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

MINES AND GEOLOGY BRANCH
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GEOLOGICAL SURVEY

MEMOIR 219

HALFWAY LAKE-BERESFORD LAKE AREA, MANITOBA

BY
C. H. Stockwell and C. S. Lord

OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1939

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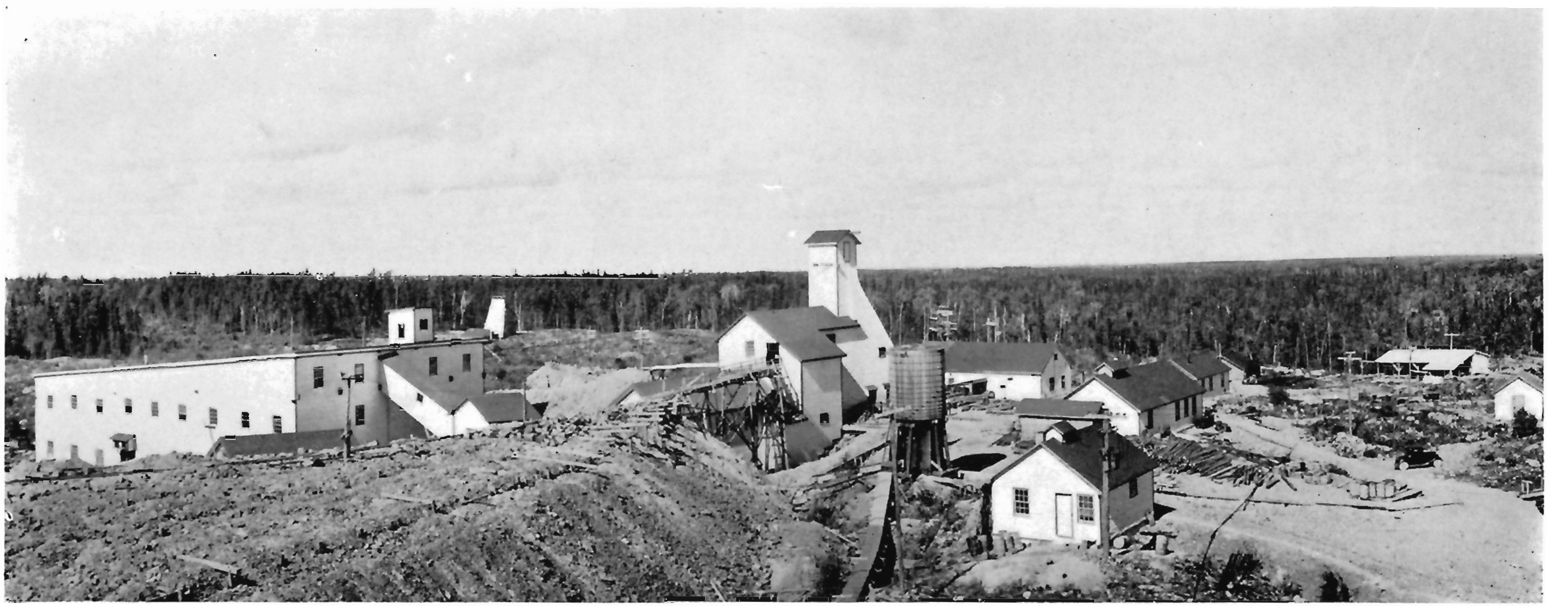

Gunnar Gold Mines, Limited, No. 1 shaft in centre foreground, No. 2 shaft in left background.

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CHAPTER I

INTRODUCTION

Beresford Lake is situated in southeastern Manitoba, 110 miles northeast of Winnipeg and 3½ miles west of the Manitoba-Ontario boundary. This report deals with the geology of a rectangle of about 25 square miles between Halfway Lake, at the west end, and Beresford Lake, at the east end. Although the area had previously been studied and geologically mapped,[1] a more detailed investigation seemed advisable because of renewed interest in the area following the discovery of the Gunnar mine, which began producing gold in 1936. The detailed work was begun in 1936 by C. S. Lord, who made a careful study of an area of about 3½ square miles in the vicinity of the Gunnar mine. The results of this work seemed so important, especially as regards the structure of the geological formations, that the work was continued in 1937, when C. H. Stockwell mapped, in a somewhat less detailed manner, the country around the Central Manitoba and Beresford Lake (Oro Grande) mines. The results of the two seasons' work are presented in this report.

Beresford Lake may be reached by air from Winnipeg or Lac du Bonnet, and, except during freeze-up and break-up, the air service for transportation of passengers, express, and mail is maintained daily. During summer months, a bi-weekly boat service for passengers and freight operates from Winnipeg to Beresford Lake, by way of Lake Winnipeg, Wanipigow River, Quesnel Lake, and Long Lake. The water route is interrupted by some five portages over gravelled roads. A winter road 45 miles long extends from Beresford Lake to Great Falls, on Winnipeg River, where rail connections are made. Electric power is transmitted from Great Falls to the Central Manitoba, Gunnar, and Beresford Lake mines. A post office is maintained at the town of Beresford Lake, on the east shore of the lake, and telephone service connects with Winnipeg and other points.

Prospecting in the area dates back to 1912, following a discovery of gold in 1911 in Rice Lake area some 15 miles to the northwest. Several gold-bearing deposits were soon found, and in 1922 a little gold was pro-

[1] Moore, E. S.: Region East of the South End of Lake Winnipeg; Geol. Surv., Canada, Sum. Rept. 1912, pp. 262-270.

Wright, J. F.: Geology and Mineral Prospects of the Northern Part of Beresford Lake Map-area, Southeast Manitoba; Geol. Surv., Canada, Sum. Rept. 1923, pt. B, pp. 86-104.

DeLury, J. S.: The Mineral Resources of Southeastern Manitoba; Industrial Development Board of Manitoba, 1927, pp. 28-34.

Wright, J. F.: Geol. Surv., Canada, Map 195A (1927).

Wright, J. F.: Geology and Mineral Deposits of a Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169 (1932).

duced from the Elora claim. In the following year underground work was commenced on a deposit on the Oro Grande claim, which has since been developed to the 500-foot level, with a small production of gold in 1932 and 1933. In 1924 intensive exploration was started on claims now held by Central Manitoba Mines, Limited, where underground workings extend to the 875-foot level; the mine went into production in 1927 and, before closing down in 1937, produced over $4,000,000 in gold. A rich gold-bearing deposit was discovered on the Gunnar fraction in 1933 and led to the development of the Gunnar mine, where underground workings had reached the 1,000-foot level in 1936; milling operations commenced in April 1936, and $573,000 in gold and some silver were recovered during the first year's operations.

Bedrock is very well exposed throughout much of the area. Rock hills and ridges commonly do not rise more than 20 to 50 feet above nearby, drift-filled valleys or muskegs, although the relief is somewhat greater toward the southwest boundary of the area and near large lakes. Much of the country was burnt over many years ago and, although now partly covered with small second growth, still presents clean rock exposures, excellent for geological study. A large area in the vicinity of Beresford Lake, however, is thickly timbered and the rocky hills are generally covered with moss.

Glacial striæ are well preserved on many outcrops, and indicate that the continental ice-sheet of Pleistocene time moved south 40 to 50 degrees west. On the retreat of the ice thick deposits of glacial drift were left in the valleys and on the southwest slopes of rock hills. Only a few small areas of clay were noted.

Indebtedness is acknowledged to all those who have in any way contributed to this investigation. Mr. James Houston, Manager of Gunnar Gold Mines, Limited, and Mr. J. Curtis Houston, Manager of Central Manitoba Mines, Limited, willingly co-operated in the study of the Gunnar and Central Manitoba Mines and in other ways, and the descriptions of these mines would have been impossible without the information and assistance that they gave. Mr. Leo Seaberg, an original locator of the Gunnar mine, and one who had prospected much of the surrounding area, gave freely of the close, accurate knowledge so gained. The Manitoba Department of Mines and Natural Resources supplied claim maps and the names of claim owners. C. S. Lord carried on his laboratory investigations at the Massachusetts Institute of Technology, where Dr. W. H. Newhouse and other members of the staff of the Department of Geology materially facilitated the work through their valued assistance, suggestions, and criticisms. Assistance in the field work was rendered in 1936 by Messrs. J. L. Atkins, P. Gaudry, W. N. Ingham, and J. C. Scott, and in 1937 by Messrs. C. O. Hage, W. N. Ingham, M. G. Smerchanski, J. C. Gibson, E. T. Hignell, D. A. Bowles, and, for the latter part of the season, by T. E. Burke-Gaffney.

CHAPTER II

GENERAL GEOLOGY

SUMMARY STATEMENT

All the consolidated rocks in the area are Precambrian. The oldest are chiefly andesitic and basaltic flows interlayered with volcanic breccia and well-bedded, arkosic and tuffaceous sediments. These are overlain by porphyritic trachyte, arkose, tuff, and iron formation, which, in turn, are overlain by quartzite, greywacke, conglomerate, iron formation, and schist. No unconformity is recognizable within these rocks, which have been named by Wright[1] the Beresford Lake phase of the Rice Lake series.

The Rice Lake rocks have been intruded by many sills, and a few irregular-shaped bodies and dykes of meta-gabbro and meta-diorite, locally with phases of quartz diorite. These intrusive rocks and the sedimentary and volcanic rocks are cut by bodies of rock varying from gabbro to hornblendite and quartz diorite, by a dyke-like body of albite granite, and by a large, irregular-shaped mass and a small stock of oligoclase-quartz diorite. Many dykes of pegmatite, aplite, quartz-feldspar porphyry, and feldspar porphyry occur in the area, and are probably closely related in origin to the oligoclase-quartz diorite and albite granite. A few dykes of lamprophyre cut the oligoclase-quartz diorite, albite granite, and older rocks.

The Rice Lake rocks and the sills of meta-gabbro and meta-diorite have been folded into a major anticline, with a northwesterly striking axis and with several smaller synclines and anticlines on the southwest limb. These rocks are crossed by a large fault formed later than the folding and extending from Stormy Lake northeasterly to Halfway Lake, a distance of 5½ miles. A dyke consisting chiefly of gabbro, but grading here and there into hornblendite and quartz diorite, has been injected along the fault.

Table of Formations

Lamprophyre
Pegmatite, aplite, porphyry
Albite granite, oligoclase-quartz diorite
Gabbro, hornblendite, quartz diorite
Meta-gabbro, meta-diorite, quartz diorite

Rice Lake series

Quartzite, greywacke, conglomerate, iron formation, schist
Porphyritic trachyte, porphyritic trachyte breccia, arkose, tuff, iron formation
Andesite, basalt, arkose, tuff, chert, breccia

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[1] Wright, J. F.: Geology and Mineral Deposits of a Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169 (1932).

ANDESITE AND BASALT

Andesitic and basaltic lavas are the most abundant rocks in the area. For the most part they lie beneath the porphyritic trachyte and associated rocks, and, together with interbedded arkose, tuff, chert, and breccia described below, are the oldest rocks in the area. The lavas, and interbedded sediments, form a group whose base is not exposed and whose exposed part varies in thickness from not less than 2,500 feet to as much as 5,000 feet. A few other flows of andesite and basalt are interlayered with the overlying porphyritic trachyte and associated rocks and with the uppermost beds of quartzite and greywacke.

The lavas are dense to medium-grained rocks varying from massive to schistose and from light green to dark green and black; weathered surfaces are green to brown. The massive variety consists chiefly of hornblende and of zoisite and epidote derived from plagioclase feldspar. Chlorite takes the place of hornblende in the highly schistose varieties. Other constituents include carbonate, biotite, clinozoisite, quartz, leucoxene, titanite, magnetite, and pyrite. Some types are porphyritic with small phenocrysts of plagioclase.

In many localities the lavas show pillow structure. The pillows vary in length from 1 foot or less to 5 feet and are nearly as broad as long, except in highly schistose rocks where pillows have been squeezed to widths of an inch or so and are many feet long. Normal andesitic or basaltic lava forms the interiors of the pillows and grades outwards into a finer grained, lighter coloured rock, which changes abruptly to a peripheral rim about ½ inch wide of dense, dark green material generally weathering brown. Amygdules are rare except within the pillows where they occur mainly in a narrow band near the dense, outer rim. Many of the amygdules are spherical; others are elliptical or rod-like and are radially arranged with respect to the centres of the pillows. The vesicles are open or are partly or wholly filled with various proportions of quartz, calcite, epidote, titanite, pyrite, pyrrhotite, and chalcopyrite. Many of the amygdules are connected with one another by a network of veinlets of the same minerals that fill the vesicles. Angular spaces between contiguous pillows are commonly filled with brecciated andesitic rock or white quartz.

Individual flows change along and across the strike from pillowed lava to massive lava lacking pillows. Across the strike, the change in many places occurs within a foot or so wherein the rock is closely packed with small pillows. Along the strike the change is abrupt or occurs in a zone, a few feet wide, holding a few, partly formed, normal-sized pillows.

Whether with or without pillow structure, many of the lava flows contain numerous, vaguely bounded lumps of pale green epidote mixed with quartz. Many of the lumps are a foot or two in diameter. In schistose rocks the cleavage bends around these masses.

Numerous bands of volcanic breccia are interlayered with the lavas, and some, at least, appear to be upper, fragmental parts of flows. The bands can rarely be followed along the strike for more than a few hundred feet, but one band, 200 feet thick, has been traced for 1½ miles. The breccia consists of irregular, sharply angular pieces of andesitic and basaltic rock from an inch to 2 feet in diameter, closely packed together and showing little or no sorting. Also interlayered with the lavas are a few beds of agglomerate composed of many vesicular and amygdaloidal bombs in a grey or green schistose matrix.

ARKOSE, TUFF, CHERT, AND BRECCIA

Beds of arkose, tuff, chert, and breccia, as already stated, are interbedded with the flows of andesite and basalt. Many bands of these sediments and fragmental volcanic rocks are only a few inches or a few feet thick, extend for only a few hundred feet or less between flows, and are too small to be shown on the accompanying maps. Other bands vary along the strike from 20 to 100 feet thick and are up to $4\frac{1}{2}$ miles long. Still others vary along the strike from 100 to 800 feet or more thick and have been traced for lengths of as much as 6 miles. Most of the bands consist of two or more of the above-mentioned rocks interbedded with one another.

The arkose is a grey to greenish grey, massive to schistose rock, weathering light grey to brownish. The grain varies from fine to coarse and the coarse material consists largely of particles about one-sixteenth to one-eighth inch in diameter. These are closely packed together and stand in relief on weathered surfaces. Most beds are 3 to 20 feet or more thick. Although the grain varies considerably from bed to bed, most beds are uniform from top to bottom. Some beds show a slight variation in grain across the strike, and the lower part of one bed was seen to be coarse grained and conglomeratic with many round pebbles of andesite and chert, up to 2 inches in diameter, near the contact with an underlying flow of andesite. The normal arkose consists chiefly of round and subangular fragments of sodic plagioclase, a few small grains of quartz, and rare, well-rounded pebbles of quartz $\frac{1}{2}$ inch in diameter, all lying in a matrix of fine-grained feldspar and quartz mixed with various amounts of chlorite, hornblende, epidote, zoisite, carbonate, sericite, leucoxene, apatite, and tourmaline.

Other sandy or gritty grained, dark grey to greenish, massive to schistose rocks resemble the arkose in general appearance, except that they contain many small, and a few large, angular fragments of light grey, dense, trachytic material. The angularity and volcanic nature of these fragments suggests that the rock is probably tuff. In addition to the fragments of trachyte, the tuff contains rare fragments of black and grey chert, little or no quartz, and small grains of feldspar varying from albite to andesine, and mixed with chlorite, epidote, zoisite, carbonate, and, in places, hornblende and biotite. Still other finer grained rocks carry many small phenocryst-like crystals of feldspar and resemble porphyritic trachyte in appearance, but are probably also tuff for they hold, in places, a few, small, angular fragments of acidic volcanic material. Much of the gritty and finer grained tuffs show little or no evidence of bedding. Here and there within these unstratified tuffs are layers from 6 inches to 10 feet wide of finer grained, lighter grey, white weathering material. These layers show excellent bedding laminations, from a millimetre to an inch or more wide, which are either straight or crenulated and are conspicuous features of many outcrops. Many such laminations show a grain variation from fine, grey, sandy material at the base to very fine or dense, white material at the top. This well-stratified material may also be tuff and, if so, the perfect laminations and the grain variation probably are the result of the material being explosively ejected from volcanoes and settling in water deep enough so that the deposits would remain undisturbed by waves or currents. Under such conditions each layer would represent a sudden supply of new material and the sorting would be the result of the larger and heavier particles settling more rapidly than the finer grained, dust-like constituents of the tuff. Much material is difficult to classify as either arkose or tuff and may be a mixture of clastic and pyroclastic material.

Chert is rarely seen, but occurs in the tuff as a few lenses and beds an inch or so wide. It is dense and hard and varies from grey to brown and black.

The volcanic breccias are coarser than the tuff. Unlike the flow breccia described in the foregoing section, they were probably explosively ejected from volcanoes. In finer grained types many of the fragments are from ¼ inch to 2 inches long, and consist of dense, white weathering trachyte, some of which is porphyritic with small phenocrysts of albite. Such fragments are scattered through a matrix of fine-grained, tuffaceous material, and in schistose types are elongated parallel to the direction of schistosity. Beds of such material are up to 50 feet thick, extend for a mile along the strike, and are uniform in appearance across the full width except for a slight increase in the size of fragments toward the bottoms of the beds. Coarser breccias contain many angular fragments a foot long with a few from 2 to 3 feet long. Such fragments make up as much as 75 per cent of the rock. A few are of dark green volcanic material, but most are of fine-grained, light greenish grey trachyte, with or without phenocrysts of albite and hornblende. Some outcrops of the coarse breccia show no evidence of bedding, others are poorly bedded due to a crude sorting of variously sized fragments into layers, and a few beds grade upward into sandy textured tuff. A few lumps of epidote like those in the andesitic lava have been developed in the groundmass of the coarse breccia.

From the foregoing description it will be observed that almost all the fragments in the tuff and volcanic breccia are of trachyte, whereas the associated flows are of andesite and basalt. That is, the more acidic material was explosively ejected from volcanoes and the more basic magma was erupted quietly to form flows. This is to be expected, for it is known that acidic magmas are viscous and their included gases escape with explosive violence, whereas basic magmas are more fluid and their gases are discharged without explosive activity.

PORPHYRITIC TRACHYTE, PORPHYRITIC TRACHYTE BRECCIA, ARKOSE, TUFF, IRON FORMATION

These rocks overlie the andesite, basalt, and associated clastics and pyroclastics, and outcrop as a belt, 1,000 feet to a mile or more wide, extending from the axis of the anticline along both limbs to the edges of the map-area. The trachyte and trachyte breccia are typically developed in that part of the southwest limb of the anticline that lies between the axis of the fold and Stormy Lake. There they are interbedded with layers of arkose, tuff, and a little iron formation. In the vicinity of Stormy Lake the trachyte and trachyte breccia appear to die out along their strike toward the northwest as tuffaceous sediments increase in abundance. These sediments continue for at least 3 miles northwest of Stormy Lake and hold a few narrow bands of iron formation. In the northeast limb of the anticline the trachyte, trachyte breccia, and associated sediments are highly altered to sericite, biotite, and hornblende schists, and cannot in most cases be distinguished from one another.

The non-fragmental trachyte lava shows white to pinkish weathering phenocrysts of sodic plagioclase up to three-sixteenths inch long, and a few of rounded quartz set in a dark greenish groundmass made up of albite with a little quartz, carbonate, sericite, and many shreds of chlorite. The phenocrysts are partly altered to brown, dusty material, epidote, clinozoisite, and sericite. In schistose phases the feldspar phenocrysts have been squeezed into thin plates half an inch long. What appear to be still more highly sheared equivalents of the porphyritic trachyte are greenish to pinkish grey sericite-chlorite schists without evidence of former phenocrysts. Certain coarse porphyritic types contain as much as 25 per cent quartz and may be sills, but resemble the lava so closely as to suggest a genetic relationship.

The trachyte breccia for the most part overlies the non-fragmental trachyte. Fragments in the breccia are up to a foot or so in diameter, are rounded to angular, and at many places have been drawn out into elliptical or rod-like masses. On most outcrops the rock shows poorly developed bedding, due to variations in the size of the fragments, to variations in the grain of the fragments, or to slight changes in the colour of the matrix. Usually the fragments are sharply outlined against the matrix, but in places appear to grade into the matrix. No chilling was noted toward the edges of the fragments. Generally the fragments are coarsely porphyritic with phenocrysts of albite and a few of quartz lying in a grey to greenish groundmass, and are identical in appearance and composition with the non-fragmental trachyte described above. The matrix is much like the fragments, but is darker and contains fewer and smaller phenocrysts. In coarse breccias the fragments are in most cases entirely of this coarse porphyritic type. In finer grained breccias where fragments are no more than a few inches long the coarse porphyritic particles may be mixed with many fragments of dense, greenish grey rock, generally holding a few minute phenocrysts of quartz. With decrease in the size of fragments the breccia passes gradually into tuffs and sandy textured, feldspathic sediments or arkose. On the Shirley claim the breccia grades into an aphanitic, dark green lava remarkable for its unusually small, well-developed pillows.

The porphyritic trachyte and porphyritic trachyte breccia resemble in general appearance the porphyritic andesite and porphyritic andesite breccia of Rice Lake-Gold Lake area.[1]

The tuff and feldspathic sediments, which extend northwesterly from Stormy Lake, and which elsewhere are interlayered with the trachyte and trachyte breccia, vary from rather fine-grained, fragmental rocks to

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[1] Stockwell, C. H.: Rice Lake-Gold Lake Area, Southeastern Manitoba; Geol. Surv., Canada, Mem. 210 (1938).

sandy textured and dense material, are generally well bedded, and are much like the tuff and arkose interbedded with the andesitic and basaltic lavas as described above.

The iron formation forms a few straight or crenulated beds varying from an inch to 2 feet wide and intercalated with layers of the fine-grained tuff. Much of the iron formation consists of fine-grained, black, magnetite-rich layers alternating with thin laminations of grey chert and red jasper and small amounts of carbonate and chlorite.

QUARTZITE, GREYWACKE, CONGLOMERATE, IRON FORMATION, SCHIST

These rocks overlie the trachyte, trachyte breccia, and associated rocks. They occur in the northeast limb of the anticline but pass beyond the south boundary of the map-area near the axis of the fold, and, consequently, it is not known if they continue along the southwest limb. At many localities in the northeast limb the sediments are so highly schistose that they are difficult to distinguish from the underlying rocks, which are also highly sheared in the northeast limb, and the contact between the two groups has not been located accurately.

Grey to buff, impure quartzite and darker greywacke containing a large proportion of ferromagnesian constituents are the dominant types. These rocks occur in beds from 1 inch to 5 feet or more thick, are generally highly schistose, and, in places, are gneissic. Crossbedding occurs, but is not conspicuous. A common type is a grey, sugar-grained, schistose or gneissic biotite quartzite, which at many localities is iron stained on weathered surfaces. Coarser varieties are highly feldspathic and contain both perthite and plagioclase. Some of these coarse, feldspathic beds contain, in addition to feldspar and quartz, many fragments of trachyte in a chloritic matrix. At contacts with sills of meta-diorite the chlorite is altered to biotite. At some localities massive beds of quartzite alternate with beds of soft, schistose, sedimentary material containing much carbonate mixed with quartz, feldspar, chlorite, and biotite. Very fine-grained to cherty, dark grey to black, quartzose sediment containing up to 40 per cent of biotite in tiny parallel scales is abundant on the Nap No. 1 claim and southward.

North of Beresford Lake, just west of the Myrtle claim, a bed of conglomerate about 40 feet thick was seen here and there along the strike for a length of $\frac{1}{2}$ mile. It is underlain by quartzite and overlain by a layer of interlaminated iron formation and schist. The conglomerate consists of numerous, rather closely spaced, lenticular pebbles of quartz and quartzite from 1 inch to 6 inches long, lying in a grey schistose matrix.

Black, magnetite iron formation occurs at many localities north and east of Beresford Lake, and is so strongly magnetic that it seriously affects a compass even at considerable distances. Exposures are poor, but the formation may be seen fairly well at a locality about $\frac{2}{3}$ mile northeast of the north end of Beresford Lake, where many beds are up to 5 feet or more wide and are intercalated with beds of similar widths of greywacke and chlorite schist across total widths up to 100 feet. Each bed of iron formation consists of abundant, fine-grained magnetite mixed with cherty quartz, and is divided into inconspicuous laminations $\frac{1}{8}$ to $\frac{1}{2}$ inch wide separated by thin partings of chlorite. At many other localities a few thin beds of black, magnetite-rich rock up to ½ inch wide occur here and there between laminations of quartzite and amphibole schist.

Amphibole schist outcrops at numerous localities north and northeast of Beresford Lake, and is very well exposed adjacent to the conglomerate bed east of the Myrtle claim where the schist and associated rocks have been exposed by stripping and trenching. At the latter locality, laminations of amphibole rock ¼ inch to 2 inches wide alternate with laminations of light grey, sugary textured to cherty quartzite of similar widths, and a few thin layers of iron formation, across total widths of 40 to 80 feet. The laminations are straight or crenulated and are conspicuous on weathered surfaces, which are generally much stained with iron oxide. The amphibole layers weather rusty to brick-red and are pale green on fresh surfaces. This material consists almost entirely of very small fibres of pale green amphibole, probably actinolite, generally either forming a felty mass or arranged with their long axes normal to the walls of the thin laminations, but in places the amphibole fibres form small rosettes with the crystals radiating outwards from a central point.

A bed of graphite schist 5 or 10 feet wide occurs within the above-described belt of amphibole schist. This is a black rock composed of shreds and flakes of graphite, sericite, and chloritic material mixed with grains of quartz.

META-GABBRO, META-DIORITE, QUARTZ DIORITE

Many sills, and a few irregular-shaped bodies and dykes of gabbroic and dioritic rock, locally with quartzose phases, intrude the volcanic and sedimentary rocks of the Rice Lake series.

The largest body is a sill-like mass at least 8½ miles long. It occurs in the axial part of the anticline at a locality ¾ mile southeasterly of Tinney Lake, whence it extends along the northeast limb of the fold to the north edge of the map-area and along the southwest limb to a point ½ mile southwest of Lonely Lake. In the southwest limb it splits in two, one branch passing just south of Wentworth Lake and the other broadening into an irregular-shaped mass that lies north and east of Dove Lake. Except for this irregular-shaped part, the sill is in most places from 500 to 1,000 feet thick. Many other sills are less than 800 feet wide and are a mile or two long. Most of the bodies have been injected into sediments or trachyte or along contacts between these rocks and andesitic or basaltic flows. In addition to the bodies shown on the accompanying maps, there are many, small, sill-like masses that are difficult or impossible to distinguish from coarse-grained, andesitic and basaltic flows, and are not shown on the map. The sediments for 3 miles northwest of Stormy Lake have been invaded by so many closely spaced sills that it was found impossible in the time available to map them accurately, although an attempt has been made to show the larger ones.

The sills in general conform to the structure of enclosing rock and follow so closely the many minor crenulations and drag-folds, which are especially well developed along and near the axes of larger folds, that there can be little doubt that the sills were intruded before the folding took place.

Although the relationships are generally conformable, the upper and lower contacts of some sills cross the bedding at small angles for a few feet along the strike and tongues branch from the edges of the intrusive rock and extend into adjacent sediments. The tongues vary from a few inches to a mile or more long, and the long ones lie close to, and parallel with, the main body. The sills are distinctly chilled for ½ foot to 5 feet from the upper and lower contacts, and the chilled rock, except for very dense material immediately at the contacts, resembles the andesite in appearance. A few small dykes of fine-grained rock, resembling the material of chilled edges of the sills, branch from the upper chilled edges of some sills and extend into overlying sediment. Other dykes of similar material cut sediments and volcanic rocks close to the upper and lower contacts of sills and are probably offshoots from the sills. At a few localities, as on the Solo claim, the diorite or gabbro holds many angular inclusions of sediment for a foot or so from the contact with overlying sediments, as if the inclusions had been derived from the roof rock. At a few other places large patches within the main body of sills hold numerous, closely spaced inclusions of country rock, either with sharp outlines or with vague boundaries as if they had been partly assimilated by the intrusive rock. Some sills, particularly the largest one where it occurs in the northeast limb of the anticline, hold bands of sediments up to ½ mile long and only 5 to 10 feet wide.

Several of the large bodies, notably the branch that passes just south of Wentworth Lake and the sill-like body that extends southwest from Dove Lake, vary considerably in composition and texture from top to bottom. Except for the chilled base, the lower three-quarters or more of these bodies consists of medium- to rather fine-grained, massive meta-diorite, composed chiefly of hornblende and milky white feldspar in about equal amounts and forming grains commonly from one-thirty-second to one-sixteenth inch in diameter. The feldspar is almost completely altered to zoisite and epidote with a little chlorite, sericite, and carbonate; a little quartz may be seen in thin section under the microscope. Weathered surfaces are grey or brown. The diorite passes upward into coarser, darker coloured material, which continues to the upper, chilled border phase. This coarser rock varies considerably in composition and texture from place to place. Much of it is dark green meta-gabbro with abundant hornblende crystals ⅛ to ½ inch long and smaller crystals of zoisitized plagioclase, either interstitial to the hornblende or penetrating that mineral and giving the rock a diabasic texture. Some of this coarse gabbroic rock contains a few grains of blue quartz. In places similar quartz grains are abundant in dark green, finer grained rock, which is probably quartz diorite; the quartz diorite is especially well developed on the Anaconda, Anaconda No. 1, and Anaconda No. 2 claims, where it forms a layer 50 to 100 feet wide and nearly a mile long. At several localities, notably near the west boundary of the Premier claim and in the north part of the Kitchener claim, the gabbro and quartz diorite hold irregular masses up to several feet in diameter and a few small dyke-like bodies of pegmatitic material composed of zoisitized feldspar, quartz, and hornblende; the hornblende crystals are up to 3 inches long and commonly occur in clusters forming fan-shaped and arborescent structures. It is probable that, during the solidification of these sills, the more fluid and siliceous parts separated from the partly crystallized, main body of material and rose toward the tops to form the coarser grained, gabbroic and quartzose phases, and that as these phases were solidifying, a final, still more fluid portion separated to form the pegmatitic segregations and the pegmatitic dykes. Where the sills hold long, thin bands of sediment, as on the Oro Grande claim and just east of the Ace No. 1 claim, the material between each two bands acted as in an individual sill and the coarse-grained or quartzose phases formed close beneath each of the sedimentary bands.

This variation in composition and texture from one side of a sill to the other is less noticeable or lacking in some bodies, especially in irregular-shaped masses and in small sills. These bodies, except for thin, chilled border facies, consist entirely of grey meta-diorite or, more commonly, of dark green, hornblende-rich, gabbroic rock in which the milky white feldspar is not abundant. Some of these gabbroic sills, especially those between Cliff Lake and Stovel Lake, are porphyritic, with phenocrysts of hornblende occurring either as scattered, single individuals or in small groups of crystals giving the rock a spotted appearance. The spotted and porphyritic textures gradually disappear toward the edges of the sills and are lacking in the chilled border phases. Other bodies consist of grey meta-diorite holding irregular patches or parallel bands of the darker meta-gabbro. In all of these rocks the feldspar is much altered to zoisite, epidote, sericite, carbonate, and chlorite, but in places can be determined as varying from andesine to albite; accessory minerals include magnetite, titanite, leucoxene, and pyrite.

The meta-gabbro, meta-diorite, and quartz diorite are generally massive, but at several localities are schistose with hornblende crystals lying parallel to one another or with the development of considerable chlorite in place of hornblende. A narrow sill lying just west of Moore Creek and extending as far south as Beresford Lake is a banded hornblende gneiss, as are also several, small, sill-like bodies north and northeast of the lake. Lumps of green, epidotized material were seen in a few of the sills; these are similar to the epidote lumps in the andesitic and basaltic lavas and in the volcanic breccia, but are much less common than in the lavas.

Several small sills of meta-diorite northwest of Stormy Lake and elsewhere hold numerous crystals of feldspar from ¼ inch to 3 inches in diameter. These commonly occur only within the upper few feet of the sills, a distribution that suggests that they may be phenocrysts that floated toward the top of the magma. However, this explanation does not hold everywhere, for in one sill the large crystals are concentrated near the bottom. The large crystals are white to flesh coloured, and like other feldspar in the diorite are almost completely altered to a mixture of zoisite with a little epidote, chlorite, and sericite.

At a few localities sediments have been bleached for a few feet from the contacts of the sills and contain occasional streaks and needles of pale greenish tourmaline and a little biotite in place of chlorite.

GABBRO, HORNBLENDITE, QUARTZ DIORITE

These rocks form sills and dykes from 20 to 300 feet wide and up to 3½ miles long. They lie along contacts between meta-diorite and sediments or andesitic lava, or cut across all of these rocks and trachyte breccia. Two of the largest bodies follow shear and fault zones, and, in part, are themselves highly sheared along these zones, as if the shearing took place both before and after their injection.

The sills and dykes are chilled to fine-grained, andesitic or basaltic material for 1 to 3 feet from both contacts. Elsewhere they consist chiefly of porphyritic gabbro with phenocrysts of hornblende either scattered through the rock as single crystals or grouped in small patches, giving the rock a spotted appearance. Some bodies are entirely of this material, whereas others vary along the strike from the porphyritic gabbro to hornblendite and to quartz diorite. The hornblendite is coarse grained, with crystals up to $\frac{1}{2}$ inch long, and in places contains much magnetite. The quartz diorite contains abundant bluish to white quartz grains and varies from a dark green, hornblende-rich rock to light-coloured material containing much grey or pink feldspar and only a little hornblende. Feldspars in the gabbro and quartz diorite are much altered to zoisite.

The bodies that follow shear and fault zones are partly altered to green, chloritic schist speckled with brown-weathering carbonate and permeated with many tiny stringers and lenses of carbonate and quartz.

The porphyritic and non-porphyritic gabbro resembles the material of many of the sills between Cliff Lake and Stovel Lake, as already described, and it is possible that these and some other rocks described in the foregoing sections although not known to be chilled against meta-diorite may be the same age as the gabbro, hornblendite, and quartz diorite.

ALBITE GRANITE AND OLIGOCLASE-QUARTZ DIORITE

Albite granite forms a large, dyke-like body, 200 to 400 feet wide and $1\frac{1}{2}$ miles long, extending from the Gunnar mine northward to a point just southwest of Tinney Lake. It trends about parallel to the axis of the anticline and lies about 1,200 feet west of it. The granite crosses bands of andesitic lava and interlayered sediment and a large sill of meta-diorite, and apparently follows a fault, for the formations on one side of the granite are offset as much as 400 feet with respect to those on the other side. Formations beyond the south end of the body are not offset, but are highly sheared and crumpled in a broad, rather vaguely defined zone along the projected strike of the granite. Although dyke-like in general features, the body is irregular in outline and, especially in its south part, sends many tongue-like offshoots into the older rocks on both sides. Most of the tongues follow zones of shearing, and it is evident that the granite was intruded subsequent to the folding and shearing of the Rice Lake rocks and the meta-diorite. The south end of the granite pitches steeply north, and near the south end the east contact of the body dips east. The granite is a grey to pinkish, equigranular, medium- to fine-grained rock with conspicuous grains of quartz commonly making 35 to 40 per cent of the material present, the remainder being albite and a little chlorite. The quartz everywhere embays and appears to have partly replaced the feldspar. Apatite and zircon are accessory. Potash feldspar is lacking. Pegmatitic border facies occur at a few localities and consist chiefly of quartz and large crystals of pink weathering albite. Small dykes of albite granite project outwards from the edges of the main mass, and others occur within a few hundred feet of the main granite body.

The oligoclase-quartz diorite forms a large body at the west end of the area and a small stock on the nearby Rex claim. The large body crosses the strike of adjacent bands of andesite, sediment, and metagabbro, and is irregular in outline with a northerly trend in the north part and a broad, easterly projecting tongue in the south part. The quartz diorite is a massive, grey to pinkish grey rock composed chiefly of oligoclase, quartz, hornblende, and biotite. In places the feldspar crystals are $\frac{1}{4}$ to $\frac{1}{2}$ inch long and give the rock a porphyritic texture. Generally they are much smaller, and, as seen in thin section under the microscope, form stubby euhedral crystals somewhat zoned and slightly altered to zoisite, epidote, and sericite. The quartz is interstitial to the feldspar or forms aggregates of crystals penetrated along the edges by feldspar laths. On weathered surfaces and in hand specimens the quartz aggregates appear as abundant, bluish and white eyes and the rock resembles the "quartz-eye" granite of Elbow-Morton area[1] and elsewhere in northern Manitoba. However, most of the quartz diorite is an equigranular rock without conspicuous eyes of quartz. Accessory minerals include magnetite, apatite, titanite, and rutile, the last occurring as thin needles forming a lattice structure in biotite crystals. Orthoclase and myrmekite are rare. Some of the biotite crystals are partly altered to chlorite. The quartz diorite is not noticeably chilled against bordering andesite, sediments, or metagabbro. The andesite has a baked appearance and is somewhat coarser grained than elsewhere for 100 feet or so from the contacts. Dykes of quartz diorite, up to 15 feet wide and like the rock described above, branch from the edges of the large body and stock, are numerous in bordering rocks for 800 feet or more from the contact, and at some localities are so abundant that they constitute about half of the rock for distances up to 100 feet from the contacts. The dykes strike in many directions.

No body of granodiorite was recognized within the map-area, although an outcrop of pink, biotite-muscovite granodiorite containing plentiful microcline and oligoclase occurs just northeast of the area.

DYKES OF PEGMATITE, APLITE, AND PORPHYRY

A few small dykes, some of pegmatite and others of aplite, from an inch to a foot wide, cut the large body of oligoclase-quartz diorite. Many larger, grey to pinkish, aplitic dykes cut the rocks near this large body and near the small stock of the same rock. The pegmatite consists chiefly of quartz and pink feldspar crystals about 1 inch long. The aplite is composed of oligoclase and quartz. These pegmatite and aplite dykes are probably closely related in origin to the oligoclase-quartz diorite. A few dykes of grey aplite up to 7 feet wide occur just east of the south part of the dyke-like body of albite granite. These dykes consist of orthoclase, plagioclase, quartz, biotite, chlorite, titanite, and ilmenite. One of them cuts a dyke of feldspar porphyry.

[1] Stockell, C. H.: Gold Deposits of Elbow-Morton Area, Manitoba; Geol. Surv., Canada, Mem. 186, pp. 5-7 (1935).

Dykes of feldspar porphyry and quartz-feldspar porphyry are especially numerous in sediments, andesite, and meta-diorite in a band up to 1 mile wide extending from Stormy Lake westerly for $3\frac{1}{2}$ miles to the end of the easterly projecting tongue of the large body of oligoclase-quartz diorite and continuing into the diorite. The dykes vary from 5 to 200 feet wide and generally strike westerly parallel to the bedding and cleavage of enclosing rocks. Several similar dykes occur in andesitic lava on the Clover No. 1 claim and in a small area just east of the south part of the dyke-like body of albite granite, where they trend northerly about parallel to the trend of the granite. Other porphyry dykes occur here and there elsewhere in the area, cut the gabbro and older rocks, and strike either parallel to the schistosity or bedding of enclosing rocks or at large angles to these structures.

The porphyry dykes are massive to schistose, grey rocks, weathering light grey to pinkish. Feldspar phenocrysts are milky white, vary from $\frac{1}{16}$ to $\frac{1}{2}$ inch long, and are much altered to sericite, zoisite, epidote, and carbonate; unaltered remnants vary from albite to andesine and, in some specimens, show a zonal growth. Quartz phenocrysts are clear to bluish and rounded; in quartz-feldspar porphyry they are less plentiful than feldspar phenocrysts, and in feldspar porphyry are lacking or rare. The groundmass in both kinds of porphyry dykes consists of quartz, feldspar, biotite, and hornblende, with secondary chlorite, sericite, and carbonate and accessory magnetite, titanite, and apatite. The groundmass varies from very fine grained in some dykes to rather coarse grained in others. Coarse porphyry dykes are most abundant between Stormy Lake and the large body of oligoclase-quartz diorite, and many of them are much like the phase of the oligoclase-quartz diorite that contains round eyes of quartz. No sharp distinction can be made between the coarse porphyry dykes and the dykes of quartz diorite that are associated with the large body and the small stock.

Such characteristics suggest that the porphyry dykes west of Stormy Lake, although, in part at least, younger than the oligoclase-quartz diorite, are closely related in origin to this rock.

The feldspar porphyry dykes just east of the dyke-like body of albite granite appear to grade into the granite, and may be offshoots from the granite. A quartz-feldspar porphyry dyke is offset by a shear zone into which a tongue of the granite projects, and the dyke, accordingly, is older than the granite. However, this dyke is sufficiently like the feldspar porphyry to suggest a close relationship in origin, and both types of porphyry are probably genetically related to the albite granite.

LAMPROPHYRE DYKES

In the vicinity of the Gunnar mine a few irregular-shaped dykes of biotite lamprophyre were noted in albite granite and in older rocks near the granite. One of the dykes follows a shear zone that offsets a dyke of quartz-feldspar porphyry, and is, therefore, younger than this porphyry dyke. The biotite lamprophyre weathers greenish brown and contains about 15 per cent biotite in flakes up to $\frac{3}{16}$ inch long; other constituents are orthoclase, albite-oligoclase, quartz, carbonate, chlorite, and white mica.

In the vicinity of the Central Manitoba mine a few northwesterly striking dykes of hornblende lamprophyre up to 10 feet wide cut the gabbro and older rocks. This is a fine-grained, black rock composed of abundant hornblende with smaller amounts of oligoclase and quartz and accessory magnetite.

Farther west and southwest, on the Redwing fraction, Gold Hill, and other claims, several somewhat coarser grained dykes of hornblende lamprophyre cut the large body and dykes of oligoclase-quartz diorite and older rocks. One of the lamprophyre dykes is 20 to 40 feet wide, strikes northwesterly, and is apparently at least ½ mile long. Other dykes are 3 to 80 feet wide and are very irregular in shape with angular bends, as if filling irregular cracks in the country rock. These dykes are dark grey to black, weather brown, and consist of hornblende, albite, and quartz with a little biotite and apatite; the feldspar is slightly altered to carbonate and zoisite.

The lamprophyre dykes may be late basic differentiates of the magma that solidified to form the albite granite and the oligoclase-quartz diorite.

CHAPTER III

STRUCTURAL GEOLOGY

FOLDING

The rocks of the Rice Lake series and the sills of meta-gabbro, meta-diorite, and quartz diorite have been folded into a major anticline, which is complicated on the southwest limb by several smaller synclines and anticlines. The axis of the major fold strikes north just east of the Gunnar mine and thence trends northwesterly through Tinney Lake to Cliff Lake. The northeast limb dips 60 to 80 degrees east, whereas the beds in the complicated folds on the southwest limb vary from horizontal to vertical, and at many localities are overturned with dips of 70 to 80 degrees northeast. South of Tinney Lake the main anticline plunges steeply south. Northwest of the lake the dip of the beds on the axis apparently flattens, and near Cliff Lake the anticline plunges northwest. South of Tinney Lake many minor folds 100 to 400 feet across have been developed along and near the axis of the fold.

Most prominent among the smaller folds on the southwest limb of the major anticline is a southeasterly pitching syncline extending southeast from the Ace No. 1 claim ¾ mile southwest of Stovel Lake. Other folds occur just north and east of the lake and, although their nature has not been completely determined, they appear to be closely compressed anticlines and synclines pitching gently northwest. The axes of the small folds strike about parallel to the axis of the major anticline.

Many small drag-folds occur in the limbs of the larger anticlines and synclines and can be seen best in outcrops of thinly laminated tuff. The drag-folds generally pitch in the direction of the plunge of that part of the major fold on which they lie. Thus, south of Tinney Lake, where the main fold plunges steeply south, the drag-folds pitch 60 to 80 degrees south, whereas between Tinney, Stovel, and Cliff Lakes, where the crest flattens and then pitches northwest, the drag-folds generally pitch 10 to 30 degrees northwest. The upper beds have been dragged toward the crests of anticlines and away from the troughs of synclines, as would be expected if they formed by differential movement along the beds as a result of the major folding. Many beds have been irregularly crenulated and the crenulations are especially well developed in beds lying on or near the axes of large folds.

Wright[1], on evidence apparently obtained chiefly just south of the map-area, concluded that the formations throughout the map-area lie in the south limb of a syncline, although recognizing the possible presence of other folds. In the more detailed work, the determination of the major

[1] Wright, J. F.: Geology and Mineral Prospects of the Northern Part of Beresford Lake Map-area, Southeast Manitoba; Geol. Surv., Canada, Sum. Rept. 1923, pt. B, pp. 95-96.
Wright, J. F. Geology and Mineral Deposits of Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169, pp. 31-32 (1932).

anticlinal structure and the smaller folds on the southwest limb was made possible by many observations showing the direction in which the tops of the beds face. Gradation from coarse material on one side of sedimentary beds to fine on the other was the most useful single line of evidence. In these beds coarse material at the bottom grades into fine at the top, and the fine material at the top of one bed changes abruptly to coarse material at the base of the next overlying bed. Such variations occur across widths of several feet in a few beds of arkose and volcanic breccia, but are most commonly seen in thin laminations of fine-grained tuff. Crossbedding and erosion scours were seen in a few places. At a few localities, particularly in the immediate vicinity of the Gunnar mine, pillows are undistorted, and their smooth, rounded tops and basal, tongue-like projections, which are moulded into spaces between underlying pillows, serve to show the direction in which the tops of the flows face. Along the south boundary of the Tene claim a bed of arkose becomes coarser grained and conglomeratic to the north toward the contact with a flow of andesite; the sediment holds pebbles of the andesite and fills irregular spaces between pillows along the contact, showing that the sediment overlies the lava.

REGIONAL SCHISTOSITY

The sediments and volcanic rocks of the Rice Lake series are generally somewhat schistose, although at many localities they are massive. Sills of meta-gabbro, meta-diorite, and quartz diorite vary from massive to schistose, but are on the whole more massive than the sediments and volcanic rocks. Thin beds of sediments lying between sills and flows or between flows are more highly sheared than the adjacent formations, and the shearing is generally concentrated toward the edges of the sediment. Schistosity is especially well developed in the sediments, volcanic rocks, and thin sills of meta-diorite throughout much of the northeast limb of the major anticline.

The secondary cleavage everywhere strikes about north to northwest and dips steeply east to northeast or is vertical. On the limbs of folds the cleavage generally strikes about parallel to the beds. Along and near the crests of anticlines and the troughs of synclines the schistosity crosses the beds and the sills at large angles and, as a general rule, strikes parallel to the axes of the folds, as might be expected if the schistose structure resulted from the compressive forces that caused the folding. Along the northerly trending axis of the main anticline south of Tinney Lake, however, the cleavage crosses the axis and strikes northwesterly. Intrusive bodies of gabbro, the dyke-like body of albite granite, the large body and small stock of oligoclase-quartz diorite, and the dykes of porphyry and other rocks were introduced after the development of the folding and regional schistosity, although they are themselves partly sheared as a result of later movement.

In the schistose sediments and pyroclastics, pebbles and fragments have been elongated parallel to the cleavage or have been drawn out into cigar-shaped bodies pitching in the direction of the plunge of nearby drag-folds and major folds. Many pillows are somewhat squeezed and, in a band of highly sheared andesite on the northeast limb of the major anticline and extending north from the Gunnar mine, pillows have been drawn out to lengths of many feet with widths of only an inch or so. The squeezed band of andesite is only about 500 feet thick, although the same band is 2,750 feet thick near the axis of the fold where the pillows are undistorted or only slightly elongated; the apparent reduction in thickness may in part be due to an original thinning of the flows, but probably is due mainly to rock flowage. Bands of sediment and porphyritic trachyte likewise are much thinner on the northeast limb of the major fold than elsewhere.

SHEAR ZONES AND FAULTS

Two large shear zones occur in the vicinity of the Central Manitoba mine, one lying south of the mine and known as the south carbonate shear and the other lying to the north and known as the north carbonate shear. Both have been invaded along much of their length by long bodies of gabbro, which are generally massive but are locally sheared as if movement continued along the zones after the solidification of the intrusive rock.

The south carbonate shear has been traced for 5½ miles from Halfway Lake, through Dove Lake to Stormy Lake, and varies from 50 feet or less to 200 feet wide. For most of its length it follows a slightly curved course and strikes southeasterly, although in the vicinity of Stormy Lake it strikes south. The dip varies from 50 to 60 degrees northeast in the northwest part to 80 degrees east in the southeast part. The zone crosses sedimentary and volcanic rocks of the Rice Lake series and sills and irregular bodies of meta-diorite, and is evidently a fault for it offsets these formations. The amount of displacement is large, but the direction and amount of offset is unknown for the formations on one side of the fault cannot be definitely matched with those on the other side and the evidence of direction of movement as furnished by drag-folds is contradictory as if the movement had been complex. The zone follows a swampy depression for much of its length and outcrops at only a few localities on the sides of the depression. In the vicinity of the mine it has been intersected in several diamond drill holes and has been entered by crosscuts. Farther northwest the shear appears to split into two branches, which diverge from one another toward the northwest until they are 500 feet apart near Halfway Lake.

On the Fighter and Growler claims the andesite and tuff are crossed by many parallel fractures for 50 feet north of the north edge of the south carbonate shear. The fractures strike and dip parallel to the shear and are spaced 1 or 2 inches apart. Similar closely spaced fractures were seen here and there is sediments and andesite for distances up to 1,400 feet south of the shear. All appear to be closely connected in origin with the forces that caused the main shear zone.

The north carbonate shear commences at a point on the north side of the south carbonate shear just west of the Central Manitoba mine, diverges from the south shear at an angle of 28 degrees, and extends easterly for at least 3¾ miles, passing just south of Wentworth Lake and continuing beyond the lake to a large drift-covered area. The locality where the two shears meet is covered with swamp and it is not known whether the north shear branches from the south shear or is cut off by this shear. The north carbonate shear is in most places about 100 feet wide. West of the Hope claim, which lies just south of Wentworth Lake, the shear dips 65 degrees south, on the Hope claim it changes through vertical to steeply north, and, farther east, continues with a north dip of 70 to 85 degrees. The shear, together with the gabbro that has been intruded along the north edge of the shear, follows a contact between meta-diorite to the south and andesite to the north, although toward the west a thin bed of tuff separates the gabbro from the andesite. The shear may be a fault, but no displacement has been recognized as the shear follows the strike and dip of adjacent formations. The shear zone generally follows a drift-filled depression, but is well exposed at some localities and has been intersected in several diamond drill holes.

The south and north carbonate shears consist of fissile schists, which in places are much crenulated and drag-folded. Schists derived from andesite and meta-diorite are dark green and contain abundant chlorite, whereas those derived from light grey tuff are light grey and sericitic. Much of the sheared rock is speckled with abundant carbonate or is penetrated along cleavage planes by numerous small lenses and stringers of carbonate and quartz. The schist and quartz carry grains of pyrite, but assay only a little gold. Many outcrops weather rusty as a result of decomposition of the pyrite and the carbonate, which is ferruginous.

In addition to the north and south carbonate shears, numerous smaller shear zones occur at many places throughout the area. These strike in many directions, but most of them trend west to northwest. The dips vary from 20 degrees to vertical and are commonly steeply to the north and northeast, although some are to the south and southwest. Many of the shear zones strike and dip parallel or nearly parallel to the bedding of enclosing rock formations; several such shears follow thin bands of sediment and are well developed in sediments close to contacts with andesite, meta-diorite, and gabbro. Others cross the bedding of sediments and volcanic rocks or the sills of meta-diorite at large and small angles; some of these shears follow the regional schistosity, whereas others cross this structure.

Many of the shear zones follow linear depressions and are largely hidden beneath muskeg or drift. The zones are up to 3,500 feet long, commonly pinch and swell along the strike, and vary from 1 to 30 feet or more wide. The walls are usually well defined. Some of the zones split into two or more branches or end one against another, others lie end to end, side by side, or are arranged *en échelon.* Some zones gradually narrow toward the ends and in depth and finally die out; others end rather abruptly along the strike and down the dip; and a few pass from massive to schistose rock and lose their identity in the regional schistosity. Andesite, meta-diorite, and gabbro are altered along the zones to dark green chlorite or chlorite-carbonate schists; more acidic rocks such as oligoclase-quartz diorite and granite are altered to serictic or sericite-carbonate schists.

The shear zones lie in sediments, volcanic rocks, meta-diorite, gabbro, albite granite, and the large body and stock of oligoclase-quartz diorite. A few zones cross or follow dykes of porphyry and aplite, and evidently formed later than these dykes, whereas other zones are penetrated along cleavage planes by aplitic material. At the Gunnar mine tongues of granite project from the large dyke-like body of albite granite into shear zones that lie in adjacent lavas, showing that the granite is younger than the shears; however, shearing along the zones extends for short distances into the main granite body, showing that, although the movement commenced before the intrusion of the granite, the shearing continued after the granite had solidified. At this mine a dyke of biotite lamprophyre follows a shear zone for a short distance and dies out in fingers in the schist of the zone; the dyke is generally massive as if introduced subsequent to the main movement, but is slightly sheared as if movement along the zone continued after the introduction of the dyke. At the Central Manitoba mine a dyke of hornblende lamprophyre is crossed by a shear zone. Accordingly, the shear zones appear to have formed over a considerable period of time; some may be contemporaneous with the intrusion of oligoclase-quartz diorite, albite granite and related dykes of porphyry, aplite, and lamprophyre, whereas others are earlier and still others are later than these rocks.

Some shear zones that cross contacts between two rock formations are wider and stronger in one rock than in the other. In the Gunnar mine, for example, shear zones are strong in pillowed andesite, but become narrow or die out on entering coarser, unpillowed andesite along the strike and down the dip; these zones lose their identity in passing from non-schistose andesite into regionally schistose andesite. At the mine and north nearly to Tinney Lake shear zones are more numerous in massive or slightly schistose rocks just west of the anticlinal axis than in more schistose rocks farther west and on the northeast flank of the large fold. In the Central Manitoba mine some zones are wide and strong in tuff and in gabbro, but become narrow and die out on entering meta-diorite; other zones, entirely in meta-diorite, are of good width and length.

Some shear zones are known to be faults and some are not. The south carbonate shear, described above, is the largest fault in the area, although the amount and direction of displacement are unknown. The dyke-like body of albite granite, as already mentioned, apparently follows a fault, for the formations on one side of the granite are offset as much as 400 feet with respect to those on the other side. In the vicinity of the Gunnar mine several steeply dipping shear zones offset dykes of quartz-feldspar porphyry and feldspar porphyry for distances of a few feet to 350 feet, as measured horizontally. In the mine a fault, which dips 23 degrees northeast, apparently offsets the lava flows but does not appreciably offset the shear zone in which the ore-bodies lie. On the Redwing fraction just south of Halfway Lake a shear zone offsets a bed of sediments and a contact between andesite and meta-diorite about 50 feet.

Vein quartz has been deposited along most of the shear zones, as described in the following chapter on Economic Geology.

CHAPTER IV

ECONOMIC GEOLOGY

GENERAL STATEMENT

All known deposits of economic interest in the area are of gold-bearing vein quartz. Almost the entire production of about $4,685,000 (April 1937) has come from the Central Manitoba and Gunnar mines. Small amounts of gold have also been produced from a small open-cut on the Elora claim and from the Beresford Lake mine. At the Central Manitoba mine ore continued from the surface to a depth of only about 375 feet; at the Gunnar mine it has been found at various depths down to 1,000 feet; and at the Beresford Lake mine no ore has been found below the 225-foot level.

QUARTZ DEPOSITS

General Character. The vein quartz has been deposited in shear zones either in the form of long, roughly tabular bodies known as veins or, more commonly, as lenses and stringers distributed here and there along and across the shear zones. The veins pinch and swell along the strike and down the dip from 1 foot or less to 25 feet wide, and are continuous for lengths up to 1,500 feet. The lenses are a few feet to 100 feet or more long. Vein quartz usually does not extend for the full width or length of the shear zones and in several shears the quartz is known to die out in depth although the shear continues. In a few deposits the quartz is wide along the crests of rolls or drag-folds in the shear zones and narrows or dies out on the limbs of these small folds, forming saddle-reef structure.

The quartz-bearing shear zones strike in many directions, but commonly trend west to northwest. Most of them dip steeply north to northeast, although some are vertical or dip south to southwest; others dip in opposite directions toward the ends and are vertical in the middle; some veins, when traced down the dip, flatten abruptly on gently pitching rolls and then resume their normal dip. Many of the zones, especially in the east half of the area, strike and dip parallel or nearly parallel to the bedding planes of enclosing rock formations; others cross the bedding at large or small angles, some paralleling the regional schistosity and others crossing the cleavage at various angles.

The deposits lie in pratically all rocks of the area. Several follow thin bands of sediment or occur in narrow or broad bands of sediments close to contacts with andesite, meta-diorite, and gabbro. Others lie wholly within andesite, trachyte, meta-diorite, gabbro, and oligoclase-quartz diorite, or cross contacts between these and other rocks. Where shear zones weaken or die out in passing from one type of rock to another, as from andesite to albite granite, from pillowed andesite to unpillowed andesite, from massive andesite to schistose andesite, and from tuff or gabbro into meta-diorite, the quartz bodies likewise become narrower or die out. South of Tinney Lake quartz-bearing shear zones are fairly numerous in the vicinity of the large dyke-like body of albite granite, and are especially abundant toward the south end of this granite body; most of them lie in non-schistose, pillowed, andesitic lava just west of the axis of the main anticline, and only a few occur in more schistose andesite immediately to the west and in highly sheared andesite on the east flank of the large fold. Quartz bodies in the Gunnar mine lie in shear zones in non-schistose, pillowed andesite near the south tip of this granite body and just west of the anticlinal axis. The Beresford Lake mine is on a deposit in a sill of meta-diorite on the northeast limb of the major anticline. Quartz deposits at the Central Manitoba mine occur on the southwest limb of this fold, both in the sill of meta-diorite and in adjacent sediments and gabbro; these deposits lie in a trough-shaped block of ground lying between the north and south carbonate shears. Elsewhere, deposits of vein quartz are more abundant than usual in and near bodies of oligoclase-quartz diorite, in andesitic lava north of the Central Manitoba mine, and along the edges of sedimentary bands in an area of close anticlinal and synclinal folding just southwest of the main anticlinal axis north and southeast of Stovel Lake.

The quartz varies from white to grey or bluish grey and glassy, and from coarse to sugary textured or very fine grained and cherty. In some veins the grey or bluish grey quartz is banded parallel to the walls. In other deposits the grey quartz is crossed normal to the strike by many gash veinlets of white or clear glassy quartz, forming a ladder structure. At some localities the quartz has a spotted or mottled appearance, due to the presence of many small, poorly defined patches of grey quartz lying in a groundmass of white quartz. In several deposits the spotted quartz appears at the surface, whereas in two veins in the Central Manitoba mine smoky grey quartz at and near the surface passes into the spotted variety at depth.

Mineralization. Pyrite occurs in the quartz of almost all the deposits in the area, generally as disseminated grains and less commonly as small patches or short veinlets or streaks. Most deposits contain, in addition to pyrite, smaller amounts of chalcopyrite, and, less commonly, pyrrhotite. All three sulphides occur in the veins of the Central Manitoba mine. In the ore from one of the veins in this mine the copper content averaged about 0·5 per cent, and analyses showed the presence of small amounts of zinc, lead, and nickel; the zinc and lead suggest that small amounts of sphalerite and galena may have been present, and the nickel is possibly contained in the pyrrhotite. The quartz in the Gunnar mine also contains pyrite, chalcopyrite, and pyrrhotite, and carries, as well, sphalerite and a little galena and arsenopyrite. Sphalerite also occurs in other deposits near the dyke-like body of albite granite and at the Beresford Lake mine. Much of the vein quartz in the area holds small patches and veinlets of brown weathering, ferruginous carbonate, and in places carries patches of massive, fine-grained chlorite, and small amounts of pink albite, biotite, sericite, and black or brown tourmaline.

Native gold occurs in the quartz and sulphides. In the Gunnar mine gold generally occurs where sphalerite is present, and is plentiful along streaks of a mixture of fine-grained pyrite and other sulphides, especially where gash veinlets of glassy quartz are numerous. As a general rule, important quantities of gold are more likely to occur in quartz bodies carrying plentiful sulphide minerals than in those in which sulphides are rare or lacking. Sulphides and gold are commonly more plentiful in fine-grained, grey and bluish quartz than in milky white quartz, although some bodies of white quartz have made ore. In some of the veins in the Central Manitoba mine sulphides and gold occur chiefly in grey quartz, decrease in quantity with depth, and are not plentiful in the lower parts of veins where white quartz appears. Chalcopyrite and pyrrhotite occur in minor quantities in the upper parts of ore shoots in No. 1 shear zone in the Gunnar mine, but become prominent at depth in these shoots. Silver, which is probably alloyed with the gold, has been recovered in the ratio of 1 of silver to 6 of gold from the Central Manitoba mine and 1 of silver to 9 of gold from the Gunnar mine.

Ore-bodies. Two ore-bodies have been found in No. 1 shear zone in the Gunnar mine; one extends from the surface to the 375-foot level and the other extends from the 500-foot to the 750-foot level. Both rake 45 to 55 degrees southeast, and are longer in vertical than in horizontal dimension. The upper ore-body is almost co-extensive with a body of quartz that ends to the southeast against or close to a dyke of quartz-feldspar porphyry. Highest gold content is well toward the southeast end of the shoot near the porphyry dyke. Although the shear in which the ore-body lies cuts through the dyke and is not blocked by it, the shear is possibly somewhat constricted along the plane of intersection, and so acted as a dam to the rising gold-bearing solutions. The lower ore-body ends to the east against a dyke of lamprophyre, which fills almost the whole width of the shear and clearly acted as a dam to the rising solutions.

In the Central Manitoba mine some sixteen ore-bodies have been mined from eight deposits. These ore-bodies occurred at or near the surface, and almost no ore was found below the 375-foot level, although vein quartz continues to greater depths. Most of the ore-bodies are much longer in horizontal than in vertical dimension, and lie either horizontally or rake at angles of 5 to 30 deegres either to the east or west. The gentle rake of some of the bodies is explained by the fact that they follow, in part at least, gently pitching rolls or drag-folds in the shear zones and extend for only short distances above and below the rolls. Much of the ore, however, was on normal dips, and some rolls did not yield ore. The largest ore-body extended along the east part of the Kitchener vein for 800 feet, continued for 650 feet in the Eclipse branch vein and for 450 feet in No. 1 Branch vein, and extended from the surface to the 375-foot level. Another large ore-body was 1,120 feet long, and likewise extended from the surface to the 375-foot level; this and other bodies are irregular in outline and contain patches of low-grade material, which was not mined.

In the Beresford Lake mine small sections of ore have been found from the surface to the 225-foot level, but are not known to form a single ore-body to this depth. No ore has been located on the 325- and 500-foot levels.

Wall-rock Alteration. Schists along and near the edges of the bodies of quartz, and forming included blocks and shreds within the quartz, commonly carry disseminated grains and cubes of pyrite and in places are much altered to brown weathering carbonate, but carry little or no gold and nowhere make ore. In the Gunnar mine, normal, dark green, chlorite-carbonate schist of the shear zones is usually altered to a buff or grey rock for a few inches from bodies of vein quartz; this altered material consists of ferruginous carbonate, chlorite, quartz, biotite, and small amounts of albite, white mica, titaniferous iron ores, leucoxene, titanite, tourmaline, pyrite, pyrrhotite, gold, and a bright green, chromium-bearing mica, probably mariposite.

Origin

The quartz deposits lie in virtually all rocks of the area and are younger than the dykes of aplite, porphyry, and lamprophyre, which are the youngest rocks and which appear to be, for the most part, late differentiates of the magmas that solidified to form the oligoclase-quartz diorite and albite granite. Although the deposits are scattered throughout much of the area, they are more plentiful in and near bodies of oligoclase-quartz diorite and albite granite, and none are far from dykes of aplite and porphyry. Both vein quartz and the dyke rocks have been introduced along some shear zones, where they are intimately mixed with one another, and in places elsewhere the granitic and dyke rocks contain abundant vein quartz in the form of irregular patches and interlacing veinlets with ill-defined boundaries. Both the quartz bodies and the intrusive rocks contain albite or other soda-rich feldspar and almost no potash feldspar. These facts suggest that the vein quartz is related in origin to the highly sodic oligoclase-quartz diorite and albite granite.

SUGGESTIONS TO PROSPECTORS

Practically all gold deposits in the area consist of vein quartz deposited along shear zones, and most of the gold occurs in the quartz or in sulphides in the quartz. Although such deposits are numerous, only a few contain, or might be expected to contain, gold in sufficient concentration and quantity to make ore-bodies. The known ore deposits occur under a variety of conditions, and no rule that applies to the area as a whole can be given for their occurrence. However, it may be inferred from a study of the deposits and the areal geology that certain places, as described below, are especially favourable for prospecting.

At the Gunnar mine ore-bodies occur in a shear zone in non-schistose, pillowed andesite close to a dyke-like body of albite granite. The shear narrows or ends on passing into the granite or into unpillowed andesite and loses its identity on passing into schistose andesite. Accordingly, these rocks are less favourable than the non-schistose, pillowed andesite. Non-schistose, pillowed andesite like that at the Gunnar mine extends for about 1,600 feet north of the mine and for about 1,000 feet east and 1,000 feet west of the body of albite granite, and all shear zones in this area should be thoroughly explored. Especially careful search should be made where the shears cross dykes of porphyry or lamprophyre, for, in the mine, dykes of these rocks have acted as dams to ore-bearing solutions. Because of the suggested genetic relationship between the vein quartz and the albite granite, the various rocks near the albite granite farther north cannot be considered unfavourable, although pillowed andesite there is generally more squeezed and distorted than at the Gunnar mine. Highly sheared pillow andesite and other rocks on the east limb of the anticline and extending northeasterly from the Gunnar mine and thence along the west shore of Beresford Lake are less favourable.

Only slightly squeezed and distorted pillow andesite occurs elsewhere in the map-area, and is plentiful on the Clover No. 4 and Clover No. 1 claims and on the Vega fraction just northeast of Stormy Lake, where the andesite is cut by dykes of feldspar porphyry. Although no important deposits are known to have been found there, the rocks are somewhat similar to those at the Gunnar mine and should be carefully prospected.

The largest ore-bodies in the Central Manitoba mine lie in a shear zone in a narrow band of tuffaceous sediment close to the contact with a narrow sill of gabbro that has been intruded between the sediments and a large sill of meta-diorite. Where the shear zone in which these bodies lie extends through the gabbro into the meta-diorite, the ore continues in gabbro, but does not occur in the meta-diorite; this suggests that the sediments and gabbro are more favourable than the meta-diorite. Other ore-bodies, however, occur in shear zones entirely within meta-diorite. The Central Manitoba deposits lie on the southwest limb of the large anticline, and the sill of meta-diorite extends to the axis of the fold just north of the Gunnar mine and thence along the east limb of the fold to the Beresford Lake mine, where small ore-bodies also occur in the meta-diorite. Any strong shear zones holding plentiful vein quartz either within sills of meta-diorite or in sediments or other rocks along the edges should be thoroughly prospected. During the folding of the area shearing movement would be expected to occur in thin beds of incompetent sediments along contacts of large sills of competent meta-diorite, and the narrow bands of sheared sediments should, accordingly, be weak zones suitable for the access of vein material.

The north and south carbonate shears contain many lenses and veinlets of quartz and a little gold, but the shear zones are so wide and long that the gold, so far as known, has been too widely dispersed to form ore-bodies. However, a careful search along the south carbonate shear might reveal certain localities where the shear has been abruptly blocked or greatly constricted by bodies of gabbro that have been intruded along much of the shear zone and have in part been sheared by later movement along the zone; it is possible that vein material and gold may be concentrated by damming of the vein-forming solutions at such localities.

It is interesting to compare the north and south carbonate shears with a large shear zone known as the Cadillac "break" in the Cadillac area, Quebec, where the soft schists of the break were not favourable for the ascent of vein-forming solutions; the solutions found their way into subsidiary fractures and formed ore-bodies in nearby, more massive rocks.[1] Likewise, in the Yellowknife Bay-Prosperous Lake area, Northwest Territories, most of the gold deposits occur in shear zones not far from a major

[1] Gunning, H. C.: Cadillac Area, Quebec; Geol. Surv., Canada, Mem. 206, p. 39 (1937).

fault.[2] The Central Manitoba deposits lie between the north and south carbonate shears and occur in shear zones that may be related in origin to these two large shears. Although important subsidiary shears are not known elsewhere, a search for branch or parallel shears near the north and south carbonate shears appears to be advisable. An area immediately southwest of the south carbonate shear, between Stormy Lake and Dove Lake, is especially favourable in this respect because any vein material emanating from the same source as the numerous porphyry dykes just to the southwest might be dammed against and beneath the northeasterly dipping dyke of gabbro that follows the main shear.

[2] Jolliffe, A. W.: Yellowknife Bay-Prosperous Lake Area, Northwest Territories; Geol. Surv., Canada, Paper 38-21, pp. 39-41 (1938).

CHAPTER V

DESCRIPTIONS OF PROPERTIES

[1]GUNNAR GOLD MINES, LIMITED

The property of Gunnar Gold Mines comprises thirteen mineral claims and ten fractional claims, or some 750 acres. Underground work has been confined to Laird and Gunnar Fraction claims, where two shafts have been sunk and a surface plant has been erected (*See* Plate I). Surface work has been done on the Madeline and other claims.

Laird and Gunnar Fraction Claims

Rich quartz was discovered in February 1933 on the surface on Gunnar Fraction mineral claim, one of a number of claims staked in 1920, 1921, and 1922. Intensive surface exploration was started on August 1, 1933. In October of the same year Gunnar Gold Mines, Limited, was incorporated. The sinking of No. 1 shaft began on April 1, 1934, and a 150-ton mill was completed by February 1, 1936. First bullion was poured on June 1, 1936, and by January 1938 the total value of gold produced was reported to be over $1,000,000.

Underground work has been done on shear zones Nos. 1, 2, and 3. No. 2 and No. 3 zones lie south and north, respectively, of the main (No. 1) zone. No. 1 shaft, 1,000 feet deep, serves No. 1 and No. 2 zones. The No. 1 zone has been explored by drifts at 125-foot intervals down to, and including, the 1,000-foot level. Shorter drifts on No. 2 zone have been opened by crosscuts from No. 1 zone on the 375-, 500-, and 625-foot levels. All ore, other than some afforded by development work has been drawn from two ore shoots near No. 1 shaft in No. 1 zone. More than 12,000 feet of crosscuts and drifts are served by No. 1 shaft. No. 3 zone is served by No. 2 shaft, sunk to the 125-foot level where about 300 feet of drilling and crosscutting are reported to have been done. A crosscut has been driven on the 375-foot level from No. 1 zone to a point vertically below No. 2 shaft. All workings on No. 3 zone were flooded (September 1936) and could not be examined.

Quartz bodies carrying free gold have been found in shear zones Nos. 1, 2, and 3, and ore-bodies have been found in No. 1 shear zone.

No. 1 shear zone (locality 13, Map 535A, and Figure 1) has been traced on the surface for at least 1,800 feet. It strikes and dips nearly parallel with the pillowed, andesitic and basaltic lavas that underlie much of the property. The flows in the vicinity of No. 1 shaft (sunk to explore No. 1 shear zone) dip 75 degrees southwest. To the northwest, along the strike of the shear zone, the angle of dip of the flows increases and becomes

[1] This description and accompanying mine map are based on an examination made in September 1936. In an Appendix on page ... some of the results of underground work up to November 1938 are described, as reported in mining journals.

vertical 575 feet from the shaft. The flows maintain this attitude for about 300 feet, beyond which they are overturned and dip northeast. About 645 feet northwest of No. 1 shaft the shear zone enters the main body of the dyke-like mass of albite granite, here about 220 feet wide. Beyond the west edge of the granite the shear zone has been traced for 320 feet in the lavas, but no attempt has been made to follow the weak shearing farther and the amount of overburden has prevented its being traced on the surface. The drift on the 375-foot level follows the shear northwesterly into the granite mass, passes through some unsheared granite, and then follows strong shearing in the lavas for 180 feet beyond. On the 500-foot level the shear zone is continuous and just skirts the south tip of the granite: on deeper levels it is continuous and passes below the northerly plunging end of the granite body. The shear zone has been traced on the surface for 615 feet southeast of No. 1 shaft, but in this direction the lavas, which at No. 1 shaft and northwest are unsheared (except along the zone), become more and more schistose and the shear zone loses its identity.

The width of No. 1 shear zone on the surface and underground ranges up to 30 feet, perhaps averaging 15 feet, and is best defined where it cuts the non-schistose, andesitic lavas. The zone does not exactly follow the bedding of the lavas, and where it passes from the well-pillowed, andesitic varieties to the coarser grained, massive lavas it narrows and in some cases ends. In the albite granite the shear also narrows, weakens, and probably dies out in the centre of the body.

The lavas within the shear zone have been altered to chloritic schist and soft, greenish grey carbonate schist. The proportion of carbonate varies from place to place. Where most abundant, the rock is composed of ferruginous carbonate, chlorite, and a little quartz, all in a streaky arrangement. Where the shear extends into the granite this rock has been altered to a schist of quartz, sericite, carbonate, and chlorite.

The principal known bodies of vein quartz in No. 1 shear zone occur near No. 1 shaft between the surface and the 750-foot level, and near the albite granite on the 375-, and 500-foot levels. The quartz near No. 1 shaft occurs in two shoots, which have yielded nearly all the ore extracted to date. Quartz occurs as solid lenses, as lenses including altered fragments of country rock, and as stockworks of interlacing or parallel veinlets within the sheared lavas. Three types of quartz were noted: (1) mottled or streaked, grey, sugary quartz, which is cut by (2) transverse veinlets of clear, glassy quartz and (3) separate bodies of rather uniformly milky white quartz. High-grade quartz is almost invariably of the grey, sugary variety cut by the transverse veinlets of younger, clear, glassy quartz. These transverse veinlets average 1 or 2 inches wide and constitute only a few per cent of the total quartz content of such bodies. Quartz near No. 1 shaft is of types (1) and (2) and often of high grade: quartz near the granite is mainly of type (3) and of lower grade. Quartz of the two shoots near No. 1 shaft averages less than stoping width, and in some places is of such high grade that a width of a foot or less may be profitably mined. Quartz bodies west of the shaft, near the granite, are up to 7 feet wide, of lower grade, and it has not yet been proved that they can be profitably mined.

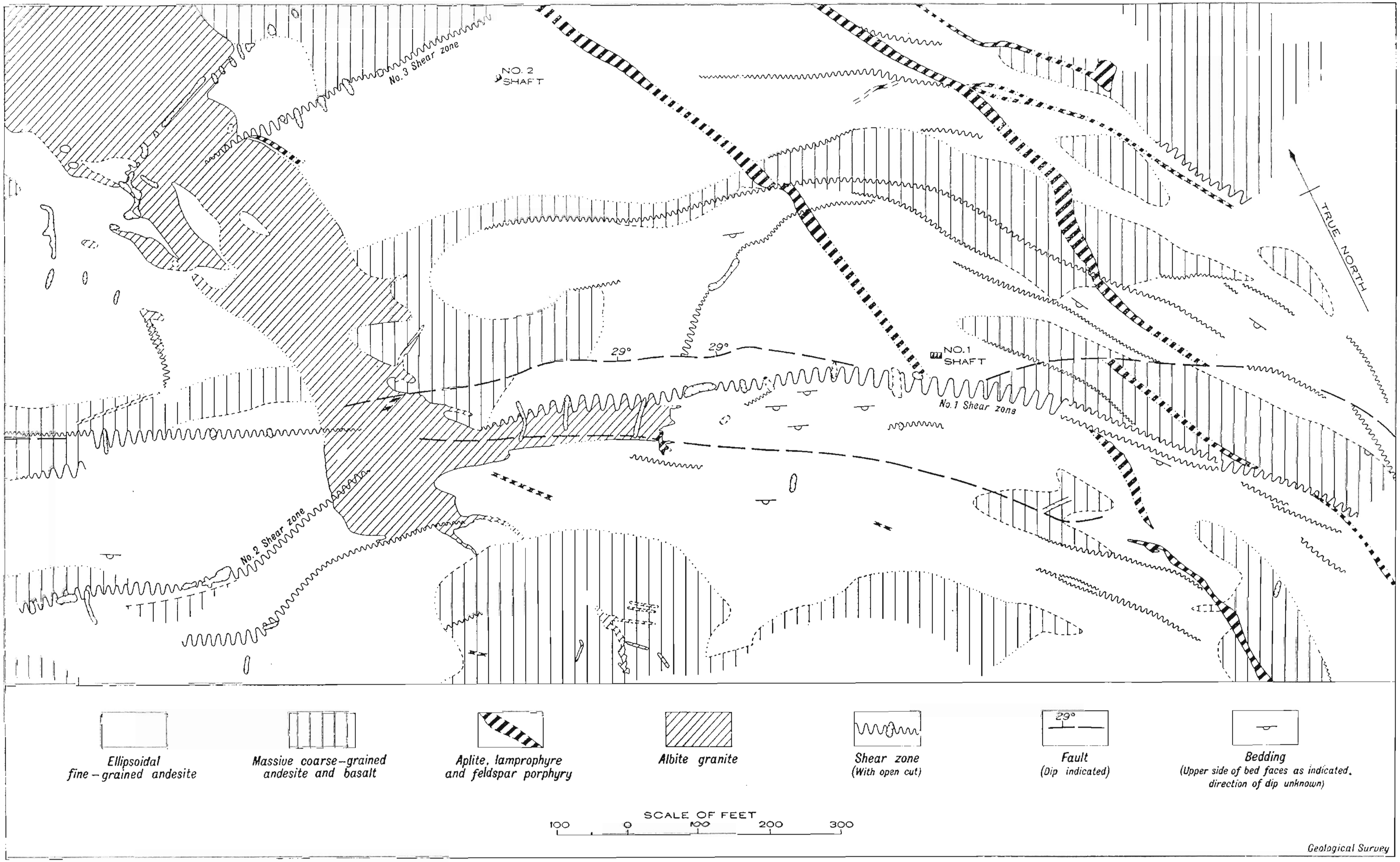

Figure 1. Gunnar mine, Beresford Lake, Manitoba.

The two ore shoots near No. 1 shaft are separated by a fault dipping gently northeast between the 375- and 500-foot levels. Neither ore shoot has been mined to the fault: the upper shoot has been partly stoped from the surface to the 375-foot level; the lower shoot has been partly stoped from the 750-foot level to a short distance above the 500-foot level, and stoping had not reached the fault at the time of examination (September 1936). The shoots plunge 45 to 55 degrees southeast, and the top of the lower shoot (as explored to date) lies about 180 feet northwest of the bottom of the upper shoot (as explored to date). The shear zone dips from 75 degrees southwest to nearly vertical in the vicinity of these ore shoots.

The lower ore shoot has been opened on the 750-, 625-, and 500-foot levels for lengths of 230, 160, and 60 feet, respectively. Ore (quartz and included schist) averages about 3 feet wide. Near the east end of the ore shoot a lamprophyre dyke a foot or so thick enters the shear zone at an oblique angle from the northwest, and within it swells nearly to the width of the zone, which here measures a little more than 10 feet. The dyke continues in the zone for distances of 35 to 65 feet, as exposed on the three levels, and the main part is unsheared. It ends to the southeast in slightly schistose tongues within chlorite and carbonate schist of the shear zone. Much of it has not been cut by quartz veins, but in places the dyke rock is cut by closely set, parallel veinlets of auriferous quartz. The gold-bearing quartz continues a few feet east of the dyke material in the shear zone, but the great bulk of it lies to the west of the dyke, as does the highest gold content. It is evident that the quartz was introduced after the lamprophyre dyke, and that the intrusion of the dyke did not take place until shearing along the zone had nearly ceased. The dyke occupies nearly the whole width of the shear zone and probably acted as a dam to the rising ore solutions. At the time of the examination neither the upper nor lower limits of the shoot had been reached. The upper limit probably reaches the fault that dips 23 degrees northeast, and that has been found on the 500-foot level east of the shaft, on the 375-foot level west of the shaft, and in the shaft between the two levels. So far as is known, the fault in no way affects the shear zone or ore-bodies, and the lower ore shoot may extend above the fault and even be continuous with the upper shoot.

The upper shoot has been opened on the 125-, 250-, and 375-foot levels, and on these levels is 170, 170, and 315 feet long, respectively. Ore (quartz and included schist) averages about 2 feet wide. The upper stope suggests that the shoot was about 110 feet long on the surface. It has not been stoped below the 375-foot level and has not been located on the 500-foot level. The quartz that makes the ore-body pinches out to the northwest. The southeast edge is marked by a quartz-feldspar porphyry dyke, which at the surface ranges in width between 5 and 20 feet. It strikes a little west of north and at one place dips 60 degrees east. Near the mine office the dyke ceases for a distance of 30 feet. This is not due to faulting and undoubtedly the dyke is continuous underground. In the immediate mine area it is crossed by four shear zones, which strike between west and north 45 degrees west, and each one of them displaces the dyke, offsetting it to the northwest on the northeast side of the shear zone. The horizontal displacement along No. 1 shear zone is 240 feet. Underground, the dyke may be seen in the north wall of the shear zone, with which it makes an angle of 45 degrees. The trace of the dyke on the shear zone dips 45 degrees along a direction south 60 degrees east. The junction of the dyke and shear zone is covered at the surface, and underground the dyke was seen at the shear zone only on the 375-foot level. Here, thoroughly schistose dyke rock, still with clearly recognizable quartz phenocrysts, walls the north side of the shear zone for 40 feet east from the juncture of dyke and shear zone. The easterly 9 feet is about 2½ feet thick. The continuation of the dyke in the south wall has not been found underground, possibly because the south wall of the shear has not been thoroughly explored. No quartz was seen veining the schistose porphyry lying in the shear zone.

The dyke appears not to have entered the shear zone but to have been faulted by it and dragged easterly along the north wall. Presumably, this faulting was accomplished prior to the introduction of vein quartz, because as already indicated the ore of the lower ore shoot was introduced into the same shear zone after the completion of all major movements. The dyke, therefore, was probably emplaced considerably in advance of the introduction of the vein quartz and formation of the ore shoot. This shoot ends where the quartz-feldspar porphyry dyke is crossed by the shear zone, and neither quartz nor ore extend east of this place. Highest gold content on each drift occurs towards the east side of the stope. The shear zone is not blocked by the dyke, although the shoot is so situated as to strongly suggest that the rising solutions were dammed along a plane corresponding to the line of juncture of the porphyry dyke and the shear zone. Possibly the dyke acted somewhat as a buttress, constricting the shear zone at this point. That there is a constriction is indicated on the 125-foot level where the shear zone is 22 feet wide opposite the shaft and 50 feet east, at the junction of dyke and shear, it is only 7 feet wide.

The bottom of the upper ore shoot had not been located when the mine was examined. It was not located on the 500-foot level where work was hindered and eventually abandoned because of broken ground and the inflow of water along the low-dipping fault zone already referred to. The fault crosses the shear zone on the 500-foot level about 230 feet southeast of the shaft and nearly vertically below the southeast edge of the ore shoot and the porphyry dyke on the 375-foot level. A bulkhead has been placed at the fault on the 500-foot level to hold back the water, and the drift was not examined in the critical ground southeast of this point. The porphyry dyke should intersect the shear about 80 feet southeast of the fault at the bulkhead, and the downward continuation of the ore shoot would be looked for near, and northwest of, the dyke. Although neither dyke nor ore shoot has been located on this level, it is expected that the dyke extends down that far.

Along No. 1 shear zone, west of the stoped ore shoots, two main quartz bodies have been opened by drifts on 375- and 500-foot levels, east and west of the main granite body. The quartz body east of the granite is 85 and 140 feet long on the 375- and 500-foot levels, respectively, averages about 1½ feet wide, and has not been located above or below these levels. It is reported that this shoot can probably be mined at a profit. The body west of the granite has been encountered only on the 500-foot level, and is there 140 feet long. Its average width is about 5 feet, but at its widest point it is a body of solid quartz 7 feet wide. The gold content is rather low.

The shear zone in the vicinity of these shoots strikes north 70 degrees west and dips 80 degrees south to 85 degrees north. On the 375-foot level, the quartz body east of the granite is closely parallelled by a tongue of granite that follows the shear for about 250 feet. This rock is distinctly sheared, and white mica and carbonate replace much of the feldspar. Where the shear enters the main mass of the granite, however, it weakens and appears to die out for 40 feet. It again becomes well defined in the lavas west of the granite. On the 500-foot level the granite does not cross the shear zone, but is visible on the north wall for about 85 feet. The granite is not intersected by the drifts on either the 625- or 750-foot levels, and hence the nose of this dyke-like mass must plunge steeply north.

Shearing continues beyond the limits of the workings to the northwest, the southeast, and in depth. Drifting at 1,000 feet, the deepest level, shows a fairly strong shear zone, averaging about 6 feet wide, for about 300 feet. The pillow lava wall-rocks, however, are all somewhat sheared, and the shear zone is not bounded by sharp walls. Some rich gold-bearing quartz, of insufficient length or width to form ore, has been found on this level. The shearing extends beyond the limits of the drift in both directions. Drifts on the 125-, 250-, 375-, 625-, and 750-foot levels, east, all end in unpillowed andesite, and the shearing is weak in all these east faces. The longest east drift is on the 750-foot level, which has been driven for about 825 feet southeast from the shaft. The strike of the shearing on this level changes from north 55 degrees west at the shaft, to north 20 degrees west at the east face. The shear zone continues beyond the faces of all the west drifts, and on the 375-, 500-, 625-, and 750-foot levels has been followed west of the shaft for about 905, 900, 825, and 905 feet, respectively. These four faces are partly or entirely within unpillowed andesite, and the shearing here ranges between 3 and 9 feet wide and is weaker than nearer No. 1 shaft.

No. 2 shear zone (locality 14, Map 535A, and Figure 1) lies south of No. 1 shear zone and has been traced on the surface from a point 65 feet within the granite, westerly for about 825 feet. Its width ranges from 7 to 20 feet. Gold-bearing quartz occurs within this zone, but has not been found in sufficient quantity to form ore shoots. The strike ranges from south 75 degrees west at the granite to north 70 degrees west near the western end. The dip at the granite is about 85 degrees south: the dip at the west end is nearly vertical. The west contact of the granite is not offset by the shear zone. No. 2 shear is paralleled on the surface by another shear zone, lying 80 feet south, which has been partly traced from the south tip of the granite, westerly for 385 feet. Both these shears have been explored by short drifts on the 375-, 500-, and 625-foot levels. On the surface, No. 2 shear ends to the east in the granite: to the west it pinches and ends where it enters unpillowed andesite. On both the 625- and 500-foot levels it has been traced for 170 feet, and continues beyond the east and west faces. On the 375-foot level it has been traced for about 100 feet, is 9 feet wide in the east face, and seems to pinch out to the west.

Neither No. 2 shear, nor the shear paralleling it to the south, was encountered by a crosscut driven from No. 1 shear on the 750-foot level. Both these shears lie principally within pillowed andesite: the southern shear dies out near the west face of the drift on the 500-foot level where it enters unpillowed, coarse-grained andesite.

Quartz bodies found within these shears average about $1\frac{1}{2}$ feet wide and have been followed for drift lengths up to 150 feet. The gold content averages less than that of the ore shoots of No. 1 shear, although some channel samples assay several ounces of gold a ton. The quartz is greyish white, sugary, and in places contains transverse veinlets of younger, clear, glassy quartz; in these places the gold content is unusually high. No quartz has been stoped from either of these shears, and no exploratory work was being done on them at the time of examination.

No. 3 shear zone (locality 15, Map 535A, and Figure 1) lies east of the albite granite and about 560 feet north of No. 1 shear zone. It has been traced on the surface for a total length of 750 feet: from the granite it trends nearly due east for about 520 feet; the strike then changes abruptly to south 60 degrees east for 230 feet, beyond which the shearing weakens and probably ends. The shearing ends to the west where the zone enters the granite. The maximum width of the zone at the surface is 20 feet, and the average width about 8 feet. The dip ranges between 60 and 80 degrees south. The quartz-feldspar porphyry dyke encountered at No. 1 shear zone meets No. 3 zone about 80 feet east of No. 2 shaft. Movements along the shear zone have offset the dyke 27 feet west on the north side of the zone. The east contact of the granite is not offset by the shear zone. Trenching indicates an ore shoot over 200 feet long between the granite and the dyke, and neither quartz nor ore has been found east of the dyke. The highest gold content is found near the east end of the ore-body, about 65 feet west of the porphyry dyke. The shear zone is blocked by the slightly offset ends of the porphyry dyke, and this probably caused the ore shoot to form to the west of and beneath the dyke, which here dips about 60 degrees northeast. The shoot is expected to plunge easterly, parallel to the trace of the dyke on the shear zone, as do the ore shoots near No. 1 shaft in No. 1 zone. Underground openings on the 125-foot level, served by No. 2 shaft, could not be examined. The west end of the shear zone at depth probably follows the east contact of the granite, which here dips about 50 degrees east. The ore shoot may be co-extensive with the quartz body and the quartz similar to that of the ore shoots near No. 1 shaft in No. 1 zone.

Mineralization. Vein material at Gunnar mine is principally quartz, with pyrite, sphalerite, chalcopyrite, and pyrrhotite together making up a few per cent.

Pyrite is the most plentiful sulphide. Occasionally, as in the quartz in No. 3 shear zone, it occurs as nearly solid masses wherein closely packed grains range up to 1 cm. It is reported that such material usually contains only a little gold. Many individual grains in these masses are clearly fractured and veined by quartz, galena, sphalerite, and chalcopyrite. High-grade ore is usually indicated by finely granulated pyrite lying along streaks or cracks of crushed sugary quartz. Galena, sphalerite, chalcopyrite, and gold also follow these crushed streaks. Some pyrite occurs as grains about the borders of, and as disseminations within, ribbons and fragments of wall-rock in the quartz. A little pyrite of a distinctly younger generation accompanies marcasite and calcite as encrustations in flat seams and open fissures, which cut through shear zones, quartz bodies, and adjacent wall-rock.

Sphalerite is considered by mine officials[1] to be a reliable indicator of gold ore. It is in most cases dark brown and, with galena and chalcopyrite, veins and embays the earlier fractured pyrite.

Chalcopyrite and pyrrhotite usually occur together. They are found in minor quantities in the upper part of the ore shoots near No. 1 shaft in No. 1 zone, but become prominent at depth in these ore shoots. They are the most plentiful sulphides in the quartz bodies of No. 2 shear zone, and gold content of the quartz bodies seems to be lower where these sulphides are plentiful. Pyrrhotite appears to have formed at depth in No. 1 zone, and everywhere in No. 2 zone, in preference to pyrite.

Galena was probably the last sulphide to form and occurs in very small quantities, usually with sphalerite and chalcopyrite.

A few isolated grains of arsenopyrite were seen on the 500-foot level.

Visible gold is common in the vein material of the ore shoots. Most of the gold occurs in quartz, but minor quantities are associated with chalcopyrite, sphalerite, pyrite, and pyrrhotite. The largest amount of the gold is in the minus 200 plus 280 mesh size.[2] Gold was noted only in the free state. Milling for the first 7 months produced gold and silver in the ratio of 9 to 1, and probably most of the silver is alloyed with the gold. Wall-rock never constitutes ore and is considered as essentially barren of gold by the mine operators. In polished section the gold is seen as grains, blebs, and veinlets in fractures in quartz: less commonly it occurs as grains along the edges of sulphide nests; rarely is it seen as grains within apparently unfractured pyrite. In thin section it is seen to be most plentiful along ribbon-like streaks of fine, granular quartz accompanied by albite, ferruginous carbonate, white mica, and fine-grained sulphides.

Three types of quartz were noted. Highest gold content is found in grey, mottled and streaked, sugary to nearly cherty quartz. Such quartz has probably first formed in the shear zones as dark grey, glassy quartz and later movements along the same zones have crushed it and formed streaks and seams of finely granulated quartz parallel to the vein walls. These streaks vary from a fraction of an inch to several inches wide and many contain finely granular sulphides and gold. A second type of quartz occurs as transverse glassy veinlets, which cut the streaked, sugary, grey quartz. These veinlets are perpendicular to the vein walls, dip at all angles, show sharp contacts against the sugary quartz, and in many cases contain coarsely granular carbonate, albite, sulphides, and gold. The veinlets are nowhere more than a few inches wide. Gold content of the quartz bodies is often highest where these transverse veinlets

[1] Houston, James: Mine manager, personal communication.

[2] Timm, W. B.: Gold Ore from Gunnar Gold Mines, Limited, at Beresford Lake, Manitoba; Mines Branch, Dept. of Mines, Canada, Ore Dressing and Metallurgical Investigation No. 626, 1935, p. 6.

are numerous. A third type of quartz is milky white and massive and occurs in No. 1 zone near the west end of the 500-foot level. Such quartz usually contains much less gold per ton than does the first type.

An iron-bearing carbonate makes up a few per cent of the gangue, and is plentiful in the transverse glassy veinlets. Pure white calcite occurs with marcasite in the flat fractures cutting the ore shoots, and is younger than the iron-bearing carbonate.

Pinkish, albitic feldspar is common within the transverse, glassy veinlets. It occurs in small quantities in the high-grade, sugary, grey quartz, in many cases close to streaks of sulphides and gold.

A little white mica occurs in the more thoroughly granulated streaks in the sugary, grey quartz. A very little brown, biotitic mica was noted, usually in contact with pyrite. Dark olive-brown tourmaline was noted within quartz as needles up to 5 mm. long.

Wall-rock Alteration. The normal dark green-grey chlorite-carbonate schist of the shear zones is usually altered to a buff or grey colour for a few inches next the quartz bodies. Fragments included in the quartz are similarly altered or may be yellowish green. This selvedge has resulted from alteration brought about by the solutions that introduced the quartz, sulphides, gold, and other vein minerals. The same solutions affected the lamprophyre dyke where it is in contact with the quartz. A sample of brownish, altered lava, with disseminated pyrite, assayed by the Bureau of Mines, Ottawa, gave: gold, 0·08 ounce a ton; silver, trace. The prominent minerals in the altered lava are ferruginous carbonate, chlorite, quartz, and biotite. Other minerals noted are: albitic plagioclase, white mica, titaniferous iron ores, leucoxene, titanite, tourmaline, mariposite, pyrite, pyrrhotite, and gold (in minute veinlets with sulphides). The buff colour of the rock is probably due to the fine biotite, which in places makes up 15 per cent of the rock. Leucoxene, tourmaline, and titanite are locally plentiful in the altered rock close to the quartz contact. A bright green, chromium-bearing mica, probably mariposite, is conspicuous in fragments of coarse-grained, massive lavas included in quartz bodies opened by the western drifts in No. 1 shear zone: it was not observed in or adjacent to the ore shoots near No. 1 shaft. Gold was noted within the altered wall-rock as minute veinlets extending out from the quartz for a few millimetres.

Appendix

Since the mine was examined in September 1936 both No. 1 and No. 2 shafts have been deepened and much lateral work done, some of it on deposits that had not been opened at the time of examination. The following notes are taken mainly from reports that have appeared in the mining press, and so far as possible complete the general description of the mine to November 1938.

No. 1 shaft has been completed to 1,250 feet and levels established at 1,125 and 1,250 feet. No. 2 shaft has been completed to 375 feet where it connects with a crosscut from the No. 1 shear zone, and levels have been opened at 125 and 275 feet.

No. 1 shear zone (locality 13, Map 535A, and Figure 1) has been reached by a crosscut from No. 1 shaft on the 1,250-foot level. Some drifting has been done at this level east of the crosscut, but no ore has been found.

No. 3 shear zone (locality 15, Map 535A, and Figure 1) has been explored from both No. 1 and No. 2 shafts, and some drifting done on all levels down to and including the 1,250-foot level, with the exception of the 500-foot level. An ore shoot with a length of about 300 feet is reported to have been stoped above the 125-foot level, and about 170 feet of ore of average mine grade and with an average width of about 4·5 feet is reported from the 625-, 875-, and 1,000-foot levels.

No. 4 shear zone (locality 16, Map 535A, and Figure 1) outcrops about 90 feet north of No. 3 shear zone and trends about north 70 degrees east. It is exposed on the surface for about 300 feet and has been traced through the albite granite, where the shearing is weak and in places ends. It has been intersected west of the albite granite by a drive from No. 2 shaft on the 125-foot level. Drifting is reported to have opened only a short length of gold-bearing quartz and only a few hundred tons of ore were milled from this deposit.

No. 6 shear zone (locality 17, Map 535A) outcrops about 600 feet south of No. 1 shaft and trends about north 55 degrees west. It has been traced on the surface for about 1,000 feet, with an average width of several feet, and has been explored underground on the 1,000-, 1,125-, and 1,250-foot levels. On the 1,000-foot level the crosscut from No. 1 shaft was continued 210 feet south of No. 1 shear zone to cut No. 6 shear zone, and drifting west of this crosscut is reported to have encountered over 180 feet of ore with an average width of 4 feet. This ore is reported stoped from the 1,000-foot level up to the 875-foot level, where it pinches out.

No. 8 shear zone has not been recognized on the surface, but has been explored by drifting on the 500-, 625-, 750-, 875-, and 1,125-foot levels. The shear makes an angle of about 30 degrees with the south side of No. 1 shear and trends about west. Drifting on the 500-, 625-, and 750-foot levels is reported to show a combined drift length of ore of about 850 feet, some of it of very high gold content. The average width of the quartz is reported to be about 1·5 feet.

Madeline Claim

Three shear zones with quartz have been exposed along the west contact of the dyke-like body of albite granite on this claim, and are named the Madeline No. 1, No. 2, and No. 3 shear zones.

No. 1 shear zone (locality 10, Map 535A) lies about 300 feet south of the north boundary of the claim, and the shear has been traced for 450 feet along a strike of north 58 degrees west. The shear zone is exposed along the south side of a prominent depression or draw about 25 feet wide. The dip is 70 degrees south. At the east end it enters the albite granite, passes under drift, and probably ends within a short distance. The rest of the exposed shear is in andesitic lavas, and at the west end it continues under drift for an unknown distance. The entire width of the shear is not exposed, but may be 30 feet. A granite tongue 2 feet wide follows the shear at the east end, and a pit there shows a 6-foot width of milky quartz containing rusty carbonate and a very little pyrite. Other exposures show only a few inches of quartz. No gold was seen.

No. 2 shear zone (locality 11, Map 535A) lies at the west tip of an albite granite tongue and about 450 feet south of the north boundary of the claim. The shear zone is weak and is followed by a quartz vein about a foot wide and traced for 150 feet along a strike of north 70 degrees east. This is probably about the total length of the shear zone and quartz. The vein dips about 60 degrees southeast. The west half is in andesitic lavas: the east half in the granite tongue. Most of the quartz is very fine grained, grey to white, and breaks with a sub-conchoidal fracture. It contains a little pyrite, sphalerite, chalcopyrite, pyrrhotite, and carbonate. The texture, colour, and mineral content are similar to those of the gold-bearing quartz at Gunnar mine. Free gold is reported to occur in this vein.

No. 3 shear zone (locality 12, Map 535A) cuts the albite granite about 650 feet north of the south boundary of the claim. The shearing has been traced for 250 feet along a strike of north 65 degrees east. It weakens and may end beyond the most easterly exposure, but may continue farther west than present work indicates. The shear cuts across the entire width of the granite body: to the east it projects a short distance into the adjacent andesitic lavas; to the west it follows the granite-andesite contact. Vein quartz about 3 feet wide is exposed in two pits 50 feet apart. It is very fine grained, white to grey, sometimes breaks with a conchoidal fracture, and contains pyrite, sphalerite, and chalcopyrite. Free gold is reported to occur in it. The texture, colour, and mineral content of the quartz are similar to those of the gold-bearing quartz at Gunnar mine.

YELLOWSTONE CLAIM

A shear zone (locality 9, Map 535A) exposed for 550 feet trends north 23 degrees east and passes nearly through the northeast corner of the claim. The shear dips steeply east and cuts schistose andesitic pillow lavas. It probably ends to the north before reaching the north boundary of the claim: to the south it passes under a drift-filled basin. It has been explored by seven crosscut trenches and five short diamond drill holes. Near the north end a single trench shows the shear to be 15 feet wide and to be cut by stringers of milky white quartz totalling about half that width. Near the south end of the exposures there is a lens of quartz 35 feet long, which ranges in width from a few inches to 18 inches. The sheared rock ranges from a flaky, chlorite sericite schist to a soft, grey, carbonate rock. The quartz contains plentiful creamy weathering carbonate in nests, a little coarsely crystalline pyrite, white mica, and pink weathering feldspar. No free gold was seen.

SCATTERGOOD MANITOBA GOLD, LIMITED

This company was incorporated in 1934 to develop a group of eleven claims formerly held by Deep Rock Gold Mines, Limited, and Tinney

Lake Gold Mines, Limited. The claims lie in the vicinity of Tinney Lake and just north and northeast of the property of Gunnar Gold Mines, Limited.

In 1934 Scattergood Manitoba Gold, Limited, did surface exploration on several quartz-bearing shear zones on the property, and in 1936 did about 3,000 feet of diamond drilling. The shear zones lie in andesitic lava, sediments, and meta-diorite on or near the axis of a large anticline and just east of a large dyke-like body of albite granite. Three of the deposits are described below, two on the Tinney No. 1 claim, and one on the Easter No. 1 claim.

Tinney No. 1 Claim

One of the shear zones on the Tinney No. 1 claim lies near the west boundary of the claim and may be called the Tinney No. 1 west zone (locality 7, Map 535A). This shear zone strikes north and is nearly vertical. It follows a swampy depression 1,000 feet long. It is exposed by pits on the west side of the depression at intervals for 350 feet and may extend the full length of the depression. The andesitic country rock has been altered within the shear zone to rusty green chloritic schist and soft grey carbonate rock, both of which contain disseminated pyrite in places. Quartz occurs within the shear as irregular stringers and some short lenses with a maximum exposed width of 6 feet. It contains a little white mica, rusty carbonate, and pyrite. No free gold was seen. Two short diamond drill holes have been put down below the largest quartz exposures.

The other shear zone on the Tinney No. 1 claim lies close to the southern boundary of the claim and may be called the Tinney No. 1 south zone (locality 8, Map 535A). This shear zone trends north 70 degrees west and has been traced by thirty-nine pits for 1,210 feet. It dips 55 to 85 degrees south and cuts andesitic lavas. At the east end it loses its identity in a wide, sheared and crumpled zone before reaching coarse-grained, basaltic lavas. At the west end it dies out in andesitic lavas about 30 feet north of the body of albite granite. The shear zone averages about 10 feet wide and a little white quartz occurs as irregular stringers and lenses throughout much of the eastern 300 feet. The rock in the zone has been altered to a green, chloritic schist or soft grey, rusty weathering, carbonate rock, and contains some pyrite. The quartz contains a little carbonate and a very little pyrite and chalcopyrite; no free gold was noted. The zone has been explored by eight short diamond drill holes about equally spaced along the eastern 700 feet.

Easter Claim

The shear zone on the Easter No. 1 claim outcrops for a length of 900 feet in the north part of the claim (locality 18, Maps 535A and 536A) and continues northwesterly beyond the limits of the Scattergood property for an additional 2,600 feet. The shear follows a thin band of tuff for much of its length and passes into andesite at both ends. The shear zone strikes north 45 degrees west and dips steeply northeast. Vein quartz has been deposited in the shear. At one locality the quartz is 10 feet wide for a length of 100 feet. Elsewhere the quartz pinches and swells from 1 foot to 5 feet wide and is practically continuous for lengths up to 300 feet, or occurs as short lenses distributed here and there along the strike. Much of the quartz is pale bluish grey and carries patches of chlorite, a little red feldspar, and little or no sulphides; at one locality the bluish quartz is cut at right angles to the strike by gash veinlets of white quartz.

EDNA GROUP

A shear zone on the Edna No. 2 claim (locality 6, Map 535A) has been exposed by twelve pits and trenches for 450 feet in the northeast corner of the claim. It strikes north 40 degrees west, dips about 80 degrees northeast, and probably nearly parallels the attitude of the enclosing andesitic pillow lavas. The shear is 7 feet wide in the most northwesterly trench and the rock is not exposed beyond that point. The shear probably ends to the southeast where it approaches the northwest end of a dyke-like body of albite granite. The maximum exposed width of the shear zone is 15 feet. Within the shear zone, the dark green andesitic lavas have been altered to a soft grey, massive to finely streaked, carbonate rock with fine-grained, disseminated pyrite in many places. A few irregular stringers and lenses of dark blue-grey, glassy quartz and coarse-grained, rusty weathering carbonate cut the carbonate rock. A lens of dark grey, glassy quartz, up to 2 feet wide, occurs in the shear near the southwest end. This quartz contains very little sulphide, except disseminated pyrite in enclosed fragments of wall-rock. No free gold was noted.

Most work on the Edna claim has been done on a shear zone (locality 5, Map 535A) that outcrops at the southwest corner of Tinney Lake and which has been traced by pits, trenches, and stripping for 1,180 feet along a strike of north 65 degrees west. The dip of the shear is nearly vertical. To the southeast the shear passes under the lake and no strong shear has been found on the opposite shore, which is about 230 feet away. To the northwest the shear zone extends for 250 feet beyond the Edna claim and probably ends there. The shear cuts dark green, andesitic to basaltic lava and lies about 300 feet northeast of, and nearly parallel with, a dyke-like body of albite granite. The width of the zone ranges from 5 to 22 feet. A lens of quartz 220 feet long and 2 to 15 feet wide occurs in the shear near the lake shore. Two other short lenses, up to 2½ feet wide, occur 350 and 600 feet from the lake. The quartz is grey and glassy to sugary and white, and in places the two varieties occur in bands. It contains a little pinkish weathering feldspar and pyrite. A little free gold was noted.

BERESFORD LAKE MINES, LIMITED

References: Wright, J. F.: Geology and Mineral Deposits of a Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169, pp. 61-62 (1932).

Annual Reports on Mines and Minerals; Mines Branch, Dept. of Mines and Natural Resources, Winnipeg, Man., 1928-1937.

History and Development

Beresford Lake Mines, Limited, owns the Oro Grande, Robert R, and ten other claims at the northwest end of Beresford Lake, and owns controlling interest in the adjacent Solo claim, which is held jointly with the Solo Mining Company, Limited.

In 1923 W. M. Dowell discovered gold-bearing vein quartz in a shear zone on the south edge of an outcrop on the Oro Grande claim. This shear zone later became known as the Oro Grande shear zone and almost all subsequent surface and underground work has been concentrated on it.

Soon after the discovery, the property was optioned by Anglo-Canadian Explorers, Limited, who trenched the deposit for 400 feet northerly along the outcrop and traced the deposit by diamond drilling in some fifteen holes, spaced at intervals of 50 feet or so, for 250 feet beneath the outcrop and for almost 600 feet to the south beneath a swamp into the adjoining Solo claim. They sank an inclined shaft, known as the Oro Grande shaft, to a depth of 50 feet in a quartz body in the shear at a point 50 feet north of the edge of the swamp. They also sank a shaft, known as the Solo shaft, to a depth of 163 feet at a point east of the shear on the Solo claim and explored the deposit on the 125-foot level from this shaft. The option was dropped late in 1926.

In 1927 Oro Grande Mines, Limited, was organized to continue work on the property. The Solo shaft was deepened to 527 feet and the deposit was explored by drifting on the 500-foot level. Operations were discontinued in January 1929 for want of adequate finances.

In 1932 the property was acquired by the Oro Grande Development Company, Limited, who operated a small test mill during the summer of that year with a production of 49 ounces of gold. In the following year they installed a steam plant and a mill with a capacity of 75 tons a day. The mill was operated at 30 to 40 tons a day with an additional production of 90 ounces of gold and 25 ounces of silver, the ore having been obtained from above the 125-foot level, which had been connected with the Oro Grande shaft. The Oro Grande shaft was deepened to 255 feet and a small amount of drifting was done on a new level at 225 feet. In February 1934 operations were again suspended.

In November 1934 the property was taken over by Beresford Lake Mines, Limited, and operations were resumed in 1936. Drifting was continued on the 225-foot level from the Oro Grande shaft and good assays were obtained in two sections south of the shaft. The deposit was then explored from the Solo shaft by drifting on a new level at 375 feet, without encouraging results. The mine was closed down in March 1937.

The mine and mill were reopened early in 1938 by J. D. Shannon, who had leased the property from Beresford Lake Mines, Limited. The mill was operated on ore from a small ore-body above the 70-foot horizon and from the two ore-bodies above the 225-foot level. Electric power was installed during the summer of 1938.

Surface work has been done on several other quartz-bearing shear zones on the Oro Grande and Robert R claims.

Geology

The deposits lie on the northeast limb of a large anticline. Nearby rock formations strike north 20 degree west and dip about 70 degrees easterly. They include andesitic flows and tuffaceous sediments, both of which have been invaded by sills of meta-diorite, the largest of which is 1,200 feet wide. Two, long, narrow bands of sediments 10 or 20 feet wide lie within the large sill 350 and 650 feet, respectively, from its west edge. A band of sediments along the east edge of the large body of meta-diorite is much covered by drift, but is possibly about 100 feet wide and is followed east by a long, narrow tongue of meta-diorite, which ends on the Solo claim. The sedimentary bands generally lie on low ground and are more poorly exposed than the meta-diorite, which outcrops on hills.

Quartz Deposits

The deposits consist of lenses and stringers of quartz lying along shear zones in andesite, sediments, and meta-diorite. Most of the known deposits lie in meta-diorite. They strike parallel or nearly parallel to the strike of the formations and dip easterly at angles varying from 40 to 70 degrees.

The Oro Grande shear zone (locality 4, Map 535A) lies in the broad sill of meta-diorite close to its east or upper contact. The zone strikes north at a small angle to the trend of the formations, and dips 60 to 70 degrees east.

On the surface, the shear zone has been traced in prospect pits for about 400 feet, pinching out at the north end and passing beneath swamp at the south. In the pits, the zone varies from 6 to 20 feet wide, and consists of dark green chlorite schist derived from the meta-diorite. Quartz lenses, together with a few stringers of quartz, are distributed here and there across a part or the full width of the zone for a distance of 250 feet from the edge of the swamp. The lenses are up to 2 feet wide and 20 feet or more long. The quartz is chiefly a fine, grey, sugar-grained variety containing a little carbonate, scattered flakes of chlorite, and disseminated grains of pyrite and pyrrhotite; gold is reported to have been seen in the quartz and small bodies of quartz are said to assay very high in gold. The grey quartz is cut at right angles to the strike by short gash veinlets of milky white quartz carrying patches of fine-grained chlorite, flakes of biotite, and a few blebs of pyrite. The wall-rock is partly altered to rustry weathering carbonate and carries many grains and cubes of pyrite, but in most places not enough gold to be of economic importance.

The mine was closed down at the time of the writer's visit in the summer of 1937, and the following information about the underground workings has been gathered from published reports and from maps of the workings. The Oro Grande shaft, which has been sunk along the dip of the deposit at a point 50 feet north of the edge of the swamp, serves levels at 125 and 225 feet. The Solo shaft has been put down on the edge of an outcrop about 350 feet east of the deposit in the swamp and 520 feet southeast of the Oro Grande shaft; the Solo shaft serves levels at 125, 375, and 500 feet, and is connected through the 125-foot level with the Oro Grande shaft. The shear zone has been followed by drifting on each of these levels and the drifts extend south of the Oro Grande shaft for various distances, up to 430 feet. The 225-foot level drift extends for almost 400 feet north of the shaft, but the other drifts continue only a few feet north of the shaft.

The shear zone apparently continues strong in depth, but the quartz bodies are narrow and discontinuous and are less plentiful on the 375- and 500-foot levels than on the upper levels. The quartz is grey and carries pyrite, chalcopyrite, pyrrhotite, sphalerite, and gold. Coarse gold is reported to have been seen in the quartz at many places on the 225-foot and upper levels. Small lenses assayed high in gold. Good assays were obtained on the surface for about 40 feet north and 50 feet south of the Oro Grande shaft, and continued to a depth of 50 feet in the shaft. On the 125-foot level an ore shoot extended south for 80 feet from a point 40 feet south of the Oro Grande shaft, and in 1932 it was stoped for about 50 feet above the level. On the 225-foot level good assays were obtained in one section extending for 160 feet south of a point 130 feet south of the Oro Grande shaft and in another section 70 feet long lying south of the first section and separated from it by 80 feet of low-grade material. These two ore sections were being stoped above the level in 1938. The ore-bodies apparently pitch south. On the 375- and 500-foot levels assays were consistently below ore grade.

Other Deposits. Another quartz-bearing shear zone lies 20 to 40 feet west of the Oro Grande shear zone and strikes and dips about parallel with it. This deposit has been intersected in diamond drill holes and in a few crosscuts underground and has been followed in short drifts, but assays are said to be low in gold.

Another shear zone commences just east of the north end of the Oro Grande shear, strikes north, dips 65 degrees east, and has been followed in prospect pits for a distance of 150 feet. In one pit a body of quartz pinches and swells along the strike, is up to 1 foot wide, and carries disseminated grains of pyrite and pyrrhotite. At the north end of the line of prospect pits the zone passes beneath drift at the east edge of the sill of meta-diorite and is not known to continue into the adjacent band of sediments, which are covered with overburden at this locality. However, the deposit may continue into the sediments and may be better there, for conditions are similar to those at the Central Manitoba mine where a short vein in gabbro continues as a larger and more important vein in an adjacent band of sediments.

A quartz vein (locality 3, Map 535A) outcrops on the east-facing slope of a ridge of meta-diorite on the Robert R claim. This vein is well exposed in a deep trench that extends for 250 feet along the strike. The vein follows a shear zone, which pinches and swells from 1 foot to 8 feet wide, strikes north 15 degrees west, and dips 65 degrees east. The vein is about 2 feet wide for a length of 100 feet from the north end of the trench and narrows to 3 or 4 inches along the southern 150 feet, but where narrow is accompanied on one or both sides by narrow stringers of quartz. The quartz is grey to white, sugar-grained, carries brown weathering carbonate, chlorite, chalcopyrite, and, in places, pink albite, black tourmaline, and biotite. The vein apparently dies out at or near the south end of the trench. At the north end it passes beneath drift and may connect with a long shear zone that follows or lies near a thin band of sediment along the base of the ridge.

This long shear zone is poorly exposed and little work has been done on it, but it apparently continues south through the Oro Grande claim and north into the Mandalay claim, where it is called the Mandalay shear zone. In places on the Robert R and Oro Grande claims the zone holds large lenses of white or mottled white and grey quartz or is cut here and there across widths up to 40 feet by a few stringers of quartz and carbonate.

MANDALAY GOLD MINES, LIMITED

Mandalay Gold Mines, Limited, was incorporated on April 20, 1934, and holds the Mandalay, Dinty Moore, Tonopah, and Navajo claims, lying northwest of Beresford Lake and north of the property of Beresford Lake Mines, Limited.

Rocks on the claims consist of andesitic lava flows, tuffaceous sediments, and sills of meta-diorite, the largest of which is 1,000 feet wide. The formations lie on the northeast limb of a large anticline, strike north 25 degrees west, and dip from 55 to 80 degrees easterly.

Many quartz-bearing shear zones have been discovered on the property and most of them lie in the meta-diorite, but some occur in sediments and andesite. The shear zones strike and dip parallel to enclosing rock formations and the quartz occurs as lenses and stringers in the shears. The lenses vary from a few inches to 5 feet wide and are of white or bluish quartz; pyrite occurs in some of the quartz and wall-rock. In 1934 the company did some surface work on the deposits and in 1936 tested a few of them by ten or eleven diamond drill holes.

Seven of the drill holes were put down near the south boundary of the Mandalay claim and were apparently projected to intersect a shear zone that is poorly exposed in a few pits along the east edge of a high ridge of meta-diorite. This zone is called the Mandalay shear zone (locality 2, Map 535A). It is the northerly continuation of a long shear zone that follows along or near a narrow band of sediment in meta-diorite and extends for 2,800 feet southerly through the Robert R and Oro Grande claims, owned by Beresford Lake Mines, Limited, and mentioned in the description of that property. In the pits on the Mandalay claim the shear lies in the meta-diorite along the east contact of the sediment, and carries white quartz and coarsely crystalline, buff weathering carbonate. It is reported that the shear zone is about 40 feet wide in the drill holes, but that assays in gold were low except in one hole where the core assayed \$5.90 for a length of 22·1 feet, including a length of 4½ feet that assayed \$11.90.

Two drill holes intersected a shear zone 400 feet west of the Mandalay vein. This western zone has been traced in a few prospect pits for a length of 900 feet in meta-diorite and continues south into the Robert R claim. Small, irregular bodies of white quartz carrying a little pyrite are exposed here and there along the zone.

At a point 150 feet east of the Mandalay shear zone a prospect shaft has been sunk on a weak shear zone in meta-diorite; the zone is 5 feet wide and dips 55 degrees northeasterly. A little pyrite and pyrrhotite were seen in sheared diorite on a dump, but no quartz is visible in the schist on the sides of the shaft. Many other shear zones occur on the property, and most of these carry vein quartz.

DIGGINS NO. 1 CLAIM

This claim is owned by Wm. Diggins and lies near the north end of Beresford Lake. A zone of vein quartz and schist (locality 1, Map 535A) has been followed by stripping and test pitting for a length of about 300 feet. The zone strikes about north 15 degrees west and the cleavage of the schist dips vertically. It lies along and near a contact between quartz pebble conglomerate on the west side and contorted, laminated sediment on the east side; the sediment consists of alternating laminations 1 inch to 2 inches wide of quartzite, pale green amphibole rock, and, in places, thin bands of magnetite.

The zone of quartz and schist has indefinite boundaries and is up to 30 feet wide. Several short, irregular-shaped bodies of white to grey quartz, from 5 to 15 feet wide, occur in the zone; these carry a little pyrite in places. Most of the pits have been dug in the schist, which is a black, graphite-bearing rock forming a layer 5 to 10 feet wide and traced for a length of 100 feet. The schist has been penetrated by a few stringers of quartz and is partly or almost completely replaced by abundant small grains and nodules of pyrite. In 1937 it was reported that this sulphide replacement material assayed up to $4.64 in tin a ton. A sample taken by the writer, and judged to be an average of the material in the pits, assayed no tin, a trace of gold, and 0·07 ounce silver a ton.[1]

CLOVER GOLD MINES, LIMITED

This company was incorporated in 1934 to explore a group of eighteen claims acquired from Clover Gold Syndicate, Limited, and lying west and southwest of the Gunnar mine. Surface work was done in 1934, and 987 feet of diamond drilling was carried out in 1936.

The diamond drilling was done in the northeast corner of the Emmanuel No. 1 claim (*See* Map 535A), where a few holes were projected southwest beneath drift from points along or near the south edge of an outcrop of porphyritic trachyte breccia on the north boundary of the claim. It is reported that the holes penetrated a wide shear zone holding well-mineralized, banded quartz, which carries gold but assayed below ore grade.

Pits have been dug along short quartz-bearing shear zones on the Clover No. 1, Clover No. 5, Clover No. 6, Nap, and other claims.

BERMUDA GROUP

On the Bermuda and Bermuda No. 1 claims, about 1 mile north of Stormy Lake, a shear zone (locality 19, Maps 535A and 536A) has been traced in prospect pits at intervals for a length of 800 feet. The zone

[1] Assay by the Bureau of Mines, Department of Mines and Resources, Ottawa.

strikes north 25 degrees west and dips 65 to 70 degrees northeast. The shear follows a porphyry dyke about 5 feet wide, which cuts pillowed and unpillowed, andesitic lava. Much of the dyke rock is altered to a brown weathering carbonate-sericite schist. A few quartz lenses up to 1 foot wide have been introduced along the cleavage, and a few stringers of quartz cut the cleavage. The quartz is white and carries sericite, buff weathering carbonate, and many patches of red, aplitic material. The aplitic material and the carbonate-sericite schist carry disseminated cubes of pyrite.

MIDWAY GROUP

On the Midway and Midway No. 1 claims, 1 mile north of Stormy Lake, a dyke of sheared quartz-feldspar porphyry has been traced by stripping and pitting for a length of 2,000 feet. The dyke cuts pillowed andesite, strikes north 55 degrees west, and is about 30 feet wide. It carries disseminated grains of pyrite and is cut by lenses and irregular stringers of quartz. Vein quartz, however, is rare except for a length of about 700 feet from the west end (locality 24, Map 536A), where it is fairly plentiful in small lenses lying parallel to the strike of the dyke and in irregular stringers.

SCOTIA GOLD MINES, LIMITED

This company was incorporated on November 8, 1933, and owns a group of seventeen claims, mostly unsurveyed, lying about 1 mile south of Stovel Lake. This group is known as No. 2 group and is not to be confused with the company's No. 1 group, which lies south of the map-area and on which surface work and diamond drilling were done in 1934. During 1936 several shear zones on No. 2 group of claims were stripped and test pitted, and in 1937 a few of the zones were explored by ten diamond drill holes.

Rocks on the property consist chiefly of tuffaceous sediments and sills of meta-diorite. The sediments are very well bedded at many localities and have been folded with the sills into a southeasterly pitching syncline, which forms a minor fold on the southwest limb of a major anticline.

Six of the diamond drill holes were projected to cut a quartz-bearing shear zone in the southwest corner of the Ace No. 1 claim (locality 23, Map 536A). This deposit occurs close to the axis of the syncline, strikes north 45 degrees west, about parallel to the axis, and dips 70 degrees northeast. It lies in meta-diorite close to the contact with sediments, and ends to the southeast on approaching the sediments. A few pits in the meta-diorite near the southeast end of the deposit expose the shear at intervals for a length of about 80 feet. The zone is 10 to 50 feet wide and lenses and stringers of quartz are distributed here and there across much of the width. The quartz varies from grey to white and carries buff weathering carbonate, pyrite, and small amounts of chalcopyrite. Grains and cubes of pyrite occur in schist near the quartz bodies. The zone passes beneath drift just northwest of the pit where the drill holes penetrated several shear zones and quartz bodies within a distance of 150 feet.

Another shear zone in meta-diorite 200 feet to the north has been traced on the surface and in three diamond drill holes for a length of about 300 feet. Quartz bodies in this zone are up to 2½ feet wide and 30 feet long and carry pyrite, chalcopyrite, and carbonate.

Prospect pits have been dug along several other shear zones on the property. These contain vein quartz in stringers and lenses from a few inches to 4 feet wide and up to 200 feet long; the quartz carries a little pyrite and chalcopyrite, but apparently assays low in gold.

MARIE AND M. W. CLAIMS

In 1936 Stovel Lake Gold Syndicate did surface work on several veins on a group of unsurveyed claims just east and north of Stovel Lake. Assays were reported to vary from $5.40 to $29.60 in gold. Most of the work has apparently been done on the Marie fraction No. 1, Marie No. 2, and M. W. No. 5 claims, which are owned by M. W. Crabb.

A deposit on the Marie fraction No. 1 (locality 21, Map 536A) follows a band of laminated tuff 6 to 15 feet wide, lying in meta-gabbro. The band strikes north 55 degrees west, dips 80 degrees northeast, and is exposed in test pits and on natural outcrops for 600 feet from the southeast end of Stovel Lake. The sediment is highly sheared in places, and for part of its length holds lenses and stringers of quartz; in one pit several small quartz lenses are distributed across a width of 3 feet, whereas another pit exposes a lens of quartz 4 feet wide. Most of the quartz is blue, is veined by buff weathering carbonate, and carries disseminated grains of pyrrhotite and pyrite; at one locality the blue quartz is mixed with white quartz, the one grading into the other, and is cut by stringers of white quartz. A few narrow streaks of pyrite were noted along bedding planes in the sediment.

A shear zone, apparently on the Marie No. 2 claim (locality 22, Map 536A), strikes north 40 degrees west and dips about 50 degrees southwest. The zone lies along or near a contact between meta-gabbro to the southwest and tuffaceous sediment to the northeast, lying in the gabbro at one end and in the sediments at the other. The shear has been traced in a few prospect pits for a length of 450 feet. Only a few lenses of blue and white quartz, from a few inches to 3 feet wide, occur at intervals along the shear. The blue quartz carries a little pyrite and chalcopyrite and the nearby schist carries pyrite.

A shear zone (locality 20, Map 536A) about 500 feet north of Stovel Lake, and apparently on the M. W. No. 5 claim, is 2 to 3 feet wide and has been traced in prospect pits for a length of 700 feet. The zone strikes north 40 degrees west, dips 75 degrees southwest, and lies in tuffaceous sediments 5 feet from the edge of a sill of meta-diorite. Vein quartz, ½ foot to 2 feet wide, follows the shear zone and is fairly continuous for the full length of the shear, but dies out in several places. The quartz varies from blue to white, holds parallel shreds of schist, patches of fine-grained, massive chlorite, and, in some places, abundant pyrrhotite and a small amount of chalcopyrite. The wall-rock is heavily stained with iron oxide.

CENTRAL MANITOBA MINES, LIMITED

References: DeLury, J. S.: The Mineral Resources of Southeastern Manitoba; Industrial Development Board of Manitoba, 1927, pp. 31-33.

Annual Reports on Mines and Minerals; Mines Branch, Dept. of Mines and Natural Resources, Winnipeg, Man., 1928-1937.

Wright, J. F.: Geology and Mineral Deposits of a Part of Southeastern Manitoba; Geol. Surv., Canada, Mem. 169, pp. 66-74 (1932).

Robinson, A. H. A.: Gold in Canada, 1935; Mines Branch, Dept. of Mines, Canada, pp. 57-58.

Annual Reports, Central Manitoba Mines, Limited, 1927-1937.

General Statement

Central Manitoba Mines, Limited, owns a group of about fifty claims lying in the area between Halfway, Lonely, Stovel, and Dove Lakes. Over $4,000,000 in gold has been produced from eight deposits lying in a narrow belt $1\frac{3}{4}$ miles long, extending from the Shorty fraction easterly to the Hope claim. Ore has been produced from the Kitchener, Eclipse, No. 1 Branch, No. 2 Branch, and Rogers veins, and from quartz bodies in the Hope, Tene 2, and Tene 6 shear zones. Exploratory work has been done on several other shear zones in this narrow belt, such as the Tene North, Tene South, Wentworth, and Tene No. 1 zones (*See* Maps 536A and 537A and Figure 2).

Very little work was done on the property before the W. A. D. Syndicate commenced operations in 1924. After doing some underground work on the Kitchener vein and surface work on the Tene 6, Hope, and other deposits, the W. A. D. Syndicate and Anglo-Canadian Explorers amalgamated their interests to form Central Manitoba Mines, Limited, on December 18, 1925. Controlling interest in the new company was held by John Taylor and Sons of London, England, and the property was under their management until 1931. After developing ore to the gross value of about $1,100,000 in the Kitchener vein, a mill with a capacity of 150 tons a day was built near the Kitchener shaft, which had been sunk near the vein in the northeast part of the Kitchener claim. The property went into production in October 1927 with hydroelectric power supplied over a transmission line 43 miles long from Great Falls on Winnipeg River. Shafts were also sunk on the Kitchener vein where it crosses the Growler claim, and on the Tene 6, Rogers, and Hope deposits. Much of the ore from the Tene 6 shear zone was recovered from the west part of the zone on the Tene No. 1 claim, which was operated under lease from Manitowan Exploration Company, Limited. The ore that was drawn from shafts on the Tene 6, Rogers, and Hope deposits was hauled in motor trucks to the mill.

As mining and development progressed, it soon became apparent that the ore-bodies died out at relatively shallow depths, and by 1935 known ore reserves were exhausted. Subsequently, additional ore was found at shallow depths in the Hope shear and in No. 2 Branch vein, and these discoveries prolonged the life of the mine for a short time and gave encouragement for a program of deeper development begun in January 1936. The Kitchener shaft was deepened from about 375 feet to 908 feet, and two new levels were established from this shaft at 625 and 875 feet on

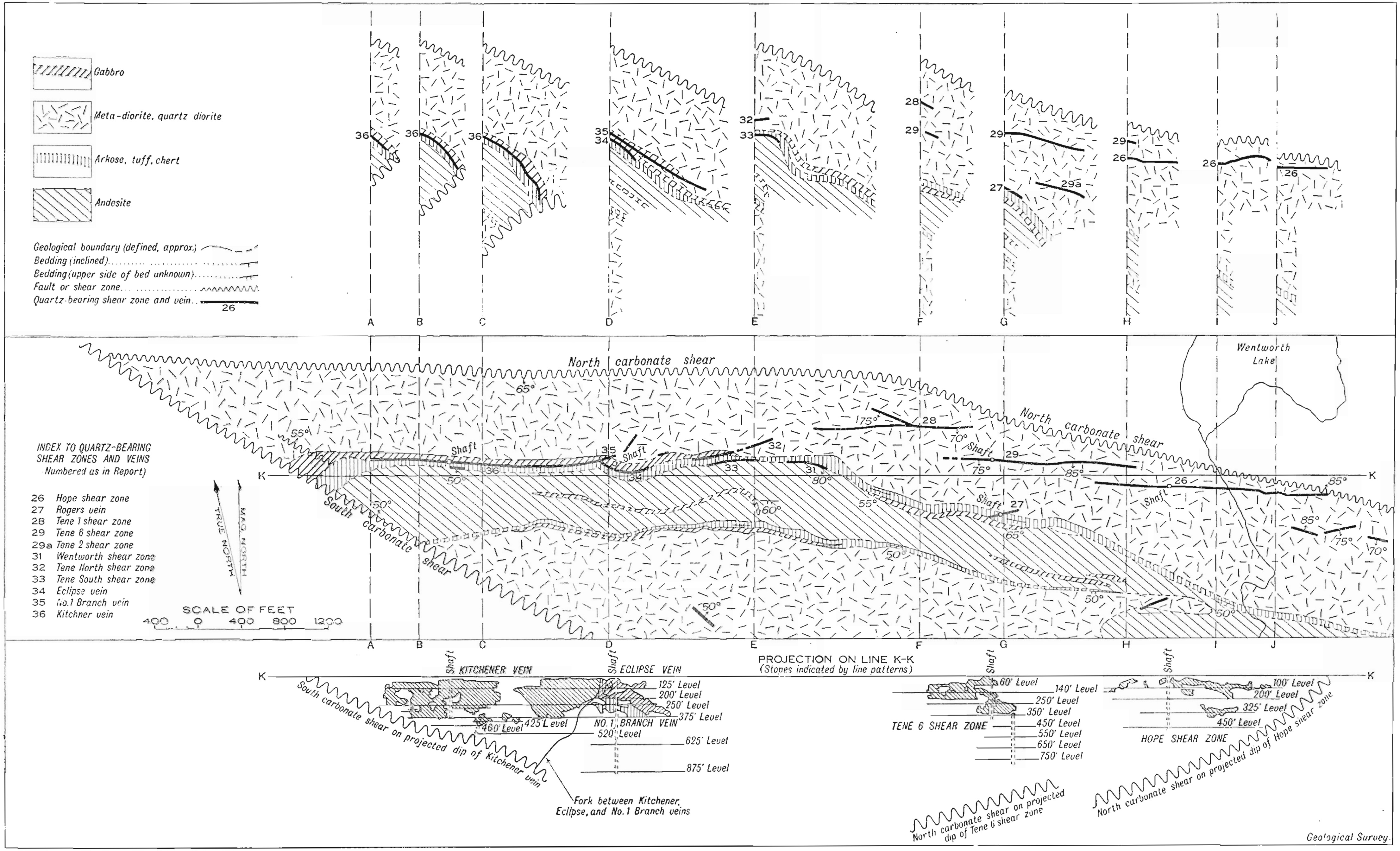

Figure 2. Plan, sections, and underground workings of Central Manitoba mine.

No. 1 Branch vein; the Hope shaft was deepened from 200 to 475 feet and new levels were established on the Hope shear at 325 and 450 feet. This deeper development was undertaken with the hope of finding a recurrence of ore at depth, but with the exception of a small ore-body on the 375-foot level in the Hope shear zone, none was found. Officials of the company stated that justification for further development work at depth did not exist, and on the exhaustion of ore reserves the mine was closed down, in July 1937. After the mine was closed, part of the tailings were re-treated in the mill until freeze-up of that year. The company then concentrated on looking for a new property.

During the life of the mine almost 10 miles of drifting and cross-cutting and 20 miles of diamond drilling were done. From 435,737 tons of ore milled there were produced 160,034 ounces of gold and 26,032 ounces of silver, with a total value of $4,106,970.

Although the mine is now closed, it is desirable to give a description of the deposits and their relations to enclosing rock formations because the knowledge and experience gained during the 10 years of operation should be of assistance in further exploration and mining operations in the region as a whole.

Geology

Rocks in the vicinity of the productive deposits include a westerly striking belt of andesitic lava about 500 feet wide and showing pillow structure in many places. Beds of very fine- to coarse-grained, tuffaceous sediment lie along both edges of the volcanics, and a few narrower beds of similar sediment lie between some of the flows. The beds dip south at angles generally from 40 to 60 degrees, although large rolls underground give local dips both steeper and more gentle than those mentioned, the beds in places being horizontal or inclined gently to the north. Grain variation in the sediments and the shapes of a few of the pillows indicate that the formations have not been overturned. The beds lie on the south-west limb of a large anticline, and the attitude of many small drag-folds in the sediments suggests that during the folding the overlying beds moved up with respect to underlying beds.

The belt of volcanics with interlayed and bordering sediments is followed to the north by a large sill of meta-diorite, 800 feet wide, and to the south by an irregular-shaped body of similar rock. The sill, for the most part, consists of medium-grained, light grey meta-diorite. Close to the top of the sill the light grey meta-diorite grades into a coarser grained, darker grey rock, generally containing grains of bluish quartz and in places holding irregular-shaped pegmatitic segregations in which hornblende crystals are as much as 2 inches long and are arranged in fan-shaped aggregates. A few dykes of material similar to that of the segregations cut the quartz-bearing diorite and are evidently late differentiates of this rock. The rock of the sill is chilled for a foot or two from the contact with overlying sediments. Sills of gabbro have been injected along parts of the contacts between meta-diorite and sediments, and dykes of gabbro occur in the lava. Younger than any of these rocks are a few dykes of lamprophyre and quartz-feldspar porphyry.

Veins and Shear Zones

A large shear zone, known as the north carbonate shear, extends easterly along the north edge of the sill of meta-diorite. This shear is about 100 feet wide. It strikes and dips parallel to the sill and other nearby formations, the dip being 65 degrees south except on the Hope claim and farther east where the shear steepens to vertical or is inclined steeply to the north. The shear may be a fault, but the amount or direction of movement is unknown. It ends to the west on meeting another large shear, known as the south carbonate shear, and either merges with this shear or is cut off by it.

The south carbonate shear strikes south 45 degrees east, crossing the easterly trending rock formations and crossing or joining the north carbonate shear at an angle of 28 degrees. The south carbonate shear is evidently a fault with a very large displacement, but the direction and amount of offset is unknown as the formations on one side of the fault cannot be definitely matched with those on the other side and the evidence furnished by drag-folds is contradictory, as if the movement had been complex. The shear varies from 100 to 200 feet wide and dips from 50 to 60 degrees northeast. The north and south carbonate shears consist of chlorite and sericite schists, which are partly replaced by carbonate and are penetrated by many small lenses and stringers of quartz and carbonate. The schist and quartz carry grains of pyrite, but only a little gold. If the dips of the two shears continue in depth at the angles indicated, the two shears would meet at the bottom of a trough striking about south 60 degrees east and pitching 20 to 30 degrees easterly for at least 4,800 feet from the west end. At this distance the bottom of the trough would be 200 feet south of the Kitchener shaft, where it would have reached a depth of 2,500 feet. East of this point the depth of the trough cannot be closely estimated.

The productive deposits and some others on which exploratory work has been done lie in the trough-shaped block of ground between the north and south carbonate shears. Within this trough the deposits lie in a broad belt striking about north 75 degrees west and angling across the trough from the north carbonate shear at the east end to the south carbonate shear at the west end. At the east end the Hope shear zone merges with the north carbonate shear, and the line of junction pitches 20 to 30 degrees westerly. At the west end the Kitchener vein dies out on approaching the south carbonate shear and pitches 20 to 25 degrees easterly. The shear zones in which the quartz bodies lie may have formed at about the same time as the north and south carbonate shears, and may have resulted from the forces that caused the two major shears.

Within the broad belt, which is generally less than 500 feet wide and is 9,400 feet long, the quartz-bearing shear zones split into two or more branches, lie end to end, are arranged *en échelon,* or lie side by side. Most of them strike about parallel to the strike of the belt as a whole. At the west end of the shear in which the Kitchener vein lies dips about 50 degrees south; toward the east it steepens to about 60 degrees south, and other shears still farther east become still steeper until at the east end the Hope shear stands about vertically.

In the west half of the broad belt the quartz deposits generally follow the strike and dip of enclosing rock formations and lie for the most part in the north band of tuff close to its upper and lower contacts. However, at two localities the easterly striking tuff band bends slightly southeast for short distances, and the deposits on the north or lower edge of the tuff continue along their easterly strike and extend for short distances into underlying gabbro and meta-diorite. At one of the bends this cross-cutting relationship is shown in the Tene North deposit. At the other bend the Kitchener vein splits into two branches, the north branch, or No. 1 Branch vein, being the easterly continuation into underlying intrusive rocks, and the south branch, or Eclipse vein, swinging southeast for a short distance along the tuff band. The fork at the junction of the Kitchener and branch veins pitches westerly at an average angle of 70 degrees and meets the south carbonate shear at a depth of about 800 feet. At a point east of these minor bends and at a locality about midway along the broad belt, the tuff and other formations swing southeast and continue in that direction for a long distance, but the deposits persist in their easterly strike and trend diagonally across the broad sill of meta-diorite in the east half of the belt.

Where crossed by the veins and other quartz deposits, dykes of quartz-feldspar porphyry and lamprophyre and the contacts between tuff, gabbro, and meta-diorite show little if any displacement, indicating practically no fault movement along the shear zones in which the quartz bodies have been deposited. Gently pitching rolls or drag-folds occur in several of the shears and the vein material follows these minor folds. Rolls in the Kitchener, Eclipse, and No. 1 Branch veins pitch easterly at angles of 15 to 30 degrees, and are such as would form by dragging of the south side up and slightly to the east with respect to the north side. A roll at the west end of the Hope shear pitches 5 degrees west and the south side was dragged up, whereas toward the east end of the shear several rolls pitch 10 degrees east and the south side was dragged down, suggesting a hinge-like movement along this shear.

The shear zones in which the deposits lie are up to 2,400 feet long and vary from 1 foot to 25 feet or more wide. Most of them narrow toward the ends and in depth. Quartz, which is the chief vein material, usually does not extend for the full length, width, or depth of the shear zone, but is virtually continuous for lengths up to 2,100 feet, is commonly 4 or 5 feet wide, and in places is 18 to 25 feet wide. The Kitchener vein continues from the surface to a depth of 700 feet, but narrows to the east and in depth as the south carbonate shear is approached. No. 1 Branch vein is of good width for distances up to 680 feet from the west end and to a depth of 625 feet, where the vein lies in gabbro, but passes into small lenses and stringers as the shear narrows on entering meta-diorite to the east and at depths greater than 625 feet. The Eclipse vein is narrower on the 375-foot level than on upper levels, and was not found below the 375-foot level. The Tene 6, Hope, and other deposits generally either died out at depths of 350 feet or less or continued as widely spaced small lenses and stringers in narrow shears below this depth. The quartz in the Kitchener, No. 1 Branch, and Eclipse shears is continuous for considerable distances, although pinching and swelling along the strike and down the dip. The quartz in the Tene 6, Hope, and other shears occurs chiefly as lenses arranged end to end or *en échelon*. In the Hope shear the quartz tends to follow the crests of gently pitching rolls, and pinches out on the limbs to form saddle-reef structure.

Most of the quartz, especially in the upper parts of the deposits, is a smoky grey variety varying from coarse to sugar grained. At a depth of about 375 feet in No. 1 Branch vein and about 250 feet in No. 2 Branch vein the grey quartz passes into a spotted variety in which small, indefinitely bounded patches of grey quartz lie in white, sugary quartz. On the 350-foot and lower levels on the Tene 6 deposit the grey quartz is crossed by irregular veinlets of white quartz. In the Hope deposit the spotted quartz occurs in places close to the surface, and at some localities the grey quartz is crossed by short, horizontal gash veinlets of white quartz, giving a ladder structure. With the exception of the Hope deposit, the white quartz was introduced chiefly in the lower parts of the deposits and everywhere appears to be later than the grey quartz, although there is no evidence to indicate that any considerable period of time elapsed between the deposition of the two varieties, and it seems probable that the white quartz is a late phase of the grey.

The grey quartz carries disseminated grains and veinlets of pyrite, chalcopyrite, and pyrrhotite. Pyrrhotite is generally less plentiful than the other sulphides, except in No. 2 Branch vein and near the west end of the 450-foot level on the Hope deposit. Gold is rarely, if ever, coarse enough to be seen, even with the aid of a hand lens. In bulk samples from the Kitchener, Rogers, and Tene 6 deposits some of the gold was associated with chalcopyrite and pyrite, but none apparently occurred in pyrrhotite.[1] A sample of ore from the Kitchener vein assayed a trace of zinc and 0·009 per cent nickel.[2] The zinc is possibly contained in sphalerite, although this mineral has not been recognized, and the small amount of nickel probably occurs in the pyrrhotite. A little lead has been recovered from the ore, but no lead mineral has been recognized. The ore contained about 0·5 per cent copper. An average of about 0·36 ounce of gold and 0·06 ounce of silver was recovered from each ton of ore milled, or a ratio of 6 parts of gold to 1 of silver. In general there is no noticeable change in the proportions of the three sulphides with depth, but the sulphides and gold decrease in quantity with depth and are not plentiful in the lower parts of the deposits where the white quartz appears. The white quartz carries blebs of chalcopyrite and possibly other sulphides. A few veinlets of white, granular and coarsely crystalline carbonate occur in the Hope deposit. Wall-rock schists generally hold disseminated grains and cubes of pyrite, but little or no gold.

With the exception of three small patches of ore between the 375- and 460-foot levels in the Kitchener vein, and two small ore-bodies on the 450- and 650-foot levels in the Tene 2 deposit, no ore was found below the 375-foot level, although in some deposits abundant quartz continued for considerable depths beneath the ore-bodies. Most of the ore-bodies

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[1] Godard, J. S.: Investigations in Ore Dressing and Metallurgy; Mines Branch, Dept. of Mines, Canada, 1929, p. 127.

[2] Godard, J. S.: Investigations in Ore Dressing and Metallurgy; Mines Branch, Dept. of Mines, Canada, 1926, p. 72.

were in grey quartz, and in No. 1 and No. 2 Branch veins the ore ceased in depth with the appearance of the spotted quartz. The ore-bodies are irregular in outline, commonly contain patches of low-grade material, which was not mined, and are greater in horizontal extent than in depth. The largest ore-body extended for 800 feet in the east part of the Kitchener vein and continued east for 650 feet in the Eclipse branch and for 450 feet in No. 1 Branch vein; this ore-body extended from the surface to the 375-foot level. Other large ore-bodies were 1,120, 850, and 840 feet long, and extended from the surface to depths of 375, 350, and 200 feet, respectively. Several of the ore-bodies followed the gently pitching rolls and extended for short distances above and below the rolls. Much of the ore, however, occurred on normal dips, and some of the rolls did not yield ore.

The relatively shallow depth of the ore and quartz may be due to a combination of several factors. The gently pitching rolls account for the greater horizontal than vertical dimension of some of the ore-bodies, but if this were the only factor other bodies of ore would be expected to occur at depth. In one vein the quartz dies out as the shear zone narrows in passing from gabbro to meta-diorite, and although the type of country rock may have been an important local influence this does not explain the shallow depth of the quartz and ore-bodies for the mine as a whole. The shear zones, however, generally narrow in depth as the north and south carbonate shears are approached, and one zone narrows toward the west as the south carbonate shear is approached. This suggests that the two major shear zones had an important influence on the development of the subsidiary shears in which the quartz bodies lie, and that the quartz-bearing shears are widest at the surface where the distance between the two major shears, as measured along the strike of the quartz deposits, is greatest and becomes narrower at depth as the distance between the two major shears decreases. The north and south carbonate shears may, therefore, bear a relationship to the shallowness of the quartz bodies and of the ore, for quartz is generally most plentiful in wide parts of the shears and bodies of ore are confined to bodies of quartz. Some of the ore-bodies cease at depth on the appearance of white quartz. In this connection it is interesting to note that, in the Gunnar mine white quartz near a body of granite is of lower grade than grey quartz at some distance from the granite; at the Central Manitoba mine, however, there is no evidence that granite lies close beneath the quartz deposits.

The deposits are described in more detail below.

The Kitchener vein (locality 36, Map 537A, and Figure 2) follows a shear zone that extends on the surface from a point near the south carbonate shear easterly for 2,400 feet to a point where the vein splits into two branches, one called the Eclipse vein and the other named No. 1 Branch vein. Although a shaft was sunk on the Kitchener vein on the Growler claim in early days of exploration, the deposit was served chiefly from the Kitchener shaft, which has been sunk vertically to a depth of 900 feet at a point near the fork at the east end of the vein. The two shafts have been connected in underground workings and the deposit has been developed on six levels to a depth of 520 feet, the lower three levels being reached through a winze sunk on the vein from the 375- to the 520-foot horizons.

The vein lies in a band of tuff close to its north, or lower, edge. The tuff band varies from 50 to 100 feet wide. It is overlain to the south by andesitic lava and is underlain to the north by a sill of gabbro averaging about 50 feet wide, which separates the tuff band from a large sill of meta-diorite. The vein, like the tuff band in which it lies, strikes north 75 degrees west and generally dips from 50 to 60 degrees south, except in depth toward the west end where the deposit flattens on approaching the south carbonate shear; at one locality the beds and the vein dip gently north away from the south carbonate shear. A roll in the tuff and vein occurs at or near the surface 750 feet west of the Kitchener shaft and pitches about 20 degrees easterly, reaching a depth of about 200 feet at the east end of the vein. The roll carries the lower part of the vein some 10 or 20 feet south of the upper part, and probably formed by dragging of the south or upper beds up and to the east over the lower beds. At the west end the vein dies out close to the south carbonate shear and rakes easterly at about 30 degrees, which is the angle of intersection of the tuff bed and the south carbonate shear as measured on the plane of the vein. The fork at the east end of the vein pitches westerly at an average angle of 70 degrees, as measured on the plane of the vein. The vein, accordingly, becomes shorter in depth, and is only about 1,000 feet long on the 520-foot level as compared with the length of 2,400 feet on the surface. It was intersected in diamond drill holes to a depth of 700 feet and would be expected to pinch out at about 800 feet.

The vein pinches and swells along the strike and down the dip and averages 4 or 5 feet in width for much of its length, but is said to narrow somewhat in depth and toward the west as the intersection with the south carbonate shear is approached. The quartz is grey and carries chalcopyrite, pyrite, a little pyrrhotite, and very fine gold. Gold was plentiful on the surface, and in the upper workings, but assays showed only a little gold on the 520-foot level. A sample of ore from the vein carried 0·78 ounce of gold a ton, 0·40 per cent copper, no lead, a trace of zinc, 1·67 per cent iron, and 0·009 per cent nickel.[1]

Almost all the ore occurred above the 375-foot level, and was mined from two ore-bodies, namely, the Kitchener ore-body and the Growler ore-body. The Kitchener ore-body was the best in the mine. It was 800 feet long and extended from the surface to the 375-foot level. At the east end the ore raked steeply west, closely following the pitch of the fork at the east end of the vein. At the west end the ore ended irregularly. The Growler ore-body commenced 120 feet west of the Kitchener, was 1,120 feet long, and extended from the surface to the 375-foot level. Many patches of low-grade material within the body were not mined. The ore-body ended irregularly in depth and at both ends. The west end was nowhere closer than about 100 feet from the south carbonate shear. The quartz vein continues below the two ore-bodies, but is below ore grade except in a few small patches above the 460-foot level.

The Eclipse vein (locality 34, Map 537A, and Figure 2) is the southerly of the two branches into which the Kitchener vein forks at its east end.

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[1] Godard, J. S.: Investigations in Ore Dressing and Metallurgy, 1926; Mines Branch, Dept. of Mines, Ottawa, pp. 72-79.

The tuff band in which the Kitchener vein lies, and also the andesite lava to the south and the sills of gabbro and meta-diorite to the north, bend sharply at the fork and continue at an angle of about 20 degrees more south of east than they do along the Kitchener vein. The Eclipse vein, like the Kitchener vein, lies in the tuff close to the contact with the underlying gabbro sill.

The vein is served from the Kitchener shaft and has been developed by drifting on the 125-, 200-, 250-, and 375-foot levels. On the 125-foot level the vein has been followed in a drift for 480 feet easterly from the fork. For distances of 100 to 300 feet easterly from the fork on the 200-foot and lower levels the deposit consists of stringers only or pinches out, and has been drifted on for only part of that distance. Farther east, however, the vein appears again on each of these levels, where it has been drifted on for distances of 450 to 600 feet. There the vein was 5 feet wide for a length of 229 feet on the 250-foot level, but was narrower and discontinuous on the 375-foot level. Some half dozen drill holes penetrated the tuff band at depths of 600 to 1,100 feet, but revealed little or no vein quartz. The vein strikes about north 55 degrees west and dips, on the average, about 60 degrees southwest. A roll in the vein and host rock, similar to the roll in the Kitchener vein, pitches 20 or 30 degrees easterly from the 125-foot level south of the shaft to the 375-foot level near the east end of the drift. The quartz in the deposit is bluish and carries pyrite, chalcopyrite, and pyrrhotite. Pyrrhotite is more plentiful on the 375-foot level than at higher horizons.

Near the fork at the west end of the vein an ore-body extended from the 200-foot level to the surface, and apparently was continuous with the Kitchener ore-body. The ore-body raked 20 or 30 degrees easterly and was followed for a distance of 700 feet down the rake to a point 20 feet above the 375-foot level, where it died out. In that distance the ore-body, except for some irregularities, gradually narrowed in vertical extent until at the east end the stope extended only between 20 and 60 feet above the 375-foot level. On and near the 125-foot level a small patch of vein material on the gently pitching roll did not make ore, but easterly down the rake the ore-body followed the roll and extended above and below it.

No. 1 Branch vein (locality 35, Map 537A, and Figure 2) is the northerly of the two branches into which the Kitchener vein forks at its east end. The branch vein continues easterly on the strike of the Kitchener vein and extends through the lower contact of the tuff into the underlying rocks. For the most part it follows a short tongue of gabbro that branches from the north side of the gabbro sill that lies along the north edge of the tuff band. Toward the east and in depth the vein extends beyond the end and bottom of the tongue of gabbro into meta-diorite, where it passes into lenses and stringers and dies out.

The vein is served from the Kitchener shaft and has been developed on seven levels to a depth of 875 feet, although on the lowest level it has been explored chiefly by means of diamond drilling from a drift lying from about 20 to 100 feet south of the vein and about parallel with it. On the 125-, 200-, 250-, 375-, and 520-foot levels the vein was followed easterly from the fork for distances of 150 to 800 feet. On the 625- and 875-foot levels the vein was traced for lengths of 860 and 1,700 feet, respectively, but was not followed westerly to the fork. The vein strikes west and dips at an average angle of about 65 degrees south. The roll on the Kitchener vein continues along the branch vein and has been traced for about 500 feet down its easterly pitch of about 15 degrees from about the 200-foot level at the fork to the 375-foot level. In stopes above the 375-foot level the quartz is said to have been of excellent width, but toward the east end of the drifts it narrows on passing from gabbro to meta-diorite and dies out in stringers in the meta-diorite. On the 375-foot level the vein continues to be of good width for a length of about 680 feet in gabbro, and in one place is 18 feet wide. On entering meta-diorite toward the east, however, the shear zone in which the vein lies narrows to 3 feet and the quartz narrows and passes into stringers. On the 520-foot level the quartz lies in gabbro, and is of good width for 150 feet east of the fork where the drift ends. The shear zone continues to the 625- and 875-foot horizons, but is narrower than in the upper workings. On the 625-foot level the shear is in meta-diorite for most of its length, and there holds only scattered small lenses and stringers of quartz. For 100 feet from the west end of the drift the shear zone is in gabbro and the vein is of drift width. On the 875-foot horizon the shear is in meta-diorite and vein quartz, as shown in diamond drill cores, and in a short drift at the west end is not plentiful. It is apparent that No. 1 Branch vein and the shear zone in which it lies are wider in the gabbro than in the meta-diorite.

In stopes above the 375-foot level the quartz was bluish and well mineralized with chalcopyrite, pyrite, and a little pyrrhotite. Below this level the quartz has a speckled appearance, due to spots of bluish quartz in white quartz, and generally carries only a small amount of the above-mentioned sulphides and only a little gold. Schistose gabbro and meta-diorite close to the quartz bodies carry disseminated grains of pyrite.

From the surface to the 200-foot level ore extended easterly from the Kitchener ore-body for 120 to 300 feet along the branch vein and ended irregularly to the east, but pitching about vertically on the average. Below the 200-foot level the ore-body was separated from the Kitchener ore-body by low-grade vein material and raked gently east to the 375-foot level. This easterly raking part of the ore-body followed the gently pitching roll in the vein for 500 feet, and extended with irregular upper and lower contacts for 15 to 50 feet above and below the roll. The ore-body was in gabbro except for a short distance at the east end, between the 250- and 375-foot levels, where it was in meta-diorite. Although abundant vein quartz continues for some depth beneath the ore-body the quartz carries less sulphides and gold than in the upper levels.

No. 2 Branch vein has been developed on the 200- and 250-foot levels, and has been followed for 160 feet in drifts on each of these levels. The vein strikes north 75 degrees east from a point near the north or foot-wall side of No. 1 Branch vein near its east end and dips 60 degrees south. The vein is in gabbro on the 200-foot level and is in meta-diorite on the 250-foot level.

It has been stoped out for a length of about 120 feet and for a distance of 40 feet above and 40 feet below the 200-foot level. The vein is said to have been narrow in the stopes and to have died out in stringers at the west end near No. 1 Branch vein. On the 250-foot level the shear in which the vein lies holds a few short lenses of quartz up to 5 feet wide, but in places the shear is only a foot wide and is without vein quartz. In the stope the quartz was chiefly blue with some white and carried plentiful pyrrhotite and some pyrite and chalcopyrite. Below the stope the quartz was mostly white, was spotted with small patches of blue quartz, and carried less sulphides than in the stope.

The Tene North shear zone (locality 32, Map 537A, and Figure 2) strikes west and dips 80 degrees south. It is exposed here and there in trenches for a length of 950 feet. It lies east of and on the strike of the Eclipse vein, but is not known to be connected with it beneath an intervening drift-covered area 400 feet wide. For 300 feet from the west end of the trenches the shear lies in tuff close to the underlying sill of gabbro. Farther east the tuff and gabbro swing 15 degrees more south of east than the strike of the shear, and the shear cuts through the gabbro and continues east into the underlying meta-diorite. In the trenches the shear contains scattered lenses and stringers of bluish quartz said to carry only a little gold. Diamond drill holes cut the tuff band at depths of 250 and 550 feet down the dip from the outcrop of the deposit in the tuff, but no important amount of vein quartz was found in the tuff. One diamond drill hole cut vein quartz 100 feet below the outcrop in meta-diorite, but another hole cut only sheared meta-diorite at 450 feet.

The Tene South shear zone (locality 33, Map 537A, and Figure 2) lies 75 feet south of the Tene North deposit and occurs in the tuff band close to the contact with overlying andesite. The shear strikes north 85 degrees west and dips steeply south. It is well exposed in prospect pits for a length of 350 feet, and has been tested in a prospect shaft 10 to 15 feet deep. Eight diamond drill holes cut the tuff band at depths up to 650 feet, but only three of the holes cut important amounts of vein material in the tuff close to the south contact. On the surface vein quartz occurs in the shear as lenses up to 10 feet wide, but generally less than 3 feet wide. The lenses are distributed here and there across 15 feet of sheared tuff, which is much stained with iron oxide. The deposit is said to assay only a little gold.

The Wentworth shear zone (locality 31, Map 537A, and Figure 2) outcrops on the Tene 4 fraction. It lies on the strike of the Tene South deposit and has been traced westerly to within 350 feet of the outcrop of this deposit, but is not known to be connected with it. Like the Tene South shear, the Wentworth shear is in tuff close to the contact with overlying andesite.

The shear strikes about north 65 degrees west and dips 80 degrees south. It has been tested in a few prospect pits where the shear zone is 10 feet wide and holds a few lenses of blue quartz carrying pyrite, chalcopyrite, and a little pyrrhotite. The sheared tuff is much stained with iron and carries disseminated small grains of pyrite. The deposit has been intersected at depths of about 30 feet by nine diamond drill holes, spaced 40 feet apart for a length of 320 feet. Assays from the cores of the nine holes averaged 0·398 ounce of gold a ton across an average width of 1·6 feet. At the east end of the section drilled in the shallow holes, three diamond drill holes cut the deposit at depths of about 200 feet, and two holes at depths of 260 and 300 feet cut the tuff band but little or no quartz. Good assays in gold were obtained from one of the holes at a depth of 200 feet.

The Tene 1 shear zone (locality 28, Maps 536A and 537A, and Figure 2) lies in meta-diorite in the north part of the Tene No. 1 claim. The zone strikes north 75 degrees west and dips 70 degrees south. It has been traced intermittently in prospect pits for a length of 1,300 feet, and has been intersected at depths of 100 feet or less by five diamond drill holes spaced at regular intervals for 940 feet of this length. The shear zone is 2 to 12 feet wide and carries scattered lenses and stringers of white and bluish quartz. The largest lens noted on the surface is 3 feet wide and 20 feet long. Some of the quartz carries disseminated grains of pyrite, chalcopyrite, and a little pyrrhotite, and the rock near the quartz bodies carries disseminated grains of pyrite. Assays indicate only a little gold.

From a point about half-way along the shear a branch shear extends north 50 degrees west for 350 feet where it is covered by drift. The branch shear also holds a few small lenses of white and bluish quartz.

The Tene 6 shear zone[1] (locality 29, Maps 536A and 537A, and Figure 2) lies in meta-diorite on the Tene No. 6 and adjacent claims. The zone strikes north 75 degrees west and dips on the average about 75 degrees south. The shear and quartz bodies in the shear have been developed on eight levels to a depth of 750 feet. A shaft has been sunk on the deposit to the 350-foot level, and a winze 200 feet east of the shaft follows the shear from the 350- to the 750-foot levels. The average dip of the shear zone is somewhat steeper than the north carbonate shear, so that the two approached one another in depth and would be expected to meet on a line pitching 15 degrees westerly from a point 300 feet beneath the 750-foot level at the winze.

The shear is exposed here and there on the surface for a length of 1,050 feet, and diamond drilling indicates that it may continue beneath drift to the east for an additional 500 feet. At the shaft the quartz is 15 or 20 feet wide. This quartz body dies out 100 feet or so west of the shaft, where the shear zone is 10 feet wide. The shear zone continues to the west, but narrows to 1 foot and dies out at a point 300 feet west of the shaft. On an outcrop 400 to 750 feet east of the shaft the shear zone has been trenched for a length of 350 feet, is 5 to 10 feet wide, dips vertically, and holds lenses of bluish quartz up to 1½ feet wide and 20 feet or more long. The wide quartz body at the shaft continues to a depth of 40 feet or so, where a branch vein splits from the main deposit and continues to a drift on the 60-foot level, where it dies out. The branch strikes about parallel to the main deposit, but dips steeply north. The fork between the main deposit and the branch vein pitches gently west. The branch vein was followed in the drift at the 60-foot horizon for 60 feet east and 400 feet west of the shaft. The main shear continues beneath the fork and was followed by drifting on the 140-foot level for 580 feet east and

[1] The underground workings on the Tene 6, Tene 2, Rogers, and Hope deposits were inaccessible at the time of examination and the description of these deposits is based largely on information supplied by J. Curtis Houston, manager, and G. D. Ruttan, mine geologist.

890 feet west of the shaft. On the 250-foot and lower levels drift lengths along the shear vary from 440 to 970 feet. Lenses of quartz as wide or wider than the drifts are arranged *en échelon* in the shear for 640 feet west and up to 270 feet east of the shaft, and from the 60-foot to the 350-foot horizons. Beyond these limits the shear zone carried little or no quartz and almost no gold. Above the 350-foot level the quartz is blue and carries pyrite, chalcopyrite, and pyrrhotite. Below this level blue quartz is crossed by streaks of white quartz and carries almost no sulphides or gold.

A short section of the branch vein was stoped between the 60-foot level and the intersection with the main deposit. An ore-body in the main shear extended from the surface to the 350-foot level. It was very irregular in outline and included many patches of low-grade material, which were not mined. The upper limit of the ore pitched 6 degrees west from the shaft for 650 feet, passing 60 feet or less beneath the narrow shear on the surface. From the west end to within 120 feet of the shaft the ore-body extended to a depth of only 200 feet, although abundant quartz continues to the 350-foot level. From a point 120 feet west of the shaft the ore-body extended irregularly to the surface and raked 45 degrees or so to the east as far as the 350-foot level, where it died out. The ore reached a maximum thickness of 25 feet where the branch vein merged with the main deposit. About 75,000 tons of ore were mined from the main and branch deposits.

The Tene 2 shear zone (locality 29a, Figure 2) lies in meta-diorite 380 feet south of the Tene 6 shear, and strikes and dips about parallel to that shear. The Tene 2 shear does not outcrop, but has been developed by drifting on the 350-, 450-, 650-, and 750-foot levels, which are reached through crosscuts from the underground workings on the Tene 6 deposit. The drifts are up to 450 feet long, but vein quartz was confined chiefly to the central part of the drifts on the upper three levels and died out toward the ends of these drifts and on the bottom level. Small ore-bodies were stoped for short distances above and below the 350- and 650-foot levels and for a short distance above the 450-foot level.

The Rogers vein (locality 27, Maps 536A and 537A, and Figure 2) occurs on the Tene 2 claim close to the west boundary, at a point 500 feet south of the Tene 6 deposit. The vein strikes west and dips 60 degrees south. It has been traced for 100 feet on the surface, where it consists of blue quartz 6 inches to 2 feet wide in a shear zone 2 to 5 feet wide. The quartz is considerably stained with iron and carries disseminated grains of chalcopyrite. The west part of the vein lies in a band of tuff close to the contact with underlying meta-diorite. The tuff is 80 feet wide at this locality, dips about 60 degrees south, and is the band of tuff that holds the Kitchener and other deposits farther west. Toward the east the vein passes out of the tuff and enters the fine-grained border phase of the underlying meta-diorite. An inclined shaft has been sunk on the part of the vein that lies in the tuff, and the shaft follows the vein for 175 feet. The vein in the shaft is narrow and follows the tuff band to a depth of about 100 feet, where the vein steepens and passes into the underlying meta-diorite. Near the bottom of the shaft the quartz pinches out in a very narrow shear. At a depth of 100 feet a drift follows the vein in tuff for 280 feet. About

5,000 tons of ore were mined from the shaft and from a stope above the 100-foot level. A diamond drill hole cut the lower contact of the tuff at a depth of 420 feet, but did not penetrate important amounts of vein quartz.

The Hope shear zone (locality 26, Map 536A, and Figure 2) lies in meta-diorite on the Hope and nearby claims. The zone strikes north 75 degrees west and dips on the average about vertically, although varying between levels from vertical to steeply north and steeply south. On the surface it has been traced intermittently for a length of 2,250 feet, narrowing and dying out at the west end and passing into drift at the east end close to the north carbonate shear. The zone has been developed on levels at 100, 200, 325, and 450 feet for lengths of 1,000 to 1,800 feet. The junction of the Hope shear and the north carbonate shear pitches about 40 degrees west from the surface to the 450-foot level, where the drift on this level enters the carbonate shear at a point 900 feet east of the shaft. Assuming that the Hope shear continues with a vertical dip beneath the 450-foot level, the junction would rake 22 degrees west from the 450-foot level to a depth of 1,100 feet at a point 800 feet west of the shaft.

The irregularity in dip is due in part to the presence of several gently pitching rolls or drag-folds in the shear. One of these near the west end of the drift on the 100-foot level pitches about 5 degrees west and the south side has been dragged up with respect to the north side. Another occurs near the east end of the same level; this roll pitches about 10 degrees east and the south side has been dragged down with respect to the north side. Toward the east this roll and a quartz body in the shear are crossed by a fault dipping a few degrees south and offsetting the overlying vein material 5 feet or so to the south with respect to the underlying vein material. Other rolls occur east of the shaft between the 100- and 200-foot levels and between the 200- and 325-foot levels; these also pitch gently east.

On the surface, lenses of bluish quartz from a foot or less wide to 3 feet wide and 30 feet long are distributed through the shear zone, which is in most places 6 to 8 feet wide and at one locality is 15 feet wide. In the underground workings the shear is said to vary from 1 to 15 feet wide, and quartz bodies in the shear are reported to be lenticular in character. The lenses are small and widely separated in drifts on the 200- and 450-foot levels and on the west half of the 325-foot level drift. Toward the east end of the drift, on the 325-foot level, quartz was essentially continuous for 300 feet and for 255 feet of this length assayed on the average slightly over 0·5 ounce of gold a ton across an average width of 3½ feet. In the drift on the 100-foot level several large lenses of quartz are separated from one another along the strike by long and short sections of sheared diorite carrying only small, scattered lenses of quartz. The larger bodies of quartz occur on the gently pitching rolls and elsewhere. Where occurring on the rolls the quartz tends to follow the crests of the rolls and may extend for short distances along the limbs, resembling saddle-reefs. The quartz on the rolls is up to 30 feet wide horizontally. Where the drift on the 450-foot level enters the north carbonate shear, the Hope shear merges with the north carbonate shear and lenses and stringers of quartz continue from the one shear into the other.

The quartz varies from a dark bluish variety to a spotted variety in which white quartz holds many small, indefinitely bounded patches of the blue. Some of the lenses of blue quartz are crossed by horizontal gash veinlets of white quartz, giving a ladder structure. Much of the quartz in ore-bodies and elsewhere carries disseminated grains of pyrite, grains and large blebs of chalcopyrite, and only a little pyrrhotite. In places the large blebs of chalcopyrite assayed very high in gold. Pyrrhotite is plentiful in quartz lenses toward the west end of the drift on the 450-foot level, where no ore was found. A few veinlets of white, granular and coarsely crystalline carbonate also occur in the shear zone. The wall-rock schist carries large cubes of pyrite and little or no gold.

Most of the larger bodies of quartz were of ore grade. The largest ore-body extended easterly from the shaft for 840 feet. It was irregular in outline but, on the whole, raked about 5 degrees east. At the shaft it extended from near the surface to the 100-foot level. The top of the ore raked gently east to the 100-foot level at the east end, and extended only 30 feet below this level. For 300 feet from the east end the ore followed closely the gently pitching roll and did not generally extend more than 10 or 20 feet above and below the roll. Just west of this roll an irregular, easterly pitching lobe extended downward from the main part of the ore-body to the 200-foot level; this lobe followed in part another easterly pitching roll. Five other ore-bodies were stoped out. The largest of these extended for the full 300-foot length of the quartz lens near the east end of the drift on the 375-foot level, but the ore generally died out in 20 or 30 feet above the level and continued for only 40 feet below the level, where the ore was only 175 feet long.

The Hope No. 7 vein (locality 25, Map 536A) follows a weak shear zone in andesitic lava 1,000 feet southwest of Stovel Lake. The vein strikes north 45 degrees west, dips 70 degrees northeast, and has been stripped continuously for a length of 600 feet. The quartz is almost continuous for this length, varies from 6 inches or less to 2 feet wide, and carries buff weathering carbonate and, in places, a little pyrite and plentiful chalcopyrite.

ALBENA CLAIM

A large quartz vein (locality 30, Maps 536A and 537A) is exposed at intervals for 800 feet on the Albena claim, crosses the north boundary of the claim, and continues for 500 feet farther north to the edge of a swamp. The vein follows a shear zone that strikes about north and lies in andesitic lava along the edge of a dyke of feldspar porphyry. The shear is up to 90 feet wide and the vein quartz at several places is 5 to 10 feet wide. The quartz varies from pale bluish grey to white and is iron stained, probably as a result of weathering of pyrite, but sulphide is generally lacking or rare.

GOLD ROCK MINES, LIMITED

This company holds the Bear No. 1, Bear No. 2, Bear No. 3, and Chief No. 5 claims, which are unsurveyed and lie about ½ mile north of the Central Manitoba mine.

A shear zone (locality 37, Map 537A) has been traced for about 600 feet on the Bear No. 1 claim, where it strikes north 10 degrees west. What appears to be a continuation of the same zone outcrops to the north on the Chief No. 5 claim, giving a total length of 1,500 feet. The shear zone is in andesitic lava for most of its length and passes into meta-gabbro at the north end. In the shear zone, vein quartz occurs as only a few stringers at some localities, and at other places forms bodies 4 to 6 feet wide. The quartz is white and generally carries little if any sulphide, although in a pit near the north end of the deposit the quartz carries a considerable amount of pyrite and chalcopyrite.

MERCON GOLD MINING SYNDICATE, LIMITED

This syndicate holds the Lakeshore group of claims on the east side of Halfway Lake in the northwest corner of the map-area. Three large quartz-bearing shear zones have been discovered in andesitic lava on the property.

The largest of these, which may be called the Lakeshore zone (locality 38, Map 537A), strikes about north 10 degrees west and dips 50 to 60 degrees east, varies from 10 to 25 feet wide, and is exposed intermittently for 3,000 feet along the strike. Vein quartz occurs as lenses and veinlets distributed irregularly through much of the shear zone; many quartz bodies are 1 foot to 6 feet wide and together with associated smaller bodies constitute, in places, over half of the material present across widths of 16 to 20 feet. The quartz varies from blue to white or to a spotted variety consisting of a mixture of the two types. Little or no sulphides can be seen in most of the quartz, although at some localities the vein material is stained with malachite.

The other two deposits lie 500 and 1,200 feet, respectively, west of the Lakeshore deposit, and strike and dip about parallel to it. They resemble this deposit in general character, but are narrower and shorter.

GOLD BIRD CLAIM

On this claim, which is owned by Letitia Germain, a vein (locality 39, Map 537A) follows a shear zone in meta-diorite, strikes north 65 degrees east, and dips 80 degrees southeast. The shear has been traced for a length of 500 feet, dying out at the southwest end and passing beneath drift to the northeast. The vein pinches and swells along the strike from $\frac{1}{2}$ foot to 3 feet wide, and averages $1\frac{1}{2}$ feet wide for a length of 200 feet. Much of the quartz carries blebs of chalcopyrite and has a speckled appearance, with spots of blue quartz lying in white quartz.

WALTON GOLD, LIMITED

Walton Gold, Limited, was incorporated on September 21, 1934, and owns a group of nine claims situated about 1 mile southeast of Halfway Lake. In 1934 the company did some surface stripping and test pitting and 3,000 feet of diamond drilling. Several deposits of vein quartz occur on the property, but most of the work has been done on quartz bodies in a shear zone on the North Star claim and in a shear and fracture zone on the Rex claim.

The North Star zone (locality 41, Map 537A) strikes north 55 degrees west and dips 65 to 75 degrees northeast. It has been traced for a length of about 900 feet. The northwest part of the zone lies in meta-gabbro and crosses a tongue of andesite that extends into the gabbro; the southeast part lies along a contact between andesite to the northeast and sediments to the southwest. The shear zone is about 10 feet wide for most of its length, gradually dies out at the northwest end, and passes beneath drift to the southeast. A dyke of aplitic material 1 to 3 feet wide and lenses, veins, and stringers of quartz have been introduced along the zone. Most of the quartz bodies are 1 inch or less to 1 foot wide and are distributed irregularly along the strike and across widths up to 4 feet; toward the northwest end a vein-like body of quartz up to 2 feet wide is essentially continuous for 120 feet. The quartz is fine grained, varies from bluish grey to white, and at some localities has a banded appearance due to alternating layers or streaks of dark- and light-coloured quartz or to thin shreds of schist lying parallel to the walls. Some of the quartz carries plentiful fine-grained pyrite and, on weathered surfaces, is stained with malachite.

The Rex zone (locality 40, Map 537A) has been traced at intervals for 1,100 feet across a small stock of oligoclase-quartz diorite and extends a short distance into adjoining sediments on the southeast side of the intrusive body. The zone strikes north 35 degrees west and dips 40 to 60 degrees northeast. Small lenses of quartz from 2 to 6 inches wide and 10 feet or more long are scattered here and there in the zone of fractured and slightly sheared country rock across widths up to 10 feet. The quartz is very fine grained, varies from dark blue to smoky and white, and carries disseminated grains and veinlets of pyrite and a little chalcopyrite.

KINGFISHER GOLD MINES, LIMITED

This company was incorporated in 1928 to develop a group of claims acquired from the Kingfisher Mining and Development Company, Limited, which was organized in 1916. The claims include the Elora fraction, Valley Vein claim, and eight others, lying about 1½ miles south of Halfway Lake.

The north part of the group is underlain by andesite and sediments, which are intruded by sill-like bodies of meta-diorite and meta-gabbro; the south part is underlain by oligoclase-quartz diorite. The formations strike easterly. Quartz deposits have been discovered in all of these rocks and strike and dip in various directions. Two of these deposits are described below.

Elora deposit (locality 42, Map 537A). In 1922 Mr. A. M. Stewart sank a shaft at the southwest end of a body of quartz, mined the deposit from an open-cut, treated the ore in a two-stamp amalgamation mill that had been erected nearby, and produced about $2,300 in gold from 200 tons of ore. The open-cut extends north 40 degrees east for 100 feet from the shaft, varies from 1 to 4 feet wide, and is up to 15 feet or more deep. A few lenses of white quartz up to 1 foot wide can still be seen on the walls of the open-cut, but the character of any vein material in the bottom could not be determined as the open-cut was partly filled with water at the time of examination. A few pieces of grey quartz on the dump carry pyrite, a little chalcopyrite, and coarse gold.

The open-cut lies in the north corner of the Elora fraction and extends across the northeast boundary into the Dardanelles claim. Nearby rocks include tuffaceous sediment cut by a dyke of granite 15 feet wide and by several small dykes of aplite and lamprophyre. The granite dyke and the beds of sediments strike easterly. The deposit lay in the sediments and crossed the granite dyke, but apparently did not offset the dyke. The deposit terminated to the southwest against a cross shear, which strikes north 10 degrees east, dips about vertically, and contains almost no vein quartz. Some diamond drilling has been done beneath the drift northeast of the open-cut.

The Valley Vein shear zone (locality 43, Map 537A) occurs on the Valley Vein claim close to its southwest boundary. The shear lies in oligoclase-quartz diorite. It strikes north 40 degrees west and dips 55 to 60 degrees northeast. It has been traced in prospect pits at intervals for 1,200 feet and passes beneath drift at both ends; in 1928 a vertical, two-compartment shaft was sunk to a depth of 34 feet on the hanging-wall side of the zone about 40 feet northeast of the southeast end of the line of pits. Prospect pits near the shaft expose a width of about 10 feet of sheared and fractured quartz diorite penetrated by a few small lenses of quartz. Toward the northwest end of the line of pits, the shear varies from 1 to 3 feet wide and generally holds only narrow stringers of quartz here and there along the strike, although at one locality quartz is more plentiful and pinches and swells from ½ foot to 2½ feet wide. Most of the quartz is bluish grey and in some bodies the bluish grey quartz is mixed with white quartz. In places the quartz is stained with iron oxide, probably resulting from the weathering of pyrite.

Several other quartz deposits in the oligoclase-quartz diorite and elsewhere carry pyrite and chalcopyrite.

OGAMA CLAIM

This claim is owned by William A. Quesnel and lies in a body of oligoclase-quartz diorite in the southwest part of the area. Several shear and fracture zones holding bodies of quartz have been explored in prospect pits. Some surface work was done on the deposits in 1925 by the W.A.D. Syndicate; other pits have apparently been dug recently.

One of the deposits (locality 45, Map 537A) strikes north 50 degrees west, dips 80 degrees northeast, has been tested in many prospect pits for a length of 800 feet, and passes beneath drift at both ends. This deposit consists of lenses of quartz, from 1 foot or less to 2 feet wide, distributed at intervals along a shear zone, 3 to 4 feet wide, in the oligoclase-quartz diorite. The quartz varies from blue to white and the quartz and sheared wall-rock carry disseminated grains of pyrite and chalcopyrite.

ROCKLAND CLAIM

This claim, which is owned by William Walton, lies in a large body of oligoclase-quartz diorite in the southwest part of the area. Several shear and fracture zones holding quartz bodies have been explored in prospect pits. Some of this work was done in 1925 by the W.A.D. Syndicate; other pits have apparently been dug more recently.

One of the deposits (locality 44, Map 537A) strikes north 45 degrees west, dips steeply northeast, has been explored in test pits for a length of 400 feet, and passes beneath drift at both ends. The deposit consists of lenses of quartz distributed here and there across widths of from 6 to 20 feet of fractured quartz diorite; the largest lens is 3 feet wide and 100 feet long. The quartz is bluish and carries disseminated grains of pyrite and chalcopyrite.

At a point 80 feet northeast of this deposit a prospect shaft has been sunk on an apparently short lens of quartz 14 inches wide and carrying much pyrite.

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