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GEOLOGY

of the

LILY LAKE - KICKLEY LAKE AREA

Rice Lake Mining Division

SOUTHEASTERN MANITOBA

by

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CONTENTS

GEOLOGY OF THE LILY LAKE - KICKLEY LAKE AREA

INTRODUCTION

LOCATION AND ACCESS

The area described in this report comprises about eleven square miles immediately south of Gem Lake in south-eastern Manitoba. The most direct means of access is by air from Lac du Bonnet, a distance of 50 miles. There is an alternative route by boat and road from Selkirk, via the Red River, Lake Winnipeg, Manigotagan, Bissett, and Beresford Lake. Gem Lake can be reached by canoe from Beresford Lake. The area may also be reached by canoe from Lac du Bonnet, via the Bird River.

PREVIOUS WORK

Several geological surveys, the earliest in 1922, have been made in the area. The most comprehensive publications are by Wright[1] and Stockwell[2]. The most recent work was completed by Stockwell in 1938.

PURPOSE OF PRESENT WORK

The present survey (1950) was made to check on new developments in the area in the 12 years since Stockwell's mapping. Certain localities were chosen for examination and five projects outlined, as follows:

1. Geology south of Gem Lake.
2. Examination of topographic lineaments in the area of Lakes A and B. (Map No. 8, Sheet 50-3a).
3. Geology of the Garner Lake-Beresford Lake Area.
4. Mapping of marker beds in the Rice Lake group.
5. Detailed mapping of a representative group of showings.

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

2 Stockwell, C. H.: Gem Lake, Manitoba; Geol. Surv., Canada, Map 811A, with descriptive notes, 1938.

The geology south of Gem Lake was selected for study because it includes one dormant property (the Diana Mine) and a gold prospect, four miles to the northwest, on Lily Lake. This prospect was discovered two years after Stockwell had finished his mapping in 1938.

The topographic lineaments in the vicinity of Lake A and Lake B were selected for study because their strike is parallel to the major shears of the Rice Lake area. There was a possibility that the lineaments were due to shearing and might carry ore minerals.

The Garner Lake-Beresford Lake area was chosen for study for two reasons. First, occurrences of iron formation had been described by Stockwell, and second, the mass of basic rock at Garner Lake was known to carry veins of cross-fibre asbestos. The iron formations were mapped to see where they fit into the general structural picture of the Rice Lake area. The outcrops of basic rock at Garner Lake were examined in detail to secure information on the amount and quality of asbestos.

The study of marker beds in the Rice Lake group was planned to obtain information which might prove of value in the exploration for mineral deposits. Beds of iron formation and conglomerate were used as markers in tracing structures.

The fifth project was to map in detail a representative number of showings which would illustrate the different ways in which ore and gangue minerals occur. Current claim maps (spring of 1950) were used as a guide in this work.

Finally, visits were made to parts of the eastern Rice Lake area in which mining or exploration was in progress. Besides the work south of Gem Lake, work was examined at the Ogama-Rockland Gold Mines Ltd. and at Wallace Lake.

ACKNOWLEDGEMENTS

The writer acknowledges, with thanks, the assistance and hospitality extended to the survey party by James and John Chanowski, and by the management and staff of the Ogama-Rockland Gold Mines Ltd. Through the courtesy of Mr. C. Gibson, Chief Geologist of San Antonio Gold Mines, Ltd., the writer had an opportunity to visit their optioned claims at Wallace Lake.

Field assistant for the season was Derek Fetherstonhaugh.

GEOLOGY OF THE AREA SOUTH OF GEM LAKE (MAP 50-3)

GENERAL GEOLOGY

The rocks of this section are a series of sedimentary and volcanic rocks that have been intruded by dykes which range from diorite to magnetite-amphibolite in composition. The entire belt has an average trend of south 75 degrees east.

The south side of the belt is composed of volcanic rocks with some narrow, interbedded layers of quartzite and slate. The volcanic rocks are pale brownish-grey ellipsoidal and massive flows of andesite.

The central part of the belt consists mainly of sedimentary rocks. Beds of tuff and agglomerate occur across its entire width. Closely spaced parallel bands of iron formation and conglomerate occur towards the north and south sides of the belt. There are limited occurrences of ferruginous limestone and graphitic schist south of the Manigotagan River, between Lily Lake and Slate Lake. The wall rocks of the southern bands of iron formation and conglomerate in the west part of the belt are predominantly coarse, gritty quartzite. In the east part of the belt the wall rocks are black slates and slaty quartzites. The occurrences of limestone and graphitic schist mark a transition between these two types of wall rocks. In the west and east parts of the belt the iron formation and conglomerate are well exposed. In the central part of the area, in the vicinity of the limestone and graphitic schist, they could not be found. This is partly because of the lack of outcrops. The association of iron formation, conglomerate, limestone, and graphitic schist resembles that at Conley Bay on Wallace Lake[1].

The north side of the belt is composed of sedimentary rocks. One prominent bed of agglomerate occurs just north of the Manigotagan River. The rest of the rocks are quartzite, slate, conglomerate, arkose, and greywacke.

There are no sharp contacts between the three main bands of rock which form the belt. Volcanic rocks grade into

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[1] Russell, G. A.: Geology of the Wallace Lake Area, Rice Lake Mining Division, Man. Mines Br. Prelim. Rept. 47-1, 1948.

sedimentary rocks by a gradual increase in the number and thickness of the sedimentary layers. North of the Diana Mine, agglomerate grades into quartzite which contains bombs similar to those in the agglomerate, and then, with the gradual disappearance of the bombs, this grades into pure quartzite.

The intrusive rocks, where they occur as small dykes, are diorite. The larger mass at the Diana Mine shows compositional variation across its strike. It has a coarse-grained pegmatitic phase and a magnetite-amphibolite phase in addition to the diorite. Similar phases occur in the basic intrusives of the Central Manitoba mine and Beresford Lake areas. One dyke west of the Diana Mine contains inclusions which look like granite but may be sedimentary. The inclusions are anomalous with respect to the wall rocks of the dyke. Some of the dykes are crooked and lenticular while others are straight with parallel walls. Most of the dykes crosscut the volcanic rocks and have a strike of north 75 degrees east. The volcanic rocks strike south 75 degrees east. North of the main belt, east of Gem Lake, lamprophyre dykes cut a mass of grey to pink granite thereby establishing the presence of a post-granite intrusion. The diorite dykes south of Gem Lake were not observed in contact with the granite and the relative ages of the granite, diorite dykes, and post-granite lamprophyres are not known.

Recent deposits in the area are unconsolidated glacial drift and an occurrence of bog-type limonite. (See Appendix). In some places the rock consists of pure reddish brown limonite; in others, the limonite forms the matrix of a conglomerate which contains glacial pebbles and cobbles and also pebbles of yellowish brown limonite. Roots can be found in the limonite. Sometimes the roots have rotted away leaving a mold of their exterior surface. These occurrences of limonite are in the vicinity of the ferruginous limestone and graphitic schist.

STRUCTURAL GEOLOGY

The belt is located on the south limb of a regional syncline which plunges to the east at 20 to 45 degrees. Drag-folding is a prominent feature. One large drag-fold is located in and near Flintstone Lake. Smaller drag-folds occur throughout the entire section of layered volcanic and sedimentary rocks. No matter what their location, size, or the type of rock in which they occur, all the folds have the same orientation and plunge as the major folds.

All of the rock layers dip north except on the noses of folds. If the folding is nearly closed, the dip may be towards the southeast. Dips in the south band of volcanic rocks are about 50 degrees north. To the north the dips steepen rapidly. In most of the sedimentary part of the belt and in the north band of volcanic and sedimentary rocks dips are steeply north or vertical.

The relative position of iron formation and conglomerate is reversed in the north and south parts of the belts. This results from overturning of the beds. The overturning may be the result of folding caused by regional compression or it may be due to dragging along the faults of the Lily Lake-Kickley Lake Belt.

If the present geology was simply the result of overturning it would be expected that the south band of volcanics would be lithologically similar to the volcanics of the north band. Also, the sedimentary rocks in the centre portion of the belt would be one unit. Field evidence does not support this view. Subsequent to the folding, the belt was broken by southeasterly trending high angle faults along which there has been a horizontal component of movement. This movement has brought into close proximity in the belt quite different rocks, either from below or above the present surface by vertical movement, or from the southeast or northwest by horizontal movement or, more likely, a combination of both. The main zone of shearing, extending from the south side of Finger Lake to the Ontario border, is responsible for most of the shifting of formations. There has been some horizontal movement along all the shear-zones.

An extensive zone of shattering and silicification is exposed on the narrow strip of land between Finger Lake and Normandy Lake. The centre part of the zone consists of greenish-grey to buff sugary quartz containing ghost-like, almost completely silicified, angular remnants of wall rock. The outer boundaries are composed of a stockwork of quartz stringers which cement a breccia of less completely silicified, angular wall rock fragments. Similar rock was noted at the west end of the big jack pine flat south of the Manigotagan River between Lily and Slate Lakes and near the north shore of Rathal Lake. Just east of Normandy Lake, on the township line, numerous wide quartz veins and some stockworks occur. They are partly conformable with the sedimentary rocks in which they occur.

MINERAL DEPOSITS

The Diana Mine

The property is located one thousand feet northwest of the west end of Kickley Lake. The rocks exposed at surface are pillow lavas and tuffs of andesitic to basaltic composition and sedimentary beds which are mainly quartzites. The volcanic and sedimentary rocks are intruded by numerous small and one large dyke of medium to basic rock.

The ore shoots are composed of tourmaline-bearing white quartz which carries native gold, chalcopyrite and pyrite. They occur along shear-zones which fault a large mass of diorite. Maps of the underground workings indicate that the ore shoots have little or no rake. A detailed map of the surface geology is included with this report (Map No. 1, Sheet 50-3a).

The strike of the volcanic rocks is southeasterly. The strike of the large diorite dyke is northeasterly. The ore bearing shears are not clearly evident in the greenstones because the strike of the shears is parallel to the strike of the volcanics. Where the shears cut the diorite mass they appear as well-defined zones of chlorite-schist and resemble those in similar rocks in other parts of the Rice Lake area (San Antonio, Central Manitoba, Gunnar, etc.).

Twenty-two hundred feet northeast of the Diana shaft, stripping, trenching, and some diamond drilling have been done on a zone of gossan and shearing. The gossan is associated with two intersecting shear-zones, one of which strikes southeast and the other northeast, and which intersect an interbedded series of sedimentary and volcanic rocks as well as the eastern portion of the Diana diorite dyke. The gossan is the result of weathering of iron-bearing carbonate which is cut by veinlets of milky quartz. Small amounts of chalcopyrite and pyrite were seen.

Northwest of the Diana shaft, north of the trail to Slate Lake, narrow dykes of diorite intrude tuff and pillow lavas. The dykes have been faulted and broken subsequent to their emplacement. The dykes and dyke fragments contain veins of white quartz which end abruptly at the contact of the diorite masses with other rocks. No quartz veins were seen in the adjacent rocks in the immediate vicinity. On a small scale, this illustrates the structural behaviour of the diorite bodies and the preferred occurrence of productive quartz veins in them instead of in the layered volcanic and sedimentary rocks.

Lily Lake Claims

This gold prospect was discovered by Edward O'Hare about 1940. It is located at the middle of the south shore of Lily Lake. A detailed map of the showing has been prepared and is included with this report. (Map No. 2, Sheet 50-3a).

The rocks are all sedimentary. Abundant native gold occurs in short, widely spaced, narrow lenticular masses of quartz in a bed of quartzite which lies between a bed of iron formation to the southwest and a bed of conglomerate to the northeast. The quartz is a combination of two types. Angular fragments of glassy black quartz lie in a matrix of sugary, greenish-black to greenish-grey quartz. The visible gold occurs mostly in the latter. Arsenopyrite is abundant and occurs as fine needles both in the quartz and in altered wall rock.

The sedimentary formations have been drag-folded. The best showings are associated with the noses of dragfolds. Shears parallel to the strike of the volcanic and sedimentary rocks and which dip vertically or steeply north are present. The extent to which shearing may have influenced the deposition of gold is not known at the present time. Visible gold occurs in the pits near the lakeshore where there is a well-defined shear, but gold is also present in the second pit southeast of the swamp where the quartz lenses have unsheared contacts with the wall rock. On the lakeshore, 500 feet northeast of the showings, a strong, rusty shear with abundant massive pyrite was seen. It strikes parallel to the main belt and is vertical.

Nora Claims

This group of claims was staked by James Chanowski. Stripping, trenching, and rock pitting have been done on several mineralized shears and quartz veins. The claims are located east and south of Nora Lake and lie partly north of and partly south of the Manigotagan River.

The north claims are underlain by agglomerate, the middle claims by slate, and the south claims by slate, quartzite, and tuff. Quartz-bearing shears with pyrite, chalcopyrite, and arsenopyrite have been found in all the rocks. At the time of the writer's examination, a new vein was being opened up by handsteel work. It is located on the face of a steep, north-facing cliff. Six feet of quartz in sheared and mineralized wall rock had been exposed at the time of examination. The vein contains pyrite, chalcopyrite, sphalerite, and arsenopyrite in quartz-carbonate gangue which contains a small amount of tourmaline. Subsequent to the writer's examination a second pit, about 150 feet east of the first pit, opened up quartz and shearing containing abundant arsenopyrite. A small amount of free gold was reported from gossan overlying the vein.

Other showings south of Gem Lake

Half a mile northwest of the Diana shaft, just south of the Manigotagan River (near the Kickley Lake portage) a deep pit has been blasted from a quartz vein located fifty feet west of a drag-fold in quartzite. The quartz occurs in a rusty shear and contains pyrite, arsenopyrite, and a small amount of chalcopyrite.

Three hundred feet southeast of the southeast end of Slate Lake, just south of the Rathall Lake portage, at least five pits have been blasted from a strong shear on an abrupt, north-facing cliff. In the east pit, the shear consists of from five to eight feet of red gouge and schist. The wall rocks of the shear are completely altered to carbonate and contain veinlets of quartz and carbonate as well as up to 90 per cent sulphides. The sulphides consist of about equal parts of pyrite and arsenopyrite. The other four pits contain similar material.

At the southeast end of Lac Bon a large pit has been blasted in a quartz-bearing shear which is mineralized with pyrite, chalcopyrite, and arsenopyrite.

Seven hundred feet south of the south side of Lac Bon, several pits have been blasted from a quartz vein in sheared sedimentary rocks. The quartz is glassy, jet black, and shows an iridescent play of colours. The quartz and sheared wall rock contain some pyrite.

South of the point where the Manigotagan River flows out of Banksian Lake, several pits have been blasted from lenticular quartz veins which occur in dragfolded agglomerate. The quartz contains pyrite, arsenopyrite, and chalcopyrite. A detailed map of the showing has been prepared and is included with this report (Map No. 3, Sheet 50-3a). It illustrates the occurrence of quartz veins in drag-folds and how what might appear to be two separate veins, or a faulted vein, can be interpreted as probably one vein, by using drag-folds mapped in the wall rocks.

Twelve hundred feet west of the southwest portion of Banksian Lake, several pits have been blasted from quartz veins and iron formation. Sulphide minerals are arsenopyrite, pyrite, and chalcopyrite. A detailed map of the showing has been prepared and is included with the present report. (Map No. 4, Sheet 50-3a). It illustrates the occurrence of sulphides in shearing combined with drag-folding. Three hundred feet slightly south and west of the main pit, a small faulted drag-fold was mapped and indicates a horizontal component of movement subsequent to folding. This small detail indicates similar deformation on a regional scale.

In the large zone of shattering and silicification between Finger Lake and Normandy Lake, rare patches of pyrite and chalcopyrite were seen. Similar occurrences were mapped during 1949 by the writer on the first range line west of the village of Wadhope P. O. (Long Lake), about one-quarter mile north of the north shore of Long Lake.

The Pixy group of claims (formerly the GX Group) is located southeast of McRae Lake. Although not actually included in the area mapped, it can be conveniently discussed here. Sulphide-bearing quartz veins occur in shear zones in diorite. It was not possible to tell whether the diorite in which the veins occur is intrusive (as at Diana Mine) or whether it is a volcanic flow of dioritic composition. At the base of the hill on which most of the showings are located, a strong shear with abundant massive pyrite is exposed by two pits. A detailed map of the showing was prepared and is included with the present report. (Map No. 5, Sheet 50-3a). It illustrates the lenticular and branching nature of the quartz veins which have been sheared and broken subsequent to their formation.

An east-west line of patented claims (Canada, Brittania etc.) appear on the claim map between Rathall Lake and Slate Lake. Several pits have been blasted from a rusty shear zone in interbedded sedimentary rocks. The shear contains narrow stringers of black quartz.

North of the main part of Gem Lake, four showings were examined. Sulphides noted were pyrite, arsenopyrite and chalcopyrite. (Map No. 7, Sheet 50-3a). The carbonate at the lake shore is about twenty feet wide and contains a small amount of quartz and carbonatized fragments of sheared granite. A few grains of pyrite were seen.

Twelve hundred feet east of the bay of Gem Lake from which the portage leads to Garner Lake, several pits have been blasted from a shear which contains lenticular veins of quartz-carbonate. The veins occur in unaltered greenstone.

A detailed map was prepared. (Map No. 6, Sheet 50-3a).

Three veins located along the Manigotagan River, east of Slate Lake, consist of quartz and carbonate which carry small amounts of pyrite and chalcopyrite, and black quartz carrying a small amount of pyrite.

TOPOGRAPHIC LINEAMENTS AT LAKE 'A' AND LAKE 'B'

The topographic lineaments near Lake 'A' and Lake 'B' (Map No. 8, Sheet 50-3a) were found to be due to differential erosion of zones of quartz, silicification, and quartz stockworks similar to the occurrence between Finger Lake and Normandy Lake. At Lake 'A' the zone is exposed on the north shore of the narrow south arm of the lake, just east of the narrows which connects the two parts of the lake. Northwest of Lake 'A' small amounts of quartz stockworks and pronounced red alteration were noted on the rocks which occur north and south of the swampy, covered ground which marks the course of the lineament.

At the west end of Lake 'B', about 500 feet north of the lake, another zone of quartz and silicified wall rock occurs. It is much wider than the zone at Lake 'A', being over 1000 feet wide, north of the west end of the lake. To the east, where the zone outcrops on the lake shore, it narrows to a width of about twenty feet. The Lake 'B' zone contains a small amount of pyrite and chalcopyrite at the lakeshore.

Zones of iron formation are also shown on Map No. 8. These are further discussed below.

GEOLOGY OF THE GARNER LAKE-BERESFORD LAKE AREA

GENERAL GEOLOGY

Field work in the vicinity of Garner Lake revealed that little, if any, geological data could be added to that already obtained by Stockwell. Some local exposures of rock are extensive, but on the whole, insufficient outcrops were available for the tracing of marker beds. Enough work was completed to substantiate the view set forth elsewhere in this report, that the Rice Lake group exhibits a continuous change in the nature of the sedimentary and volcanic rocks from south to north rather than an isoclinal repetition of beds.

The outstanding characteristic of the sedimentary rocks of the Rice Lake group in the vicinity of Garner and Beresford Lakes is the marked increase in the number and thickness of beds of iron formation and ferruginous limestone. From south of Flintstone Lake to Gem Lake, only two narrow beds of iron formation were found and only one limited occurrence of ferruginous limestone. In the narrows towards the west end of Garner Lake, on the north shore, extensive exposures of complexly folded ferruginous limestone were noted. The limestone is interbedded with thin beds of chloritic tuff. Some beds of limestone are weakly magnetic.

Stockwell noted the presence of iron formation near the west end of Garner Lake, on the north shore. The writer tried to locate the extension of this bed but failed owing to lack of outcrops. However, similar iron formation, with abundant associated ferruginous limestone was found near the north end of the Garner Lake-Beresford Lake portage. On a ridge to the east of the first rock encountered southward from Beresford Lake (along the Winter road) five more beds of iron formation were found. Traverses east of Beresford Lake and Moore Lake show that this wide zone of iron formation beds is continuous northward and curves parallel to the east shores of Beresford Lake and Moore Lake. Between Moore Lake and Little Bulldog Lake, eight parallel beds of iron formation are exposed. Near Moore Lake the iron formation is highly siliceous and is composed of uniform beds of quartzite (one half inch to one inch thick) separated by thin beds (one eighth inch to one quarter inch thick) of granular magnetite. Towards Little Bulldog Lake, the iron formation shows a marked increase in the amount of magnetite and, just west of Little Bulldog Lake, five-foot bands of nearly pure magnetite were seen. The eastward increase in magnetite is accompanied by an increase in the amount of basic volcanic rock in the section. The bands of iron formation just west of Little Bulldog Lake occur between massive bodies of diorite.

The basic intrusive mass at Garner Lake is a composite one composed of dark-green weathering pyroxenite-amphibolite and brown-weathering serpentine rocks. The pyroxenitic and amphibolitic rocks form the outer rim of the mass. The core is composed mainly of serpentine-rich rocks (altered peridotite). The south boundary of the mass is marked by a shear zone which is exposed along the south shore of Garner Lake. Near the centre of the south shore the shear zone bounds the serpentine-rich phase, whereas to the east and west of the centre point, the pyroxenitic and amphibolitic phases are exposed. Stockwell noted that the mass was altered to amphibolite where it was in contact with the granite, implying a pre-granite age for the intrusive. The writer was not able to secure positive proof of age but noted that the mass is amphibolite around its outer edge, regardless of what rocks are in contact with it.

STRUCTURAL GEOLOGY

Mapping of drag-folds, fracture cleavage, and bedding shows that in the vicinity of Garner Lake and Beresford Lake (and north as far as Moore Lake), the Rice Lake group forms the southwest limb of a syncline. This is in accord with data secured in other parts of the area. Only one shear zone of any size was noted. It occurs on the south shore of Garner Lake and is partly in the lake.

MINERAL DEPOSITS

Stockwell noted the presence of veinlets of cross-fibre asbestos in the basic intrusive at Garner Lake. During the present work all exposures were examined carefully to determine the amount of asbestos present. Nearly continuous exposures may be seen around the shores of the islands. The asbestos veinlets are confined to the brown weathering, serpentine-rich rocks. A typical outcrop shows brown-weathering "peridotite" cut by veins of pure serpentine which weather to a greenish grey colour. A portion of some of these greenish grey weathering serpentine veins contains narrow veinlets of cross fibre asbestos. Except for one occurrence, the asbestos veins are extremely rare. At the occurrence noted on Map No. 8 Sheet 50-3a by a cross, asbestos makes up to 50 per cent of the rock. The maximum fibre length noted was one-eighth inch.

The shear zone which occurs along the south shore of Garner Lake has been explored by several pits near the Garner Lake-Gem Lake portage, and towards the west end of the lake near the cabin indicated on the map. The shear occurs along the bedding planes of quartzose sediments which are altered to a lemon-yellow colour near the shear. Quartz, with a small amount of pyrite, occurs on the shear.

Near the north end of the Garner Lake-Beresford Lake portage, numerous pits have been blasted into the occurrences of iron formation and ferruginous limestone.

MAPPING OF MARKER BEDS IN THE RICE LAKE GROUP

PURPOSE OF THE STUDY

When exploring for mineral deposits in areas of layered rocks, either sedimentary or volcanic, a knowledge of the arrangement of the layers is important for the following reasons:

1. The recognition of displacement, repetition, or omission of beds may indicate the extension of an ore-bearing shear when the shear itself is not exposed.

2. A particular layer may be more favourable to the occurrence of ore than other layers.

In 1949 the writer made a brief examination of the showings on the Lily Lake claims and noted the presence of iron formation and conglomerate in close proximity to the gold-bearing veins. The gold values are localized on drag-folds in a bed of quartzite which occurs between the iron formation and conglomerate. It was decided to select iron formation and conglomerate as marker beds during the 1950 season. The purpose of this was two fold: first, to try to find evidence of further gold occurrences, and second, to try to separate into more distinct units the sedimentary rocks which Stockwell grouped under his symbol 4, (quartzite, greywacke, arkose, conglomerate, slate, chert, iron formation, gneiss and schist).

THE MARKER BEDS

Banded iron formation is an excellent marker bed. Even where it is not exposed, it can be picked up by systematically noting compass deflections on a picketed or carefully lined traverse. The rock may be associated with either sedimentary or volcanic rocks. In this area the rock occurs chiefly in association with sedimentary strata. On an island

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1 Stockwell, C. H.: Gem Lake, Manitoba; Geol. Surv., Canada, Map 811A, with descriptive notes, 1938.

in Gem Lake an occurrence of iron formation is associated with volcanic rocks, where magnetite forms the selvage of some of the pillows. An average specimen of iron formation consists of layers of either fine-grained or coarse-grained magnetite separated by siliceous layers. If the siliceous layers are coarse-grained (sandy) the magnetite is coarse-grained. If the siliceous layers are fine-grained (cherty) the magnetite is fine-grained. The siliceous layers may be chert, granular quartz, or jasper.

The conglomerates contain a wide assortment of fragments representing granites, greenstones, and sedimentary rocks (including some black chert and jasper). The fragments vary from 1 inch to 18 inches in maximum dimension. The matrix may be either a greyish green slaty rock or slaty quartzite.

The marker beds vary considerably in thickness along the strike. Part of this is due to the tendency of all sedimentary beds to be lenticular. Most of it is the result of squeezing during folding. On the noses of folds, the marker beds are thicker than on the limbs. Iron formation on the limbs of folds shows straight parallel banding. On the noses of folds it is complexly crumpled into hundreds of small folds. Conglomerate beds also show abnormal thickness on the noses of folds. On the limbs, the fragments are elongated because of squeezing during folding.

All drag folds mapped show an orientation of strike, dip, and plunge similar to that of the regional fold whose area of maximum curvature is outlined by Flintstone Lake. On their normal strike (south 70 degrees east) marker beds show consistent small drag-folds and are displaced a few feet to the south by each fold. At intervals, a large drag-fold occurs and then the marker beds may be displaced as much as 500 to 1,000 feet to the south. On small closed drag-folds the marker-beds show abnormal thickness due to the isoclinal folding. In the larger, open drag-folds, where the marker beds cannot be traced continuously, due to lack of exposures, the impression may be given that there are several beds instead of one bed which recurs on a section line across the fold.

Interbedded with some of the quartzites in the Lily Lake-Kickley Lake Belt are coarse, gritty or pebbly beds, the constituents of which show the same heterogeneity as the fragments in the conglomerate. They were not used as marker beds but most of them occur somewhere near the conglomerate and are an aid in locating it.

RESULTS OF THE STUDY

From evidence supplied chiefly by the mapping of drag-folds and to a lesser extent by the mapping of fracture cleavage-bedding relationships, it is concluded that the Rice Lake group forms the south limb of a syncline which plunges south 75 degrees east at about 45 degrees, the bedding dips north at from 50 degrees to nearly vertical. Where large drag-folds occur, alternate south and north dips may be seen, giving the impression of closely spaced anticlinal and synclinal axes but if a marker bed can be followed it is possible to trace out the drag-fold. This is not possible when only dips and strikes on different beds are mapped.

Subsequent to folding, the rocks were faulted along numerous shear zones which strike south 75 degrees east and are vertical or dip steeply north. There is a horizontal and a vertical component of movement. In spite of the complexities introduced by folding and faulting, the gradational nature of all contacts between sedimentary and volcanic rocks, and the confusion introduced in considering whether tuffs and agglomerates should be included with volcanic or with sedimentary rocks, it is possible to outline three broad units which are progressively younger from south to north.

The oldest unit is a series of quartzites which are well exposed south of Flintstone Lake and from Flintstone Lake to Moose River. Most of the rock is a fine-grained, dark quartzite with thin lenses and narrow beds of black chert. Thicker beds of pale, greenish grey, cherty quartzite, which weather to a reddish brown colour, are exposed southwest and west of Flintstone Lake. One zone has abundant garnets, and andalusite, and kyanite, and a narrow band of iron formation. This zone is exposed on the west shore of Flintstone Lake. From there it was traced northward to a point about halfway between the east end of Tooth Lake and Moose River. South and southeast it lies under the lake. The garnet-kyanite-andalusite-mica schists were seen at the west end of Lost Claim Lake but no iron formation was seen at this point. The unit as a whole, particularly the dark quartzites to the south, is lithologically similar to the series of quartzites and related mica schists which extend eastwards from Lake Winnipeg along the course of the Manigotagan River.

The second unit consists almost entirely of greenstones. Some sedimentary rocks are present at Rathall Lake as noted by Stockwell[1]. The lower part of this unit, from

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1 Stockwell, C. H.: Gem Lake, Manitoba; Geol. Surv., Canada, Map 811A, with descriptive notes, 1938.

Moose River to Anderson Creek and Rathall Lake, is composed of tuffs and thin-bedded agglomerates, with rare ellipsoidal flows. Towards the top of the unit, between the Diana Mine and Rathall Lake, the unit shows abundant pillow lavas and massive flows of andesite. The number and thickness of tuff beds increases northward as the boundary with the third unit is approached.

The third unit is predominantly sedimentary. It is composed of alternate beds of slate, quartzite, and some arkose, with thin tuffaceous beds occurring throughout most of the section. Near the base of this unit are coarse, gritty and pebbly beds interlayered with quartzite, tuff, and slate. Above these are a bed of iron formation and a bed of conglomerate separated by a bed of quartzite. These are followed to the north by slate, tuff, and some agglomerate. Towards the south shore of Gem Lake, this unit shows a gradual increase in the amount of tuff and agglomerate. Along the south shore of Gem Lake and on islands immediately adjacent to the shore, another series of sedimentary rocks is exposed. It consists of white to greyish white pure quartzites and beds of very fine-grained light green to greenish grey chert. These sedimentary rocks do not resemble those south of Gem Lake.

Northwards from Gem Lake to Garner, Beresford, and Moore Lakes, the greenstones are similar to those occurring farther south, with the exception of the area north of Garner Lake where glassy black ellipsoidal and vesicular lavas become prominent. As noted previously under the description of the geology of the Garner Lake-Beresford Lake area, the sedimentary series shows a marked increase in the number and thickness of beds of iron formation and ferruginous limestone. Accompanying this increase in the number of iron-rich beds in the series is an increase in the amount of dark-green amphibole in the associated sedimentary rocks. In the vicinity of Garner Lake and Beresford Lake, hornblende (commonly altered to chlorite) becomes sufficiently abundant to impart a dark green colour to some of the sedimentary beds and a greyish green colour to most of them.

Detailed mapping of the Lily Lake Claims has indicated that the gold values there are not located solely with respect to drag-folds but that shearing is also a part of the structural control of the deposits. Throughout the area south of Gem Lake, quartz veins occur mainly in the brittle beds as quartzite and the massive bed of agglomerate thick outcrops along the north side of the Manigotagan River. The only commercial veins which have been found so far occur in the diorite at the Diana Mine and thus are similar to those of other deposits in the area such as Central Manitoba Mines and Gunnar Gold Mines.

ADVICE TO PROSPECTORS

A consideration of the assay results of 40 grab samples taken during the present field work shows that gold values are not associated with any particular veins or ore minerals which occur in the veins. Assay values were generally low. No samples of the quartz at the Lily Lake Claims were taken because the lenses contain abundant visible gold. The only sample which returned positive gold values were taken from the pits at Banksian Lake and the pits on the south side of Garner Lake.

Diorite, of the type in which the Diana veins occur, must be considered as the most favourable rock type not only due to the gold values present but also because of the size of the shoots and the continuity of the shears. The shear zones in the area south of Gem Lake extend eastwards into Ontario and there is a possibility that they may intersect the large mass of diorite which strikes into the west end of Anderson Lake. If they do intersect the diorite mass there would be an almost exact duplication of conditions at the Diana Mine where shears, which are barren of gold values in the greenstone country rock of the diorite mass, become gold-bearing in the diorite.

Appendix

A sample of bog limonite from the swamp south of the Manigotagan River between Lily Lake and Slate Lake was analyzed by D. F. Brown of the Provincial Mines Branch Laboratory. The results are as follows:

Total Fe	61.98
SiO_2	19.58
S	0.014
P_2O_5	0.17
TiO_2	0.24
MnO	0.094
H_2O +	10.09
H_2O −	3.63
MgO	0.23
CaO	0.56