large part been recrystallized under conditions favourable for the deposition of tourmaline. The shape of the body of basic rock on the Perras mineral claims is unknown, it is at least 900 feet wide from north to south along the mineral claim line extending north from the cabin, and outcrops were noted in an area from 200 to 900 feet wide, extending from a point 400 feet west of the cabin north for 1,000 feet and from there eastward for another 1,000 feet.

Prospecting has been done at two localities on the Perras group, namely at points 400 feet northwest and 1,200 feet northeast, respectively, of the cabin. The trenches expose chloritic and sericitic schists carrying quartz. In both cases the schist zones are adjacent to outcrops of the basic, gabbro-like rock. The moss has been stripped off several small outcrops 100 feet or thereabouts east of the trenches northwest of the cabin, and there chloritic schist is cut by small dykes and lenses of granite. Small needles of black tourmaline are an accessory constituent of some of this granite, and perhaps the tourmaline was added to the nearby gabbro-like rock by solutions emanating from the tourmaline-bearing granite magma. At the locality northwest of the cabin the trenching exposes an area of schist 320 feet long and up to 16 feet wide. The schist is folded into several drag-folds. The average trend of the mass is south 40 degrees west and the dip nearly 70 degrees southeast. Small areas of black, slightly porphyritic, fragmental rock, perhaps representing the brecciated top of a lava flow, are exposed in the trenches. Small areas of quartz-sericite schist are considered to represent sheared granite. The quartz is in irregular masses and lenses cutting all the varieties of rock present in the schistose area. The quartz bodies are discontinuous, a quartz mass 8 feet wide in a trench near the southerly end of the working being represented only by

a series of stringers in trenches 25 feet on either side along the strike. The quartz is of exceptionally fine grain and has more the appearance of white and dark chert or flint, except that no sign of lamination is present. A thin section shows areas of subangular quartz grains of about 0·05 millimetre diameter surrounded or veined by angular grains of nearly 0·15 millimetre across. The accessory minerals are small bits of biotite, magnetite, pyrite, and red iron oxide. No free gold was seen in the quartz on the dumps, nor is any information available regarding the average gold content indicated by assays.

At the locality northeast of the cabin, the drift is thin and prospect pits expose both dark flinty and white quartz similar to that in the pits described above. The quartz is in a grey, quartz-chlorite-sericite schist just south of outcrops of the gabbro-like rock. The trend of the schistose zone is south 25 degrees west and it is exposed for a length of 110 feet and across widths varying from 2 to 12 feet. In one trench the dark flinty quartz is jointed and crossed by veinlets of white quartz. In this trench white quartz is estimated to form one-third of the rock across a width of 10 feet. No free gold was seen in the quartz which carries small bits of pyrite, arsenopyrite, and chalcopyrite. A number of pits extending at intervals for 300 feet to the east and 400 feet to the southeast, expose schistose acidic rock carrying stringers and lenses of quartz. No definite vein or single large body of quartz has been uncovered in the workings on the property. The quartz on this property is markedly different in appearance from the characteristic gold-bearing quartz of the district.

Gold Hill (14). In the early spring of 1930, free gold was discovered in quartz about one-quarter mile south from a point on Snow river just east of the second portage east of Snow lake. The Gold Hill group of a dozen or more mineral claims was staked at once by Mr. Charlie Stayback and associates.

At this locality rock outcrops are scarce along Snow river, although from 700 to 950 feet to the south the rocks are well exposed along the north side and top of a ridge trending nearly east and west. The rock here is a grey to black, medium-grained, quartz-mica gneiss. Bedding is still recognizable in some parts of the outcrop. Small crystals of red garnet, staurolite, and andalusite, spindle-shaped bits of quartz, and large flakes of black biotite are conspicuous on the weathered surface of some beds. Layers of a dark, hornblende-bearing gneiss are developed about 700 feet south of the top of the ridge. The trend of the foliation of these rocks is north 85 degrees west and their dip 45 degrees north.

Two small quartz bodies have been opened up by prospect pits, one at the northwest corner of Gold Hill No. 2 and the other near the northeast corner of Gold Hill No. 1. The deposit on Gold Hill No. 2 trends south 45 degrees east and is exposed 250 feet along its strike. At one place the quartz is 12 feet wide; throughout most of the length the quartz is in lenses and stringers a few inches wide and a few feet long. The deposit is irregular in detail of outline and trend. Free gold is present in some of the quartz, which is a white, vitreous variety without sulphides.

The second quartz body is 450 feet southwest of the northeast corner of the Gold Hill No. 1 mineral claim. Here, the quartz follows a jointed zone trending north 30 degrees east or nearly at right angles to the strike

of the deposit described above. For 12 feet from the south end the quartz averages 2½ feet in width and for 60 feet farther the width averages 4 inches. This deposit, and the deposit on the Gold Hill No. 2, follow jointed and schistified zones of irregular width zigzagging across the beds of quartz-mica gneiss. Prospect pits about 300 feet south of the southwest end of the last quartz body described expose a slightly schistose bed of dark, hornblende-rich gneiss carrying considerable pyrrhotite.

Sask-Mani. The Sask-Mani Precious Metals Mining Company controls a group of mineral claims along the west shore of the northeast arm of Herblet lake. In 1926, a small mill was built near the lake shore, and it is reported that 30 tons of ore were milled, returning $11.60 in gold a ton. The surface work comprises trenching, prospect pits, a vertical shaft 50 feet deep, and an inclined shaft from 30 to 40 feet deep.

The bedrock is quartz-biotite and quartz-hornblende gneiss faintly bedded and considered to be a recrystallized sediment. About 550 feet west from the west showing, granite outcrops along the east side of a hill and this rock apparently is the country rock for a considerable distance to the west. The sedimentary gneiss is cut by small dykes of pegmatite and of aplite. The foliation and bedding of the gneiss are parallel, strike north 5 degrees east, and dip 45 degrees east. No red garnets were seen in the sedimentary gneiss at this locality.

Workings on the hill back of the mill and about 150 feet from the lake shore, expose a slightly sheared and jointed mica gneiss carrying stringers of quartz, pegmatite, and aplite, and forming a zone exposed for 450 feet along a strike of north 8 degrees east and across widths of from 3 to 18 feet. The dip of the gneiss is 45 degrees east. No large quartz body is present, the quartz being distributed in veinlets from ¼ inch to 2 inches thick, and in small lenses. Some of the gneiss is crossed by parallel joint planes carrying quartz veinlets. The quartz is in part localized to thin beds of black amphibole gneiss lying between thicker, more massive and jointed gneiss. A section at the top of the inclined shaft at a point about midway between the north and south ends of the deposit, shows, commencing at the foot-wall: a seam of gouge-like material 9 inches thick; 3 feet of mica gneiss cut by a few quartz lenses and stringers not over ¼ inch thick; 15 inches of jointed mica gneiss carrying veinlets and lenses of quartz up to ½ inch thick; and a veinlet of quartz 2 inches thick next the hanging-wall of quartz-mica gneiss. The narrow quartz vein next the hanging-wall is reported to carry the gold. Crystals and grains of pyrite are abundant in some of the gneiss and also in a few of the quartz stringers.

A second locality where surface work has been done is 300 feet west of a vertical shaft near the south end of the deposit already described. Here gneiss carrying veinlets of quartz along planes of foliation and schistosity is exposed at intervals of from 20 to 40 feet for 430 feet and across widths up to 60 feet. The strike of the foliation is north 5 degrees east and the dip 52 degrees east. The overburden is thick along both the north and south projected strike of the deposit. In a few of the trenches, the quartz is estimated to be 5 per cent of the rock across widths of 5 feet. Large flakes of black biotite are abundant in some of the quartz. Granular pyrite and pyrrhotite occur in the gneiss between some of the larger quartz veinlets. No free gold was seen in the quartz.

Durand. Prospect pits expose small quartz veins in sedimentary gneiss on a number of mineral claims along the west shore of the northeast arm of Herblet lake south of the Sask-Mani property already described. About 300 feet south of Mr. Peter Durand's cabin, a few feet from the lake shore, a prospect pit exposes sheared hornblende gneiss carrying red garnets and injected along the foliation planes by stringers of quartz. Small grains of pyrite and pyrrhotite are present in both the hornblende gneiss and vein quartz. This deposit is small and no information is available regarding its gold content.

About a quarter of a mile north of the cabin considerable work has been done to expose three small veins. The bedrock is a quartz-mica-hornblende gneiss of sedimentary origin. The gneiss is cut by a large body of granite at about 800 feet west of the prospect pits. The foliation of the gneiss strikes north 10 degrees west and dips 75 degrees east. The southernmost of the three veins is exposed for 40 feet along the strike, and the average width is 18 inches. A second vein is 100 feet to the northwest, is 65 feet long, and averages 28 inches in width. Free gold is reported to be abundant in the quartz where the vein cuts across the structure of the rocks. Some of this quartz is also reported to carry a gold-bearing telluride. The third vein is just east of the second and is exposed for only 30 feet along the strike. A prospect shaft has been sunk here and apparently the quartz was wider in depth than at the surface, for a large percentage of the material on the dump is white, vitreous quartz. Pyrite, arsenopyrite, and chalcopyrite are sparingly present in the quartz.

Gold Prospect Between McLeod and Squall Lakes. A number of outcrops of mica schist carrying some vein quartz have been found in the long, narrow area between McLeod and Squall lakes, about 4 miles west of the west bay of the northwest arm of Herblet lake. The area has been staked, the first stakings dating from 1926. Mr. Edgar Stewart and associates were interested in the group during the summer of 1930, and more mining claims were located in this vicinity.

Most of the prospecting work has been done just west of the south end of McLeod lake in the vicinity of the 18th base line. A few prospect pits are distributed at intervals in an area extending northeast for $1\frac{3}{4}$ miles to the portage between McLeod and Squall lakes. The bedrock exposed is quartz-mica gneiss carrying red garnet. Some beds are siliceous, are almost a micaceous quartzite, and others are of biotite and red garnet with only a small percentage of quartz. The strike and dip of the beds are fairly uniform, being, respectively, south 25 to 30 degrees west and 40 degrees east.

The prospect trenches expose beds of mica schist and more massive, siliceous gneiss. In some trenches a width of 6 feet of mica schist holds from three to eight stringers of quartz, each from $\frac{1}{2}$ inch to 3 inches thick. In other trenches the quartz is in a single body from $1\frac{1}{2}$ to 4 feet thick. The wider quartz bodies are apparently lenticular, and no exposed body is more than 150 feet long. Adjacent to the base line crossing, the trenches expose at least three areas wherein quartz lenses and stringers are present. The quartz is white to greyish and of medium grain. Some of it carries pyrite and arsenopyrite. No free gold was seen in the quartz of the few

trenches examined. The individual bodies or areas of mica schist carrying lenses and narrow veinlets of quartz apparently are not large, though a number of such bodies of schistose rock are distributed at intervals along the strike of what appears to be the same general horizon within the quartzose sediments.

Rice-Woosey (15). An outcrop of rusty weathering schist on the south end of what is now Rice island, Wekusko lake, was noted by prospectors during the early prospecting of the field. In the early years prospectors were searching for gold-bearing quartz, hence this sulphide deposit received little attention until 1928. The deposit was staked in 1917, however, by Miss Kathleen Rice and Mr. Richard Woosey. Early in 1928, Mr. C. E. Herman agreed to do a certain amount of diamond drilling of the deposit for an interest in the group. In the summer of 1928, the group was optioned to Ventures, Limited, and seven additional holes were drilled by this company. The option was later dropped, and it is understood the property is now controlled by Messrs. Herman, Woosey, and Miss Rice.

Quartz gabbro outcrops prominently around the edges of the island, in places as nearly vertical cliffs. The surface within 300 feet from the south end of the island rises to a height of 85 feet above the lake, from there gradually sloping north. A thin mantle of moss and drift covers a part of the rock in the central part of the island. The north-south profile of the island is typical of that of many of the glaciated rock ridges of the area.

The quartz gabbro is typically a medium-grained, black or slightly greenish rock of massive appearance. Many outcrops are uniform in appearance and show greyish crystals of feldspar, needles and crystals of green and black amphibole, and specks of pyrrhotite. The size of the crystals and the relative proportion of feldspar to hornblende vary slightly in different outcrops, and from point to point in the same outcrop. The more feldspathic or more hornblendic types show no regularity in their distribution, and no evidence was noted to suggest that the magma differentiated in situ into definitely spaced basic and acidic fractions. A thin section of a specimen of feldspar-rich quartz gabbro from the south-east corner of the island has the following approximate mineral composition, in percentage of areas measured by a Wentworth micrometer: labradorite (Ab 55) 48·4; orthoclase 5·2; hornblende 36·5; biotite 1·9; quartz 4·2; calcite 2·5; and pyrrhotite and magnetite 1·6. The plagioclase is in lath-shaped and rectangular crystals from 0·80 to 2·25 mm. across. These crystals are not granulated or cracked and are only slightly altered to calcite, zoisite, and white mica. The hornblende is slightly altered to epidote and uralitic and chloritic materials. No augite or evidence that the hornblende or uralite are secondary after augite was noted. The biotite is brown and highly pleochroic. Quartz grains, with dust inclusions, and calcite grains crossed by cleavage lines, fill interstices between some large feldspar and hornblende crystals. The magnetite is in small grains in altered hornblende, and the pyrrhotite also probably crystallized early from the magma.

Diamond drill cores show that the quartz gabbro at depth is like the rock at the surface. Some sections of the cores are feldspathic and slightly porphyritic, whereas other sections are greenish black and the rock is

estimated to contain more hornblende than feldspar. The two main types of rock may alternate several times through 200 feet of core. At a few points the hornblendic gabbro is slightly schistose, and pyrrhotite is more abundant here than in the more massive rock. Chalcopyrite is present also in most sections of the core where the quantity of pyrrhotite is in excess of that in the average quartz gabbro. Veinlets, either of quartz or of calcite, also cross some sulphide-bearing zones of schistose quartz gabbro.

Quartz gabbro does not outcrop on the nearby islands east or west of Rice island. The bedrock of these islands is andesite, tuff, slate, and greywacke. The bedding and schistosity of these formations strike about south 25 degrees west and the dip is from 75 to 85 degrees west. Schistose zones in these rocks contain veins and stringers of white quartz. The quartz gabbro mass apparently does not extend far under the lake beyond the outline of Rice island, for most of the drill cores passed through quartz-gabbro into the surrounding greywacke, slate, and chloritic and talcose schists. The south end of the gabbro mass appears to be roughly canoe-shaped, the mass plunging about 45 degrees northward.

The main sulphide mineralization is in the quartz gabbro, near the contact with sediments which, as indicated by diamond drilling, underlie the south end of the quartz gabbro body and occur under the lake along the west side of the intrusive.

The sulphide body on the south end of the island is exposed in two long trenches and a prospect shaft. Schistose gabbro carrying disseminated pyrrhotite and chalcopyrite is also exposed along the west side of Rice island in two cuts on the side of the hill just above the water level. Rusty-weathering, intermixed schistose and massive quartz gabbro carries disseminated pyrrhotite and chalcopyrite, and veinlets and lenses of these sulphides, developed along joint planes. The joints cut the mass in various directions, the most prominent sets strike, respectively, north 90 degrees east and south 55 degrees east. At some points, rounded and subangular blocks of massive quartz gabbro lie in a matrix of schistose gabbro carrying sulphides. In thin section, the rock of the blocks is similar in texture and mineral composition to the quartz gabbro away from the mineralized area, except that no grains of sulphide were recognized. The body of schistose, jointed, and brecciated, sulphide-bearing quartz gabbro grades outward into fairly massive quartz gabbro carrying only accessory sulphides, hence the size and outline of the sulphide-bearing masses, as shown on Figure 8, are necessarily only approximate and, furthermore, only small, erratically distributed parts of these masses appear to contain a large enough proportion of sulphides to be commercial ore. The sulphides in the sections crossed by the trenches are in part oxidized to limonite. Chalcopyrite is not abundant enough to be an ore in the wide body of schistose gabbro on the west side of Rice island. If exploration of the deposit is again undertaken, it would seem that the margin of the quartz gabbro body and the adjoining sediments to the west, north from the outcrop of the main deposit, should be drilled at shorter intervals than was done.

The assay results of drill cores, kindly supplied by Miss Rice and Mr. Woosey, show that wide sections of quartz gabbro carry a small percentage of copper and nickel and that narrow sections hold up to 5 per cent combined copper and nickel. In No. 6 hole, 29·5 feet of the 60 feet

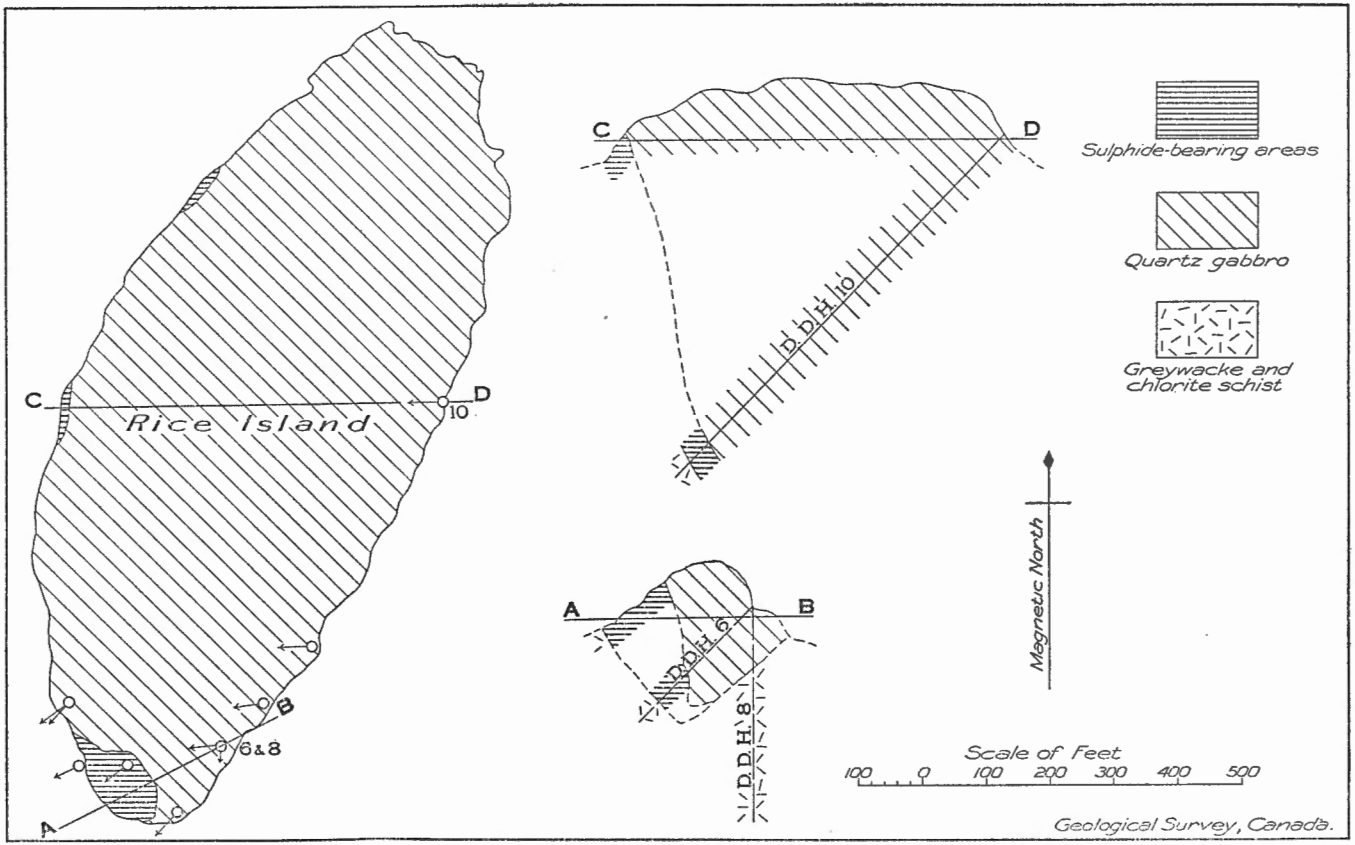

Figure 8. Plan and cross-sections of Rice island, Wekusko lake, Manitoba, showing outcropping sulphide-bearing areas of quartz gabbro, and their situations with respect to the underlying greywacke and chlorite schist.

of sulphide-bearing rock penetrated by the drill held an average content of 0·93 per cent copper and 3·2 per cent nickel. In this hole, schistose greywacke containing veinlets and grains of sulphides was penetrated for 12 feet or more below the quartz gabbro contact. One section, 1 foot wide, of the black greywacke cut by veinlets of sulphides assayed 0·60 per cent copper and 2·55 per cent nickel. The copper content is less than that of nickel in practically all the assay returns, but there is no constant ratio between the percentages of the two metals. For example, one section of core assayed 0·58 per cent copper and 1·03 per cent nickel, and another 0·50 per cent copper and 2·50 per cent nickel. A veinlet of massive sulphides assayed 0·54 per cent copper and 4·98 per cent nickel. In some such veinlets of massive sulphides, chalcopyrite penetrates pyrrhotite in small veinlets. The high nickel content of some of the massive sulphide veinlets, etc., suggests that some pentlandite may be present with the pyrrhotite.

Copper Dome (16). The Copper Dome group of mineral claims was staked in the spring of 1929 by Messrs. Felix Bordeau and Michael Hoot. Prospecting work has been done at two localities on the group.

At about 250 feet north of the No. 3 post of the Copper Dome No. 7 mineral claim, a pit 12 feet wide has been sunk 10 feet. The rock is jointed quartz gabbro carrying disseminated grains of magnetite, pyrrhotite, and chalcopyrite, and veinlets of the sulphides along a few joint planes. The strike of the two most prominent sets of joint planes is north 30 degrees east and north 20 degrees west, and their dips are 70 degrees west and 65 degrees east, respectively. Horizontal joints also are well developed. Some of the medium-grained, massive quartz gabbro carries a few crystals of black tourmaline up to one-half inch long. Needles of tourmaline 1 inch long are present along some joint planes. Tourmaline crystals are abundant in small, narrow, micaceous areas within the quartz gabbro. A few flakes of molybdenite are disseminated through small areas of the quartz gabbro. Crystals of red garnet are abundant in small areas of the quartz gabbro.

In thin section the essential minerals of the quartz gabbro are plagioclase (Ab 45), hornblende, and a few grains of quartz. Some plagioclase crystals exhibit crenulated and embayed margins; many, however, are lath-shaped or tabular. The plagioclase is fresh, whereas some of the hornblende is altered to colourless amphibole or chloritic and uralitic products. Brown biotite, orthoclase, magnetite, pyrrhotite, and chalcopyrite are present fairly abundantly in parts of the thin section. Tourmaline and molybdenite were not recognized in the specimen studied microscopically.

At this locality the sulphides are in part oxidized for 2½ feet below the surface. Some massive pyrrhotite contains small, round balls of pyrite, perhaps formed from pyrrhotite by weathering, for such spheres of pyrite have not been seen in pyrrhotite except along the zone between oxidation products above and massive sulphide below. Chalcopyrite is not abundant in most of the sulphide-bearing rock and the combined copper and nickel content of any large tonnage of the mineralized rock as exposed is estimated to be too low to be of value.

The second deposit on the Copper Dome group is about 3,000 feet by trail southwest of the deposit described above. The bedrock between the two localities is quartz gabbro with inclusions of lava and pyroclastic

materials. At the south deposit, two trenches, 85 and 95 feet long, respectively, cross medium and coarse-grained quartz gabbro carrying sulphide. A large mass of pillow lava south of the trench farthest southwest is cut by dykes of feldspar-rich, black, basic quartz gabbro. Red garnet is abundant in the lava and in some of the quartz gabbro near the junction between the two rocks. Some of the finer-grained gabbro is schistose and small grains of pyrrhotite and of chalcopyrite are distributed throughout the mass. The coarser-grained quartz gabbro appears to include blocks of the finer-grained type, and in the coarser rock the pyrrhotite and chalcopyrite occur for the most part along cracks. A few veinlets of pyrrhotite with some chalcopyrite cut both types of quartz gabbro along joint planes. The areas wherein sulphides are abundant are too small and too widely scattered to encourage further exploitation of the deposit.

In thin section the quartz gabbro of the second locality is similar in texture and mineral content to the specimen already described from the north pit. No tourmaline nor molybdenite, however, were seen in the rock exposed in the two trenches. A few veinlets of a micaceous, pegmatitic rock cross the quartz gabbro along joint planes, and a few crystals of red garnet occur in the quartz gabbro adjoining some of the pegmatitic veinlets. At about 5,500 feet by trail southwest of the trenches at this locality, quartz gabbro is cut by a granite dyke. The dyke has been displaced 75 feet by a transverse fault and a pegmatite dyke has intruded along the fault plane.

Arctic (17). The Arctic group of nine mineral claims was staked in May, 1929, by Messrs. Wendal H. Bryenton, Fred F. Miller, and associates. During the summer of 1929 two rock cuts, each about 75 feet long, were made to explore an outcrop of rusty-weathering quartz gabbro on the west slope of a hill about 200 feet south of the No. 1 post of the Arctic No. 5 mineral claim. A wet, swampy area lies west and north of the deposit, whereas to the east outcrops of quartz gabbro containing a few lava inclusions are numerous. The quartz gabbro along the trenches is fine to medium grained on the east side, but on the average is coarser grained towards the west. Some patches of the coarse-grained rock are almost pegmatitic in texture and contain more than an average quantity of quartz and black mica. Chalcopyrite also is more abundant within or near the areas of coarse quartz gabbro than elsewhere. In small areas, the coarse and fine-grained phases of the rock are intimately intermixed and in fairly sharp contact, but no chilled margins or other definite evidence was noted that would indicate the age relations of the two texturally different types of quartz gabbro. Near the south end of the north trench, fine-grained, black quartz gabbro adjacent to the coarser-grained type is crossed by a few narrow seams of altered rock of epidote-green colour. The general relationships along the junction between the coarse and finer grained rock suggest that here the magma had in part crystallized to form the fine-grained black gabbro, which, slightly later, was brecciated and intruded by the slightly more acidic, coarser-grained phase.

Both the fine and the coarse-grained quartz gabbro carry sulphides in scattered grains, blebs, lenses, and veinlets. The sulphide-bearing rock is jointed and although the joint planes strike in many directions a number in different parts of the trenches strike north 70 degrees east and south 60 degrees east. Many joint planes dip steeply and in different directions, a few prominent joint planes being nearly horizontal. Many

of the lenses and veinlets of massive sulphides are along joint planes, and some of the wide masses are at the intersection of sets of joint planes. Some of the bodies of massive sulphides are 6 inches wide, the majority, however, are under 2 inches in thickness. The body of sulphide-bearing rock is about 50 feet wide and 200 feet from north to south. The walls are not sharp, the quartz gabbro to the south carrying grains of pyrrhotite for 50 feet or more south of the workings. Narrow sections of the wide area wherein veinlets and lenses of pyrrhotite and chalcopyrite are localized, assay nearly 5 per cent combined nickel and copper. The average metal content of the whole mass of sulphide-bearing rock, however, is estimated to be far below commercial grade ore. The following is an analysis of a sample from a veinlet, judged to be massive pyrrhotite and chalcopyrite, and made by Mr. E. A. Thompson, chemist of the Mines Branch.

		Per cent
Copper		4·91
Nickel		1·78
Zinc		none
Arsenic		none
Cobalt		none
Titanium		trace
Iron		35·38
Sulphur		22·65
Insoluble matter		33·90
Gold		trace
Silver	Troy per ton of 2,000 lbs.	0·26 ounce
Total		98·62 per cent

The high percentage of insoluble matter indicates that even the small bodies of massive sulphides contain silicate gangue minerals, and small fragments and clusters of crystals of plagioclase, amphibole, biotite, and quartz are visible among the sulphides in a specimen selected from the material collected for analysis and studied microscopically. These silicate minerals are the essential minerals of the quartz gabbro bordering the sulphide veinlets, but are more altered. The plagioclase is crossed by cracks oriented in various directions, but many of which are at right angles to the long sides of the crystals. Greenish grey, secondary minerals with high interference colour fill some of the cracks and also border some of the feldspar grains. The amphibole is altered to needles of actinolite and shreds of chloritic materials. The brown biotite is fresh or only slightly altered. The sulphides penetrate the silicates as veinlets along cracks and clearly replace the gangue minerals. Some sulphide areas are crossed by veinlets of saussurite-like alteration products and this suggests that the alteration of the silicates was in part later than the crystallization of the sulphides. A narrow area of saussuritic and chloritic materials lies between some areas of sulphides and gangue minerals, whereas a few large grains of sulphide are in sharp contact with unaltered plagioclase. Fragments of fresh feldspar and aggregates of the secondary minerals are scattered through the sulphides.

In a thin, polished section of massive sulphide, veinlets of chalcopyrite cut pyrrhotite, and the margin of pyrrhotite against some of the chalcopyrite is crenulated. These and other features prove that the chalcopyrite replaces pyrrhotite. The pyrrhotite in some areas shows noticeable differences in colour, and copper-bronze and lighter bronze varieties meet with sharp, straight, or only slightly curved, contacts. The lighter bronze pyrrhotite may carry the nickel.

Arctic Extension (18). An outcrop of rusty-weathering quartz gabbro on the Arctic No. 7 mineral claim was prospected during the summer of 1928. On the side of a ridge west of a wide muskeg, a pit 8 feet deep is in an area of sulphide-bearing quartz gabbro 70 feet long and 40 feet wide. The quartz gabbro surrounding the pit contains included masses of andesite lava, some bodies of which show pillow structure. The quartz gabbro east of the pit contains red garnets and inclusions of quartz-mica-garnet gneiss. The black quartz gabbro is massive or only slightly schistose. The grain size is variable, in some specimens the feldspars are up to one-half inch long, whereas in most outcrops the crystals are less than one-eighth inch long. The approximate percentages of the minerals in a specimen from the pit are as follows, as determined in thin section: plagioclase (Ab 45) 39·9; hornblende 30·1; biotite 6·9; quartz 6·3; orthoclase 5·1; pyrrhotite and magnetite 12·3. The hornblende is in part altered to chloritic and uralitic materials.

Small grains and clusters of grains of pyrrhotite and of chalcopyrite are distributed fairly evenly throughout the massive quartz gabbro exposed in the pit. The sulphides may be original constituents of the rock. The sulphide-bearing rock is crossed by numerous joint planes, along some of which are narrow veinlets of sulphides. The nickel and copper-bearing sulphides were judged to be present in amounts too small to make a commercial body of copper and nickel ore. Further work done after the locality was visited in the early part of August, 1930, is reported to have exposed an area of quartz-gabbro wherein the veinlets and lenses of massive sulphides are larger and more numerous than in the pit examined.

West (19). The West group of mining claims adjoins the Arctic group on the west, and was staked in July, 1929, by Mr. Charles Stayback and associates. Prospect pits have been dug at two points on the group, namely 250 feet north of the No. 2 post of the West No. 3 mineral claim, and about 775 feet southwest of this locality. The bedrock is quartz gabbro with included masses of pillow lava and quartz-mica-garnet gneiss. An included mass of pillow lava occurs just west of the trench north of the claim post and several masses of quartz-mica-garnet gneiss are exposed south and east of the second group of pits southwest of the claim post. The pits are about 4,000 feet and 1,500 feet distant from, respectively, the north and south contacts of the quartz gabbro body with sedimentary gneiss. The south contact follows the foot of the northwest side of a steep-walled depression trending northeast and locally known as the "basin". The depression here is nearly a mile wide but gradually narrows towards the southwest. Crowduck bay is in part along the northeast continuation of this wide valley. The bedrock of the valley, at the localities examined, is quartz-mica-garnet and quartz-mica-staurolite gneiss of sedimentary origin. The strike of the foliation of the gneiss is south 70 degrees west and the dip 71 degrees east. Small dykes and lenses of granite and black quartz gabbro cut the gneiss and the trend of some of these bodies is south 35 degrees west or at an angle to the general strike of the foliation.

The northern trench, the one nearest the mineral claim post, is 65 feet long and exposes massive quartz gabbro carrying disseminated pyrrhotite and chalcopyrite. Though the rock is jointed, no veinlets of massive sulphides were noted along the joint planes. The quartz gabbro is black and crystals of hornblende, biotite, dark plagioclase, smoky quartz, and

specks of chalcopyrite and pyrrhotite are recognizable in hand specimens. The following percentages of minerals, by area, were determined microscopically in a thin section of a specimen judged as representative of the rock at this locality: labradorite 40·2; hornblende 47·6; biotite 2·3; quartz 4·8; and sulphides 4·7. A sample taken across 25 feet of quartz gabbro carrying disseminated pyrrhotite and chalcopyrite, and assayed by Mr. E. A. Thompson, chemist, Mines Branch, carries 0·12 per cent copper and 0·11 per cent nickel.

Three prospect pits at the second locality where work has been done, expose an area of sulphide-bearing quartz gabbro about 50 feet wide and 200 feet long. The rusty rock is in part covered by a thin mantle of glacial drift. The sulphides are distributed through the rock in grains and blebs. The chalcopyrite is localized to areas wherein blebs of pyrrhotite occur. Veinlets of chalcopyrite cross grains of vitreous quartz and penetrate pyrrhotite. Quartz is more abundant in the quartz gabbro carrying chalcopyrite than in the sparingly mineralized rock surrounding the pits. The average combined copper and nickel content of mineable bodies of the sulphide-bearing rock is estimated to be less than 1 per cent.

Chalco (*20*). The Chalco group of mineral claims is controlled by Mr. Edgar Stewart. The bedrock in the vicinity of a prospect trench is mineralized quartz gabbro situated about 3,000 feet southeast of the northwest side of the quartz gabbro intrusive mass. The sulphide-bearing phase of the quartz gabbro has been explored by a trench 80 feet long and up to 12 feet deep. The rock is jointed and schistified, the schistose zones trending north 50 degrees west. Sulphides are absent from, or only sparingly present in, the highly schistose phases. About 60 per cent of the rock in the trench is massive, jointed, coarse-grained quartz gabbro carrying specks of pyrrhotite and chalcopyrite. The average combined copper and copper and nickel content of the sulphide-bearing rock, however, is estimated to be less than 1 per cent.

Mundic (*21*). The Mundic group was staked in 1929, by Messrs. R. Ellis and G. Johnson. The bedrock is quartz gabbro cut by dykes of granite, aplite, and pegmatite. Quartz-mica-garnet gneiss outcrops near Crowduck bay on the southeast side of the group. The rock is largely covered by a thin mantle of glacial drift and stratified clay stained reddish over areas where the quartz gabbro is mineralized.

A trench 250 feet west of the No. 1 post of mineral claim No. 17658 crosses 110 feet of mineralized quartz gabbro. The rock is of medium grain except for some areas wherein a few crystals of feldspar are one-half inch long. Some of the rock is almost entirely of a dark, lime-rich plagioclase. Specks of pyrrhotite and chalcopyrite are distributed through the rock for the length of the trench. In no section 4 feet or more in width, however, are the sulphides estimated to be abundant enough to assay 1 per cent combined copper and nickel.

Three large prospect trenches, respectively, at points 1,200 feet northeast, 2,500 feet southwest, and 3,000 feet southwest of the trench described above, expose mineralized quartz gabbro. The areas of mineralized quartz gabbro are just southwest of the edge of a long dyke of pegmatite which outcrops at the No. 1 post of mineral claim No. 17658 and extends to the

northeast and southeast. The quartz gabbro in the trench farthest southwest is cut by a dyke of aplitic granite and some pyrite is associated with the pyrrhotite and chalcopyrite in this sulphide-bearing rock. Though the bodies of mineralized rock are wide at the localities trenched, the average content of copper and nickel is estimated to be low, perhaps ½ to 1 per cent across narrow widths.

Waldron (22). Prospect pits expose mineralized quartz gabbro at two points on a group of mineral claims west of the south end of Crowduck bay, and controlled by J. Waldron, D.L.S., and associates. The bedrock is quartz-mica gneiss intruded by quartz gabbro and pegmatite. Masses of quartz-mica gneiss lie in the quartz gabbro and occur at least as far inwards as 1,000 feet from the edge of the intrusive body. The areas of quartz gabbro carrying pyrrhotite and chalcopyrite are within the intrusive body, 600 feet from the east margin, near included masses of quartz-garnet-mica gneiss.

A prospect pit on the east side of the hill of quartz gabbro, just west of the contact of this rock and sedimentary gneiss to the east, exposes 30 feet of jointed, schistified, and massive quartz gabbro mineralized with sulphides. The sulphides are widely disseminated in small specks throughout much of this rock, and blebs, lenses, and veinlets of pyrrhotite with some chalcopyrite are confined to small areas. If more prospecting is done at this locality it would seem advisable to strip the contact between the quartz gabbro and the sedimentary gneiss where it lies under the talus near the foot of the hill. To the west of this pit, two long trenches expose mineralized areas about 600 feet within the quartz gabbro mass. Here the quartz gabbro north of a number of inclusions of garnet gneiss is jointed and slightly schistified. Small grains and blebs of pyrrhotite and chalcopyrite are disseminated through from 40 to 60 feet of the rock. The mineralization is not concentrated enough to suggest the possible existence of a large tonnage of commercial copper-nickel ore.

Eureka (23). An outcrop of mineralized quartz gabbro at water-level on the west side of a small island near the west side of Wekusko lake, about half-way between Goose and Berry bays, has been explored by a large prospect pit and two diamond drill holes. The work was done in 1929 by Mr. C. E. Herman and associates. The north end of the island is underlain by quartz gabbro and the south end by andesite. The islands immediately to the west and northwest are underlain by greywacke and andesite. The prospect pit is in quartz gabbro just north of the andesite. The contact between the two rocks trends nearly east. The quartz gabbro is jointed and slightly schistified along the contact. The quartz gabbro across widths of 30 feet or more from the andesite carries grains of pyrrhotite and chalcopyrite, but no areas are exposed wherein veinlets or other small bodies of sulphide are abundant enough to give rise to mineable quantities of rock assaying 1 per cent or more combined copper and nickel.

Puella Bay (24). During the summer of 1928, Puella Bay Mining and Development Company did trenching and diamond drilling on a group of thirty-five mineral claims and fractions, covering nearly 1,800 acres.

The forest has been burned at this locality so that near the prospect workings bedrock is fairly well exposed on the ridges projecting through a thick overburden of sand and clay. Some outcrops are of micaceous

quartz-hornblende gneiss, and other outcrops are white and grey, schistose, acidic rock perhaps originally rhyolitic or dacitic lava and associated tuff beds. The gneiss and schist are interpreted as interlayered beds of sediments and flows of lava lying between a large area of sedimentary gneiss to the east and lava to the west. The prospect trenches are near the contact between gneiss on the east and lava on the west, most of the mineralization being in schistose lava. The gneiss and schist west of the prospect trenches are cut by small bodies of granite and pegmatite, probably representing dykes formed near the margin of the large body of granite west and south of the property. The gneiss just east of the south or main workings is cut by dykes of mica lamprophyre up to 5 feet wide. The strike of the foliation and schistosity of the lavas and sediments is north 25 degrees west and the dip 75 degrees northeast.

The main surface work has been done at two localities; the first just northwest of the No. 3 post of lot 275 of group 422; and the second, 1,000 feet farther northwest. At the first locality five long trenches cross schistose lava and gneiss cut by narrow granitic and pegmatitic dykes and by quartz veinlets carrying iron carbonate. The contact between schistose lava and gneiss strikes north 25 degrees west and is exposed over a length of 400 feet. Some of the schist carries abundant iron pyrite in cubes and grains. Seams of white schist contain narrow quartz veinlets wherein or near which a few crystals and grains of chalcopyrite, galena, and sphalerite occur. The sulphides are erratically distributed in small quantities in this manner, across widths of from 10 to 60 feet of schist.

At the second locality, the gneiss and schist carry disseminated pyrite over widths of 20 to 40 feet, and in such zones chalcopyrite and galena are present only sparingly in narrow seams of schist.

The diamond drill holes were located just northeast of, and at intervals from, the southeast to the northeast trenches. In all, nine holes were drilled, varying in length between 431 feet and 728 feet, and totalling nearly 4,463 feet. The drill cores are of a grey rhyolite and dacite, green and black basic schist, and gneiss. Some of the core is quartz-sericite schist carrying disseminated pyrite. A few narrow pegmatite dykes and quartz veins were intersected, and also seams of massive pyrite an inch thick. The seams of massive pyrite are near quartz veins and the small amounts of chalcopyrite and galena present are also associated with the quartz.

Some trenching was also done along the projected strike of the schist zone, both northwest and southeast of the two localities mentioned above. These trenches also expose schist carrying some disseminated pyrite and a few seams wherein chalcopyrite is present. No mineable body of schist carries enough chalcopyrite, galena, and sphalerite to make commercial ore. The drill cores intersected at depth carry material very similar to that crossed in the trenches.

Manitoba Basin (25). In the winter of 1928, officials of Manitoba Basin Mines, Limited, staked nearly 4,000 acres of ground southwest of the southwest end of Wekusko lake. Good camps were built and surface work was commenced at once. Over half the mineral claims were surveyed in the spring of 1929 and a Radiore survey was made over a large part of the holdings. In November, 1928, diamond drilling was commenced, to explore in depth the surface showings and also areas indicated by the Radiore survey. This work continued until the summer of 1929.

Bedrock is not well exposed on the property, large areas being covered by a thick deposit of sand and clay, and muskeg areas are large. Some of the trenches cut at least 20 feet of overburden before reaching rock.

The bedrock of the southern part of the property is nearly horizontal Ordovician limestone and dolomite. The northern edge of the Ordovician sediments forms an escarpment 10 to 30 feet high and striking south of west. The Precambrian rocks of the northern part of the property comprise andesite, tuff, and quartz gabbro. The andesite and associated tuff beds are for the most part altered to chloritic and sericitic schists. The strike of the schistosity is north 20 to north 30 degrees east and the dip 70 degrees east. Some of the andesite is massive appearing. Just west of the camps massive rock is followed to the south by brecciated and pyroclastic schists containing fragments of black lava and cherty material. The quartz gabbro is a massive, medium to coarse-grained rock. Plagioclase (Ab 50) and hornblende are the abundant constituents. Large and small, irregular grains of quartz fill the interstices between many of the feldspar crystals. The quartz gabbro may represent a basic border phase of the large granite body lying west of the south end of Wekusko lake. The quartz gabbro outcrops in two small areas northwest of the camp buildings.

An isolated outcrop of sulphide-bearing rock lies about 1,500 feet north of the camp buildings, on the shore of Wekusko lake. This mineralized outcrop, the only mineralized area seen, is about 525 feet long in a northeasterly direction by 80 to 100 feet broad. The rocks are greyish green, quartzose, chloritic, and sericitic schist cut by veinlets of quartz. Sulphides occur in both the fine-grained schist and in the quartz. Some of the quartz-bearing zones in the schist are up to 1½ feet wide and carry abundant sphalerite, chalcopyrite, and pyrite. The quartz is dark, fine grained, with small lenticular areas of white and coarser-grained quartz. Chalcopyrite is more abundant around the areas of white quartz than elsewhere. In thin section the sulphide-bearing quartz consists of small, subangular quartz grains and some chloritic material. The sulphides lie between the quartz grains and along cracks crossing some of the larger quartz crystals. Small, round grains of quartz lie in some of the sulphide grains. On polished surfaces, the pyrite is seen to be cut by both sphalerite and chalcopyrite. Some of the sphalerite contains minute needles and tiny round grains of chalcopyrite, suggesting that the two sulphides in part crystallized at the same time. No sphalerite was recognized within chalcopyrite; the boundaries between these two sulphides are straight or only slightly curved. The sulphides were deposited later than the quartz and chloritic gangue and apparently in the order: pyrite, sphalerite and chalcopyrite together, with perhaps some chalcopyrite later than sphalerite.

The following reported assay results, taken from page 141 of the "First Annual Report on Mines and Minerals" (1928), by the Manitoba Department of Mines, indicates the grade of the ore of sections of the surface showing.

——	Gold	Silver	Copper	Zinc
	Ozs.	Ozs.	Per cent	Per cent
Average of 40-foot section.....	0·02	0·15	1·37	2·78
Assay of 10 " "	0·03	0·30	2·73	4·24
" 10 " "	0·20	0·05	1·07	2·24
" 6 " "	0·20	.....	2·66	3·50

It is reported that in the drill cores the mineralization at depth was similar to that exposed in the trenches. The bodies of sulphide-bearing rock of commercial grade are narrow and the average metal content of the whole large body of mineralized schist is too low to be ore at present.

Maple (26). The Maple group of mineral claims was staked by Mr. W. A. MacRae in May, 1929. Surface work on the group was done in the summer of 1929 by Manitoba Basin Mines Limited. The prospect trenches are reached by a poor trail about 1,800 feet long, leading from the first rapids on Berry creek southwest from Berry bay of Wekusko lake.

The prospect trenches expose andesite lava intruded by dykes of diorite porphyry and lying about 300 feet southeast of the edge of a large body of grey granite. The trench farthest southwest crosses a shear zone 8 feet wide within andesite adjacent to the edge of a dyke of diorite porphyry. This shear zone strikes north 55 degrees east and dips 78 degrees northwest. Two feet of the schistose andesite near the porphyry dyke is silicified and carries pyrrhotite, pyrite, and chalcopyrite. The assays of the sulphide-bearing rock are reported to show some nickel, in addition to a small amount of gold and copper. Three trenches 150 feet to the northeast, cross sheared lava cut by narrow dykes of diorite porphyry. In one trench 4 feet of chloritic schist contains stringers of quartz and is sparingly mineralized with pyrite, chalcopyrite, and sphalerite. In another trench, a quartz vein one foot wide is present. The work proved the schist zone to be of irregular outline and that the mineralization is not uniformly distributed.

Eagle (27). Trenching on this group has been done on two outcrops of rusty gneiss along the portage from the southwest end of Anderson lake to the next lake to the southwest. Deposits of glacial drift and clay are thick and widespread at this locality. The rock exposed in the trenches is garnet-bearing quartz-mica and quartz-hornblende gneiss. The foliation of the gneiss strikes south 45 degrees west and dips 78 degrees northwest. About 800 feet southeast from the trenches, black dioritic rock outcrops, and 200 feet farther southwest, grey granite outcrops. The granite holds masses of andesite.

In one trench 12 feet of schistose garnet gneiss carries disseminated pyrrhotite and chalcopyrite. A few, thin, highly micaceous layers of the gneiss carry quartz veinlets and blebs and lenses of pyrrhotite and chalcopyrite. In a trench about 300 feet west, 32 feet of gneiss is mineralized with sulphides and vein quartz. In a third trench, 150 feet to the southwest, 45 feet of highly foliated and schistified garnetiferous gneiss is exposed. Some crystals of red garnet are 1 inch across; the large garnet crystals are near lenses of quartz with which is associated some chalcopyrite. The vein quartz is more abundant along the south side of the zone of mineralized gneiss. Narrow sections of the highly schistose gneiss carry enough chalcopyrite to assay 2 or 3 per cent copper. The average copper content, however, is estimated to be less than 2 per cent across widths of 10 to 15 feet.

Polo (28). The Polo group of eight mineral claims is controlled by Mr. Paul Gasse and associates. Some surface work was in progress on the group during the summer of 1930. Five trenches expose a faulted zone within quartzite, for 575 feet along a strike of north 40 degrees east. The bedrock on the group consists of interbedded quartzite and greywacke. The strike of the bedding is north 40 degrees east and the dip 60 to 65 degrees northwest. A large muskeg lies southeast of the deposit.

The trenches expose faulted, jointed, and sheared quartzite. The strike and dip of the fault and schistosity planes parallel the bedding. The zone of sheared and broken rock is from 3 to 10 feet wide. Within this zone some beds of gouge and layers of quartz-sericite schist are heavily mineralized with pyrite, pyrrhotite, chalcopyrite, arsenopyrite, and vein quartz. The arsenopyrite is in the quartz. Some veinlets of sulphides are 4 inches wide. The intervening, less deformed quartzite carries disseminated pyrite and pyrrhotite. The bands of more heavily mineralized rock are 6 to 18 inches wide, and in a trench near the mineral claim post are estimated to form one-fourth of the material exposed across 10 feet. No assay results are available of the average gold, nickel, and copper content of the mineralized zone.

Ruby Silver-Lead (29). A deposit of silver-bearing galena was discovered and staked by Mr. Paul Gasse and associates north of Wekusko river, at a locality a few miles west of where the river turns abruptly to the southerly course ending at Herb bay, Wekusko lake. Work has been done near the south side of the Puzzler mineral claim, lot 235, group 422, where in 1923 and 1924, ten long trenches were dug through thick overburden and a shaft was sunk 43 feet and a drift extended from the bottom of the shaft northeast 45 feet. The trenches exposed a deposit about 50 feet wide and assaying high in lead, silver, and zinc. Subsequent work, however, proved that the dip of the deposit is nearly horizontal and that, consequently, the outcrop width is several times greater than the true thickness of the deposit.

Early in 1929 Mr. R. J. Jowsey, of Toronto, R. Kerr, and associates, bought the property and organized the Ruby Silver-Lead Syndicate to continue exploration work. The mineral claims were surveyed and a Radiore survey was made. Following this six holes were drilled to depths of 122 feet to 408 feet and a total length of 1,583 feet. No further work has since been done.

The deposit is along the side of a hill and drift deposits are thick to the north and east. The rock exposed in the trenches is quartzite and thin beds of mica gneiss cut by small bodies of quartz and pegmatite. To the west along the line between the Puzzler and Ruby mineral claims, quartz-mica gneiss outcrops on the side of the hill. The strike of the foliation of the gneiss is from north to north 25 degrees east, and the dip from 40 to 60 degrees east. The gneiss is cut by small dykes of pegmatite, and a large, sill-like mass of pegmatite and pegmatitic granite outcrops on top of the hill 300 to 400 feet west of the west line of the Puzzler mineral claim. The bedding and foliation of the gneiss on the west side of a low, flat outcrop near the No. 1 post of the Puzzler claim dip 10 degrees west, whereas the dip is from 8 to 12 degrees east on the east side of the outcrop. The main exposures of the deposit are about 200 feet northeast of this outcrop. The deposit, therefore, appears to be along the axis and on the south limb of a small anticline. The axis of this fold strikes about north 15 degrees east and the plunge is northward about 30 degrees.

The mineralization appears to be confined to two horizons within the gneiss. The west mineralized zone is exposed along or near the nose of the anticline and is a bed of quartz-mica gneiss lying between quartzite and cut by veins and lenses of quartz. The quartz veins dip at a low angle

to the east. Crystals and grains of tourmaline, pyrite, pyrrhotite, and chalcopyrite are abundant in some of the quartz. The second mineral-bearing zone is to the east and is along an horizon within the sedimentary gneiss about 10 feet above that bearing the western mineralized zone. Here, veinlets and small lenses of galena and sphalerite are distributed through the lower part of a quartzite horizon overlying a bed of quartz-mica gneiss. The mineralized zones appear to follow the dip and strike of the beds and the dip of the galena-sphalerite deposit steepens to the east away from the axis of the anticline. Since the axis of the fold pitches northward, the deposit would be expected to be deeper below the surface in this direction.

Two specimens of sphalerite-galena ore were studied microscopically. These show grains of quartz and feldspar and flakes of biotite surrounded and veined by pyrrhotite, pyrite, arsenopyrite, chalcopyrite, sphalerite, and galena. The silicate minerals are unaltered except that small areas of feldspar have been transformed to a grey, saussurite-like material. Flakes of fresh biotite lie between large grains of sulphides. Lenticular bodies of grains of vein quartz, up to one-quarter inch long, are present within the massive sulphides. The sulphides clearly replace the silicate minerals of the sedimentary gneiss. Pyrite and pyrrhotite are veined by chalcopyrite and galena. Arsenopyrite occurs only sparingly, and its age relations to the other sulphides were not apparent in the specimens studied. Grains of chalcopyrite are present within sphalerite. Galena penetrates chalcopyrite as veinlets. The pyrrhotite and pyrite, and perhaps arsenopyrite and chalcopyrite, were deposited first and the sphalerite and galena later, perhaps representing a second phase of mineralization. No silver-bearing mineral was recognized. The assays indicate three units of silver for each percentage of lead. The silver perhaps is carried in the galena.

The clay walls of many of the trenches are slumped, so that it is difficult to secure exact data regarding the thickness, extent, and general character of the deposits. R. C. Wallace visited the deposits when the trenching and underground work were in progress and states[1]:

"The work on the shaft and crosscut shows that the silver-bearing galena is confined to the quartzite, which extends to a depth of 17 feet at the shaft. The galena occurs in bands in the sediments, the main band striking 20 degrees east of north. The most northerly trench in this zone shows very heavy mineralization with galena over a width of 20 feet. The ore seems to increase in width and value towards the north, and there is good prospecting country north of the north trench.....Massive sphalerite has been uncovered east of the main galena mineralization, though apparently not associated with the galena."

Woods. Some surface work and diamond drilling have been done to explore a sulphide-bearing shear zone near the west shore of the northwest arm of Herblet lake. The deposit was staked in 1925 and is controlled by Mr. A. E. Woods. In the winter of 1929 two shallow holes were drilled by a syndicate organized in The Pas. Overburden is thick at this locality and in one pit the sulphides have been leached from the schist for at least 18 feet below the surface, thus it is difficult to determine the merits of the deposit by surface work.

[1]Can. Min. Jour., vol. 44, p. 759 (1924).

The rock exposed is quartz-mica gneiss cut by dykes of pegmatite up to 2 feet thick. The foliation of the gneiss strikes north 40 degrees west and dips 70 degrees east. Quartz-mica gneiss outcrops along the ridges in the swamps for half a mile east of the prospect workings.

The walls of the northernmost three trenches have slumped and no rock is now exposed in these trenches. Specimens of rusty schist on the dump contain a little chalcopyrite. At 250 feet south of the north trench, 7 feet of brecciated rock is exposed in a trench. At 260 feet farther south, a pit 15 feet deep exposes brecciated gneiss stained by iron oxide. The two diamond drill holes were located 35 and 80 feet, respectively, east of this pit. The dip of the mineralized breccia zone appears to be from 85 degrees east to vertical and the strike south 40 degrees west. Arsenopyrite is an abundant sulphide in the rusty rock on the dump. The samples taken from the drill cores are reported to have assayed some nickel. The deposit appears to be along a wide, brecciated zone that may continue both south and north under the overburden of clay, or the lake, for some distance beyond the end points where the work has been done.

Molybdenum. A number of molybdenite-bearing quartz and pegmatite bodies have been known for some years in Wekusko Lake area. In 1918, F. J. Alcock[1] examined a few of these and describes a deposit south of the Bengal deposit, to be discussed in a succeeding paragraph. Alcock states that here

"The molybdenite occurs in a pegmatite dyke that runs at right angles to the river and cuts a fine-grained, dark-coloured, biotite gneiss. The dyke is 20 feet long and has a maximum width of 3½ feet. The pegmatite is composed of coarse orthoclase crystals and quartz, the quartz being so abundant in places that it resembles a true quartz vein. The dyke contains molybdenite, pyrite, and chalcopyrite. The molybdenite is concentrated in seams along the borders of feldspar crystals, along the contact of the dyke and country rock, and occurs also in the wall-rock for about half an inch from the dyke."

Alcock also states that "On the north arm of Herblet lake molybdenite has been found in quartz veins, but in only small quantities."

R. C. Wallace[2] mentions an occurrence of molybdenite on the Ginger mineral claim, on the west side and near the south end of the narrows leading from Wekusko lake to Crowduck bay.

The Bengal group of mineral claims (locality 30, Figure 5) were staked along the northwest side of Grass river, north of Crowduck bay, in 1929, by Messrs. R. Rosen, A. Hansen, and associates. The bedrock along the river bank is quartz-mica-garnet gneiss, which, 35 to 200 feet inland, is cut by a large body of granite and granodiorite. The contact of granite and sediments follows the foot of a hill, and the main prospecting has been done at two localities near the foot of this hill and at one point to the northeast on the face of a low cliff just above water-level.

The prospect pits expose bodies of pegmatitic quartz striking north 50 degrees west, or approximately at right angles to the strike of the foliation of the gneiss and of the contact between granite and gneiss. The quartz bodies extend from the sedimentary gneiss into massive granite, but, within 200 feet in the granite, the quartz masses narrow and end. The southeast continuation of the deposits across the gneiss is under drift and water.

[1] "The Reed-Wekusko Map-area, Northern Manitoba"; Geol. Surv., Canada, Mem. 119, p. 38 (1920).
[2] "Mining and Mineral Prospects in Northern Manitoba"; Northern Manitoba Bull. 1919, p. 36.

The south molybdenite-bearing quartz deposit, explored in 1929, is 28 inches wide in a trench at the foot of the hill and extending 15 feet up the side of the hill. The quartz body narrows and ends in the granite 50 feet northwest of the trench. The white quartz is crossed by joint planes; flakes of molybdenite up to 1½ inches across are distributed along a few joint planes. Some small flakes of molybdenite apparently are in unfractured quartz. Crystals and grains of pyrite and grains of chalcopyrite are associated with the larger flakes of molybdenite. The deposit dips 80 degrees northeast and the molybdenite and sulphides are localized along the hanging-wall of the mass.

Another parallel quartz body about 100 feet to the north is 18 feet wide where it lies in the sedimentary gneiss, whereas in the granite it splits into two crooked branches, ending to the west within 200 feet. The quartz of the large body in the gneiss is white, coarsely granular; small areas of it contain large feldspar and mica crystals, and a few grains of pyrite and chalcopyrite occur close to the walls.

Several other similar but smaller quartz bodies outcrop to the north along the contact between the granite and the sedimentary gneiss. One of these, about 3,500 feet northwest of the deposit described in the foregoing paragraph, is 19 feet wide, and is of coarse-grained quartz with many crystals of greyish microcline, light mica, and, in a few areas, grains of pyrite and chalcopyrite are abundant. No molybdenite was seen in the quartz exposed in the large cut along the side of the cliff at this locality.

Most of the pegmatitic quartz and pegmatite of the area carry only disseminated flakes of molybdenite, or the areas wherein molybdenite is abundant are small. Gold is absent or assays show only a trace. A few specks of free gold were found in a narrow quartz vein adjacent to the quartz body, 19 feet wide, described above. Small grains of galena and sphalerite occur in some of the molybdenite-bearing quartz.

AREA ALONG GRASS RIVER FROM WEKUSKO LAKE TO THICKET PORTAGE ON THE HUDSON BAY RAILWAY

In September, 1930, the geology and mineral prospects were examined along Grass river northwest of Wekusko lake and on Setting, Paint, Ospwagan, Mystery, Partridge Crop, Wintering, and Landing lakes. Bedrock is fairly well exposed along the lake shores, whereas inland and for stretches of several miles along the river, rock outcrops only locally through a thick mantle of stratified clay and glacial drift. At some points inland, where ridges rise 50 feet or more above the general level of the country, rock exposures are abundant. Muskeg covers the surface over wide areas. Granitic intrusives are by far the most abundant rocks; the older volcanic and sedimentary schists and gneisses are limited to small areas within the granite.

Grass River from Wekusko to Setting Lakes. The rocks exposed along Grass river for 16 miles from Wekusko lake are sedimentary gneisses and black, andesitic lavas cut by gabbro, granite, and pegmatite. In 1922, Mining Corporation of Canada explored thoroughly a large body of siliceous rock in the andesitic lava west of Grass river near the portage

to Niblock lake. It was thought that this siliceous rock would serve as a flux for the Flin Flon ore and would carry enough gold to pay costs of transportation to the smelter. Impurities in the siliceous rock, however, prohibited its use as a flux, and the average gold content is low.

Rock outcrops are not abundant along the stretch of Grass river between the portage to Niblock lake and Pakwa lake. The country back from the river is slightly undulating and is covered by thick deposits of post-Glacial Lake Agassiz stratified clay. The forest was burned over large areas during the summer of 1929. Some of this area would be suitable for agriculture if cleared. The rocks exposed at the rapids and falls on the river, and at a few other points, are quartz-mica-garnet gneiss and granite. Eastward towards Pakwa lake granitic rocks are widespread and the gneisses are limited to small masses included in the granite. A ridge of grey, foliated, quartz-mica-garnet gneiss crosses the river at the falls west of Kanisota falls. The bedding and foliation strike south 40 degrees west and the dip is 70 degrees east. Granite and pegmatite are intimately injected along the foliation planes of this gneiss. Pink and grey granite and granite-gneiss outcrop from one-half mile east of Kanisota falls to Whitewood falls. At Whitewood falls another ridge of grey to black, fine-grained, quartz-mica-garnet gneiss crosses the river to form a falls 29 feet high. The strike of the foliation here is north 17 degrees west and the dip 72 degrees west. Some of the beds are black, mica-hornblende rocks, others are grey, garnet-rich gneiss, and others are grey, gneissic quartzite. Dykes and stringers of granite, pegmatite, and quartz are developed along the foliation planes. The river below Whitewood falls follows a narrow depression in granite carrying inclusions of black gneiss. Massive, pink granite and foliated, grey granite with inclusions of sedimentary gneiss outcrop along the river northeast to Pakwa lake and the south end of Setting lake. Granite carrying small inclusions of black and grey gneiss outcrops to the east of Setting lake at Wabowden on the Hudson Bay railway.

On Pakwa lake and to the west on Grass river, pink or white, massive or only slightly gneissic granite may outcrop in ridges on one side of the river or lake and on the other side grey, highly foliated granite-gneiss with abundant inclusions of mica-garnet gneiss may be present. Both the grey granite-gneiss and its included masses of older garnet gneiss are cut by narrow pegmatite dykes, some paralleling the foliation and others crossing it. In some outcrops the foliation of both the included masses of garnet gneiss and the grey granite gneiss exhibit intricate drag-folding. Some narrow pegmatite dykes cut across the foliation and drag-folds and others follow in detail the minute crenulations of the folding. J. E. Spurr[1] studied these rocks in some detail and discusses their age relationships as shown on Pakwa lake (called Pokatohogan by this author and formerly known as Pakwahigan and Paquehigan).[2]

"Here the older grey biotite granite is highly gneissic, the lines of the gneissic structure being very straight, close, and parallel. It is split and intruded, parallel the gneissic structure, by dykes of alaskite, belong to the later red granite intrusion, and without gneissic structure. These dykes at the point examined are up to 30 feet across, but to the west of here alaskite is found in immense masses. There are here (at lake Pokatohogan) smaller pegmatite vein dykes belonging to the same red granite series and without gneissic

[1] "The Ore Magmas", vol. I, pp. 163–171 (1923).
[2] Eighteenth Report, Geog. Board of Canada, p. 214 (1924).

structure, which either lie in or parallel to the alaskite dykes, or have the grey gneiss-granite for walls. Latest of all are certain pegmatitic quartz vein dykes, representing also the red granite series, which lie in the pegmatite sheets, or occur independently in the gneiss.....accordingly we find here, in the grey gneissic granite, narrow pegmatite vein dykes which are older than the later red granite series of alaskite, pegmatite, and quartz, and which have been affected, with the grey granite, by the gneissic deformation".

Spurr gives sketches of several of the older, crenulated pegmatites crossing the foliation of the grey granite-gneiss. The crenulated dykes are considered to have been originally straight and the difference between their original length, as measured along the crenulations, and their present length, in a straight line, gives the amount of shortening, and thereby a rough estimate of the loss of volume of the host rock (grey granite-gneiss) due to flowage. The dykes thus measured indicated a loss of volume of from 30 to 50 per cent. The rock is calculated to have flowed vertically or diagonally upward, thereby developing the gneissic structure so prominent in some areas of grey granite. The possibility should be mentioned, however, that the dykes may have been intruded along structural features of the host rock and may originally have formed in their present crenulated outline. No evidence against this interpretation of the origin of the crenulations in the dykes is presented by Spurr.

Setting Lake. Bedded quartzite and greywacke outcrop along the west shore of Setting lake from the inlet northwest to near the end of the bay west of the outlet, a distance of nearly 17 miles. This area of sediments is at least 2 miles wide north of the mouth of Setting creek, and the point and chain of islands north of the bay into which this creek enters are of quartzose sediments. The general strike of the beds north of the mouth of Setting creek is north 20 degrees east and their dip 65 degrees west on the west shore and about 75 degrees east on the east side of the point. The strata thus are folded into an anticline near the south end of the area. The quartzite beds vary in thickness from 4 to 30 inches, and are grey and fine grained; some beds contain flakes of black mica. Some of the beds are very fine-grained, dense rocks of the appearance of non-laminated cherts. The greywacke-like layers are dark coloured, fine grained, schistose or finely laminated, and consist of quartz, fragments of feldspar, mica, and chloritic materials. Garnet is abundant in some beds. Thin dykes of pink and white granite, aplite, and pegmatite are numerous in some outcrops and follow the bedding planes of their host.

The east side and north end of the lake are bordered by grey and pinkish grey granite and granite-gneiss carrying inclusions of black and grey, garnet-bearing schist and gneiss. The grey granite is cut by gabbro dykes, and these are cut by pegmatite and pink aplitic granite. Spurr[1] has described the relationships of these dykes as follows:

".....on the east side of Setting lake, trap dykes cut the granitic gneiss and are themselves locally involved in the shearing, although not to the same extent as the granite. Most of the older, contorted, pegmatitic vein dykelets came in before these trap dykes, but a few of them intersect the dykes, showing that the dykes appeared during the later part of the earlier pegmatitic intrusion. Vein dykelets of the later unsheared pegmatite cut the trap dykes as well as the gneiss and the older pegmatite."

Galena has been discovered on the west shore of the point about 1,000 feet north of the mouth of Setting creek. The bedrock on the west side of this point is quartzite cut by thin dykes of aplitic granite, and of

[1] "The Ore Magmas"; vol. I, p. 169 (1923).

pegmatite, and by quartz stringers. The pegmatite near the galena showing contains crystals of greenish plagioclase. One quartz veinlet is cut by a narrow dyke of aplitic granite in an outcrop north of the main pit. The quartzite is jointed but only slightly schistose, except in a few beds that are micaceous. Veinlets and lenses of galena, sphalerite, chalcopyrite, and quartz occur along joint planes in some quartzite beds and the schistose, micaceous quartzite carries scattered grains of pyrite, galena, and chalcopyrite. No calcite veinlets were noted. In thin section the sulphide-bearing rock is comprised mainly of large, irregular grains of quartz containing abundant dust inclusions, and of hornblende. Biotite is sparingly present. Sulphides penetrate and include grains of hornblende and some of quartz. Sphalerite and galena are more abundant in the part of the thin section carrying hornblende. The silicate minerals are fresh. Pyrite, chalcopyrite, and sphalerite were deposited; the galena cuts and includes grains of sphalerite and chalcopyrite and is clearly later than these sulphides.

The sulphide-bearing zone is covered along its strike to the north by from 3 to 12 feet of stratified clay underlain by gravel and boulder clay. The pits exposing the deposit are at the water-level of the lake and were full of water at the time the locality was visited. Several deep trenches have been dug through the drift to the east, but apparently no sulphide-bearing rock was found there. About 150 feet north of the main pit, along the projected strike of the strata, numerous pegmatite dykes and quartz veins cut the quartzite along planes of bedding and jointing. This outcrop extends 10 feet from the water-level and in this distance was not mineralized.

Grass River from Setting Lake to Paint Lake. In this area the river flows through a number of lake-like expansions with narrow connecting channels. At Pisew (Lynx) falls, 3 miles below Setting lake, the river flows north from an area of granite and granite-gneiss, to cross beds of quartzite and micaceous quartzite cut by dykes of granite and pegmatite. The strike of the strata is south 30 degrees west and the dip 75 degrees east. Below Pisew falls, which is 42 feet high, the river follows a narrow canyon in quartzite. From Pisew to Kwasitchewan (Pelican) falls, sedimentary gneisses, andesite, grey granite-gneiss, and pink granite, aplite, and pegmatite outcrop at various points along the river. Some beds of the sedimentary gneisses are black, micaceous, and calcareous, and carry some graphite. Gneissic quartzite is the most abundant type of sediment. At the Dominion Lands survey monument No. 104 (1920), the rocks on the west side of the river are granite-gneiss; on the east side the same rock holds inclusions of sediments and quartzite. Some prospecting work has been done at a few points along the river. The pits expose schistose sedimentary gneiss cut by pegmatite. A few of the pegmatite dykes carry flakes of molybdenite. Pyrrhotite is abundant in some of the schistose sedimentary gneiss. Chalcopyrite was noted in only a few specimens.

At Kwasitchewan falls the river flows east across quartzite, micaceous quartzite, and slate. The strike of the beds is north 25 degrees east and the dip 80 degrees west or vertical. Below the falls, which are 46 feet high, the river continues east to the east side of the main area of sediments, then follows the contact zone between the sediments on the west and granite and granite-gneiss on the east. At some bends the rocks on both

sides of the river are quartzite with interlayered beds of quartz-mica-garnet gneiss. At other localities the outcrops are of granite and granite-gneiss with long, narrow inclusions of sediments. To the northeast, towards Paint lake, the granitic rocks are more abundant than near Kwasitchewan falls.

Paint Lake. This lake is underlain by grey granite and syenite-gneiss, some outcrops of which are highly foliated and have the appearance of bedded strata. Some of the granitic gneisses carry red garnets. The foliated granite contains numerous masses of grey and black, micaceous, sedimentary gneiss and schist; garnet is abundant in much of this rock. Besides these foliated rocks, pink and pinkish grey, massive granite occurs in long, sill-like, and boss-shaped masses. Some outcrops of this granite contain inclusions of black, coarse-grained, basic rock that may be pyroxenite or gabbro. Dykes of pegmatite, pegmatitic granite, and aplite cut the grey, granitic gneisses. Some of the bodies of sedimentary gneiss and also some of the foliated granite-gneiss, weather rusty. Prospect pits along such zones expose schistose gneiss heavily mineralized with pyrrhotite. Some outcrops of the gneisses exhibit from a distance the appearence of being painted red, due to the reddish colour of the moss covering the surface. The name Paint was given the lake on account of this unusual appearance of certain outcrops.

Ospwagan Lake. The geology about this lake was studied by Alcock[1], who divides the rocks there exposed into three groups: (1) grey gneiss, greenstone, and hornblende schist; (2) undifferentiated, chiefly granite-gneiss; and (3) pegmatite. The area of grey gneiss and greenstone extends from 4 miles southwest of Little Pipe lake north 20 miles to Burntwood river. Similar rocks occur on Mystery lake along the projected strike of this belt and 10 miles farther to the north. The maximum width of this area of gneiss and greenstone is 3½ miles. Some of the grey gneiss is definitely of sedimentary origin, but the gneisses of other areas may be igneous. The greenstone includes highly altered, andesitic and basaltic lavas. Deposits of clay are widespread inland and outcrops are confined to the shores of the lakes, to a few points along streams, and to the tops of the higher ridges.

The belt of grey gneiss and greenstone about Ospwagan lake has been prospected in a general way. Shear zones in the volcanic rocks are sparingly mineralized with pyrite, pyrrhotite, and specks of chalcopyrite. Some mining claims were staked in 1929, near the outlet of the lake, along bands of quartz-feldspar-sericite schist intruded by pegmatite. Other zones of talcose schist in greenstone have been trenched recently and some chalcopyrite occurs at all these localities.

Mystery Lake. A deposit of silver-bearing galena was discovered on the west shore of Mystery lake by Mr. Gordon Murray in the summer of 1927. In 1928 the deposit was taken up by Mr. J. P. Gordon, and Royden Mines, Limited, was organized to develop it. Surface trenching and diamond drilling were done in 1928 and 1929.

Massive and schistose andesite and basalt outcrop on the west shore at the south end of the lake. Bedded quartzite and greywacke, striking north 5 degrees west and dipping 75 degrees east, outcrop farther north along the west shore and on the point extending from the west shore about

[1] "Ospwagan Lake-Burntwood River Area, Northern Manitoba"; Geol. Surv., Canada, Sum. Rept. 1920, pt. C, pp. 1-6.

half-way up the lake. Pillow lava is interbedded with cherty quartzite at some horizons. Granite outcrops on the northwest shore and also on the east side, where it holds masses of lava and sediments. The granite, lavas, and sediments are cut by dykes of gabbro and diabase. A large, well-defined terminal moraine trending north 40 degrees east, passes about 3,000 feet west of the northwest bay of Mystery lake. These hills extend at least 7 miles along their strike. On their northwest side the country is flat or gently undulating and heavily drift covered.

The galena deposit is on the west shore of the lake, about 2 miles north of the outlet. It is at about the high-water level of the lake and has been exposed by seven trenches spaced at intervals along a distance of 450 feet, and a strike of north 5 degrees east. The rock west of the trenches is a grey, acidic rock that may be quartzose sediments recrystallized and injected by granitic matter. Granite outcrops on the side of the hill farther west. The acidic rock is followed to the east by pillow lava and thin beds of cherty quartzite and greywacke. The lava is schistose and the sediments exhibit fracture cleavage and some beds are drag-folded. The dip of the schistosity and cleavage is 75 degrees east. The lavas and sediments are cut by a few small bodies of gabbro.

The sulphides occur in schistose andesite adjoining the grey, acidic rock. The schist zone varies from 2½ to 20 feet in width. It gradually narrows towards the north; to the south it passes under the boulder beach and lake. Small lenses of intermixed calcite and quartz carrying galena and sphalerite occur along the schist zone. One vein containing lenses and pockets of galena, is 2 feet wide, but the majority of the veins are under 1 foot in width. The individual veins do not continue more than 100 feet along their strike. A few veinlets of quartz mineralized with pyrite, chalcopyrite, and galena occur in the same zone as the calcite-quartz-galena veins. A few narrow dykes of aplitic and pegmatitic granite cut the schist along the mineralized zone.

In thin section the galena-quartz-calcite ore shows saussuritized feldspar, small fragments of albite, and abundant chloritic material representing the lava. This altered rock is cut by veinlets of calcite and quartz. Some of the calcite exhibits crystal form. The quartz is in small grains. The altered lava and vein-like calcite, and quartz are cut by veinlets of galena and sphalerite. The galena invades and includes grains of sphalerite. The altered lava first was injected by veinlets of calcite and quartz; these were penetrated first by sphalerite and then by galena. The relations of pyrite and chalcopyrite to galena and sphalerite were not shown in the specimens studied.

Wintering Lake. The area about this lake has been prospected at intervals during the past 15 years; two sulphide deposits have been explored in detail and one of these was diamond drilled in 1928. The greatest length of the lake is 25 miles in a northeast direction and the bays are about 2 miles across at their widest points. Bedrock is well exposed along the several, long, narrow bays.

The rocks about the lake, in order of age from youngest to oldest, are as follows: olivine diabase; granite, aplite, and pegmatite; pyroxenite and gabbro; grey granite and syenite gneiss; and quartz-mica-garnet sedimentary gneiss.

The sedimentary gneisses are typically exposed along the east bay running parallel with the railway from Thicket Portage west. The abundant type is a grey to black, micaceous, garnet gneiss accompanied by some beds of gneissic quartzite. Some beds carry abundant pyrrhotite and these weather rusty. The sediments are intimately intermixed with massive granitic rocks injected along the foliation planes. Some outcrops have the mineral composition of acidic granites and carry abundant red garnet, whereas others are a grey to black mica and hornblende rich gneiss without quartz, and are classed as syenite-gneiss.

The complex of sedimentary and intrusive gneisses is cut by dykes and bosses of pyroxenite and gabbo. These are medium to very coarse-grained, black rocks, either massive or slightly schistose. Augite and an orthorhombic pyroxene are the abundant minerals. Some of the augite has the brownish colour of titaniferous augite. Rounded crystals of olivine occur within some of the pyroxene. These minerals are in part altered to serpentine and chloritic and epidotite-like materials. Biotite and hornblende, probably of secondary origin, occur in some specimens. A few bits of labradorite occur in most specimens, and in some this feldspar is abundant enough to warrant classifying the rock as a gabbro. Magnetite, titaniferous magnetite, and pyrrhotite are abundant accessory minerals. Red garnet is abundant in some outcrops, and is altered to micaceous and chloritic materials along cracks. The basic rock is penetrated by dykes of pink and white granite, aplite, and pegmatite. Several large areas of white and pink, massive, coarse-grained, pegmatitic granite occur about the lake. One of these lies inland on the large point between the long southwest and west bays of the lake. The many granite and pegmatite dykes cutting the basic intrusives and the older gneisses, may be phases of the magma that consolidated in these bodies of massive granite. The older gneisses and the massive granite are crossed by dykes of olivine diabase, trending about 20 degrees east of north and crossing the foliation structure of the older rocks, which strikes from north 65 to 80 degrees east. The diabase weathers brownish in some outcrops and in thin section its abundant minerals are olivine and augite. These minerals are fresh or only very slightly altered.

During the summer of 1929, Atlas Exploration Company trenched and diamond drilled a sulphide deposit at the northeast end of an island near the east short of Wintering lake, just south of the junction of the long, west, southwest, and northeast arms of the lake. The bedrock exposed along the shore of this island consists of grey to black, granitic gneiss locally carrying red garnet and small inclusions of garnet-rich sedimentary gneiss and of black chloritic schist. No quartz is visible in some specimens of the dark-coloured, only slightly foliated, granitic rocks. These rocks are cut by pyroxenite, and the sulphide mineralization is along the contact between the pyroxenite and the granitic gneisses. The pyroxenite and the associated sulphide-bearing zone are cut by pegmatite, some masses of which contain greenish plagioclase and hornblende crystals up to an inch long. Pyrrhotite and chalcopyrite appear to be localized in small areas near these pegmatites. Dykes of massive diabase cut all the rocks. One such dyke about 10 feet thick and dipping 25 degrees east, apparently cuts across the sulphide zone near the east end of the island.

The trenching was done along the shore near the east end of the island. The rocks are exposed only within 3 to 15 feet from the lake; the interior of the island is covered with clay. No large, continuous body of mineralized rock is visible. Some trenches reveal narrow zones wherein pyrrhotite and chalcopyrite are abundant, but such zones do not appear to continue far along their strike. Apparently only small separate bodies of rock mineralized with pyrrhotite and some chalcopyrite were found. The pyrrhotite is reported to be nickeliferous.

The Huronian Belt Company, in 1928, also prospected a sulphide deposit on a point along the northwest shore of Wintering lake, about 2 miles southwest of the outlet of the lake. The pits are along the east and west sides of the point. The rock exposures are limited to a narrow fringe along the shore between water-level and the clay banks. The geological relations here are very similar to those on the deposit explored by the Atlas Company. A white-weathering, garnet-rich rock outcrops within the grey granite-gneiss at the north end of the island-shaped area joined to the east side of the point on which the prospecting work has been done. Outcrops of a similar rock were noted at localities along the east shore of the northeast arm of Wintering lake. Some outcrops are estimated to be 60 per cent opalescent quartz, 35 per cent red garnet, and 5 per cent mica. The garnets are evenly distributed through the whole mass except for small, lens-shaped and long, narrow areas wherein garnet is estimated to form at least 75 per cent of the rock. In thin section the large grains of grey garnet are crossed by cracks containing mica and chloritic materials. The garnet is surrounded by quartz grains, some of the larger of which contain long needles that may be apatite. Some biotite and grey chloritic material occur between the quartz grains. The contact of the garnet rock is sharp against surrounding grey, quartzose gneiss. No evidence was seen to prove an intrusive relation of this quartz-garnet rock. Blocks of quartzose sediments occur in the surrounding granite-gneiss. The quartz-garnet rock may be a phase of a granitic magma enriched with garnet and quartz derived from the digestion of the quartz-garnet gneisses.

The sulphide body on the east side of the point is within or near pyroxenite, cut by pegmatite. The mineralized pyroxenite is jointed and slightly schistified. Some of the pyroxene crystals are an inch long and these and the olivine are in part altered to chloritic and talcose materials. A few irregular areas of grey carbonate occur between some of the pyroxene crystals. Magnetite and pyrrhotite are abundant. Magnetite is estimated to form one-fourth of the pyroxenite of an outcrop 40 feet long and 10 feet wide on the east side of the point just north of the low neck of land connecting with the island to the east. The bluish magnetite is distributed evenly throughout the rock in single and small patches of grains. This rock is crossed by seams up to 1 inch wide of fine-grained pyroxenite, in part altered to serpentine and magnetite. Red garnets are present in most outcrops of pyroxenite. The outline and size of the pyroxenite bodies could not be determined because of the overlying clay deposits inland.

Some of the pegmatitic rock exposed in the trenches on the west side of the point, carries tabular crystals of hornblende up to an inch long. These large crystals are crossed by veinlets of pyrrhotite and quartz, which also fill the interstices between the hornblende crystals. Other small bodies

of pegmatite contain greenish grey plagioclase. The pyrrhotite and chalcopyrite are localized for the most part to the pyroxenite or to grey gneiss adjoining these unusual pegmatites. Such bodies of sulphide-bearing rock, however, are narrow. Some lens-shaped areas of pyrrhotite are 5 inches across. Some of the pyrrhotite is reported to carry nickel. Most of the chalcopyrite is in small areas of schistose rock with abundant quartz. Extensive trenching was done to trace the continuity of the several occurrences of sulphide in the intervening areas. The main sulphide mineralization apparently was confined to two or more small lenses, and the concentration of the sulphides appears to be related to the intrusion of the pegmatites of unusual mineral content.

Clay Deposits on Wintering Lake. Stratified clay of post-Glacial age is widespread about Wintering lake, and two deposits were sampled to determine their suitability for the manufacture of clay products. As the deposits are near the Hudson Bay railway they might be utilized at some future date if their quality was satisfactory.

The two deposits sampled lie north of the southwest arm of Wintering lake and about 3½ miles north of the Hudson Bay railway. One of the deposits underlies a meadow about ½ mile north of the lake, along a creek entering a bay about 2½ miles east of the west end of the arm; the second deposit is along the north shore about 2,000 feet east of the west end of this arm. Three samples were collected at the first locality and one at the second. The clays are especially well developed about the west end of this arm of the lake, and at a few places are exposed in cuts 6 to 15 feet high. The clays are greyish and buff, and are finely laminated. All are calcareous.

The samples collected were tested by J. G. Phillips, ceramic engineer of the Division of Ceramics and Road Materials, Mines Branch, Department of Mines. The following information regarding the clays is from the report furnished by Mr. Howells Frechette, Chief of the Division.

Sample No. 1556-1 from the meadow is a soft clay of light grey colour. Its properties are as follows:

Tempering water	35 per cent
Working properties	Highly plastic, works well
Drying behaviour	Cracked during moderately rapid drying
Average drying shrinkage	9·3 per cent
Softening point	Cone 2 (2075°F.)

Firing behaviour—

Cone	Fire shrinkage	Absorption
010 (1634°F.)	2·1 per cent	15·3 per cent
06 (1841°F.)	8·4 "	0·3 "
04 (1922°F.)	9·0 "	0·3 "

Colour	Hardness
Salmon	Hard
Poor red	Very hard
"	"

"This clay has several objectionable features: (1) A high shrinkage with a tendency to crack during fairly rapid drying; (2) an unfavourable fire colour; (3) an abrupt and large increase in fire shrinkage between cones 010 and 06. This clay is considered to be of little value for the manufacture of clay products."

The results of the tests of the other two samples from this locality are similar to those of the sample given in detail above. All the clay at this locality apparently has the same objectionable features, namely, "defective drying properties, an unfavourable fired colour, and a high fire shrinkage which developed abruptly with increase in firing temperature." The clay has a high content of carbonate of lime and poor working properties and for all these reasons is considered to be unsuitable for use in the manufacture of clay products.

The sample from the second locality near the west end of the arm of the lake is a soft clay of buff colour.

"It was found to have a high carbonate of lime content and after tempering with 17 per cent water (the optimum percentage) it was found to be low in plasticity, flabby, and to be generally poor in working properties. Its softening point was determined to be at cone 4 (2129°F.). This material is also considered unsuitable for use in the manufacture of clay products because of a very high carbonate of lime content and poor working properties."

The samples of clay submitted for testing are representative of the post-Glacial clays about Wintering lake, and at present they are of little or no commercial value for use in the manufacture of clay products.

Partridge Crop Lake. This lake lies northeast of Wintering lake and is a series of irregular-outlined expansions of Grass river. There is only one small rapid on Wintering river between Wintering lake and Partridge Crop lake, which can be reached by canoe easily in half a day from either Thicket Portage or from Mile 205 on the Hudson Bay railway. The geology about Partridge Crop lake is very similar to that about Wintering and Paint lakes.

The oldest rocks recognizable about Partridge Crop lake are grey quartzose and micaceous gneisses occurring in small areas within granite-gneiss and granite. Red garnet is abundant in most beds of the old gneisses and flakes of graphite occur in some specimens. The surface of some of the micaceous gneiss weathers rusty and the fresh rock beneath is heavily mineralized with grains of pyrrhotite and magnetite. These gneisses may be recrystallized sediments. Grey to dark grey, foliated granite and syenite-gneisses outcrop at a number of localities about the southwest end of Partridge Crop lake, and both the igneous and sedimentary gneisses are penetrated by dykes and small, boss-shaped masses of pyroxenite and quartz diorite. Some bodies of the basic rocks are schistose, others are coarse-grained and massive. The gneisses and basic intrusives are cut by dykes of pink and white, medium-grained granite and pegmatite. Eastward from Wintering lake, the pinkish, massive granite is more abundant than on Paint or Wintering lakes, and at the west end of Natawahunan lake, which adjoins Partridge Crop on the east, the areas of older gneisses and intrusives in this granite are small and widely spaced. The strike and dip of the foliation of the older gneisses is variable from point to point about Partridge Crop lake. Dykes of massive diabase, trending north 20 degrees east, are the youngest rocks recognized in the area.

The relationships of the various rocks mentioned above are well exposed along the west end of the long bay extending west from south of the narrows between Partridge Crop and Natawahunan lakes, nearly to the narrows north of the entrance of Grass river. A fairly large area of the older gneisses occurs here and the highly foliated, granitic and syenitic

gneisses contain inclusions of garnet-rich sedimentary gneisses. Both these types of gneiss are cut by pyroxenite and black, schistose, quartz diorite. The black intrusives are penetrated by dykes of pink granite and this granite forms lit par lit gneisses in the older, foliated, igneous and sedimentary rocks. Some granite dykes cross the foliation of the older gneisses.

In 1928 and 1929, Manitoba Basin Mines, Limited, explored a copper-nickel deposit on the Norite group of mineral claims on Partridge Crop lake. This deposit is described as follows, on page 140 of the First Annual Report on Mines and Minerals of the Manitoba Department of Mines and Natural Resources for 1928.

The Norite group

"includes twelve claims situated on the south arm of Partridge Crop lake, about 8 miles north of Mile 205, on the Hudson Bay railway. Claims were staked along the west shore of the lake and also on several islands. The islands, part of a chain running north and south, are parallel the long axis of the lake and consist entirely of a dark, crystalline, basic rock, probably gabbro. Along the west shore of the lake there are also greenstones and granitic rocks.

In the contact zone, parallel breaks and fractures occur and contain copper, zinc, and nickel sulphides in association with pyrrhotite. In one place it is reported that 8 feet of pyrrhotite with chalcopyrite seams running through it are exposed and in the centre of the pyrrhotite zone a 6-inch band of high-grade material occurs."

Some surface trenching has also been done to explore several other bodies of rusty sulphide-bearing rock outcropping at several points along the lake shore. Chalcopyrite occurs only sparingly with pyrrhotite at the localities visited.

Landing Lake. This lake is east of the Hudson Bay railway and is accessible by a wagon road about a mile long from Thicket Portage. The lake trends east and west and is 30 miles long. The maximum width of the main body is $2\frac{1}{2}$ miles. A number of long, narrow bays extend inland from both the north and south shores.

Grey, foliated granite with inclusions of garnet gneiss and black schist, outcrops about the west end of Landing lake. To the east about 7 miles, thin layers of pink granite occur along the foliation planes of the grey gneiss. Farther east the pink granite is more abundant and it is the widespread rock at the east end of the lake. This granite is pink or pinkish grey and is massive or only slightly foliated. The strike of the foliation of the grey granite is from north 65 to 80 degrees east and the dip from 55 to 75 degrees north. The grey and pink granite are cut by diabase dykes trending north 20 to 25 degrees east or nearly at 45 degrees to the strike of the foliation of the gneissic granite. The diabase is a massive black rock weathering brownish. The dykes vary in width from 40 to 600 feet and some continue for at least 6 miles along their strike and may extend much farther inland beyond where they were observed. The diabase forms ridges, in some cases rising 50 feet above the hills of granite. Sixteen parallel dykes of diabase were noted along the north shore of the lake within 11 miles east from a point about 8 miles east of the road to Thicket Portage.

The minerals in most thin sections of the diabase are fresh or only slightly altered. Large crystals of olivine and augite are the abundant constituents. Some grains of olivine are altered to serpentine and magnetite along cracks. Some of the augite has the brownish pleochroism

characteristic of titaniferous augite. A few small areas of augite are surrounded by hornblende. In parts of the thin sections, laths of labradorite are abundant and occur between the augite and olivine crystals. Some labradorite crystals penetrate both olivine and augite. Small grains of these minerals and of hornblende are included in the feldspar. Magnetite and titaniferous magnetite are abundant accessories in most specimens. In one thin section all the minerals are slightly altered to epidote, zoisite, chlorite, talc, serpentine, grey carbonate, and leucoxene. Dykes of olivine diabase are not known to be of widespread distribution in northern Manitoba. They appear to be localized along belts trending about north 20 degrees east and cutting diagonally the structures of the older rocks. J. B. Tyrrell[1] describes dykes of olivine norite and diabase along Nelson river north of Cross lake, apparently along the southward extension of the area containing the abundant olivine diabase on Landing lake.

Several groups of mineral claims have been staked about Landing lake. Some trenching has been done along the north side of the long east-west bay, 5½ miles east of the entrance of Lucky bay, and on the south shore about one-half mile west of where the canoe route leaves for Sabomin lake. The trenches at the locality on the north shore expose slightly schistose, quartzose gneiss carrying disseminated pyrrhotite. Outcrops of this rock weather rusty. It occurs at intervals for several miles along the shore. Some beds of the gneiss are highly foliated and some carry abundant red garnet. The pyrrhotite is more abundant in the micaceous, garnet gneiss, which may be a long, narrow body of sediments included in the granite-gneiss. The pits at the locality on the south shore expose grey, quartzose gneiss that is jointed, schistified, and cut by small bodies of coarse-grained pegmatite. Pyrrhotite and some chalcopyrite occur across a width of about 30 feet of this rock. As the deposit is exposed only between the water-level of the lake and the clay bank, its size and trend could not be determined. Chalcopyrite is not abundant except in small patches.

[1]Geol. Surv., Canada., Ann. Rept., vol. XIII, pt. F, p. 26 (1900).

OTHER FIELD WORK

J. R. Marshall. Mr. Marshall, assisted by J. Satterly, completed geological mapping of an area of Precambrian rocks constituting a 4-mile quadrangle bounded by latitudes 53° and 54°, and longitudes 102° and 104°, Saskatchewan.

C. H. Stockwell. Mr. Stockwell continued a geographical and geological exploration of the eastern part of Great Slave lake, North West Territories.

L. J. Weeks and D. F. Kidd. Messrs. Weeks and Kidd continued the geographical and geological exploration of two 4-mile quadrangles (latitudes 62°–63°, longitudes 92°–96°), extending west from Hudson bay, North West Territories.

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