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GEOLOGY OF THE

WANIPIGOW RIVER AREA

RICE LAKE MINING DIVISION

Manitoba

by

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INTRODUCTION

LOCATION AND ACCESS

The Wanipigow River area, located in the Rice Lake Mining Division of southeastern Manitoba, comprises approximately 188 square miles bounded by longitudes 95° 30' and 95° 45' west and latitudes 51° 00' and 51° 15' north. Activity within the area centers about the gold-mining town of Bissett on the north shore of Rice Lake in the southern part of the area. San Antonio Gold Mines Limited is situated on the immediate north shore of Rice Lake. During the summer months a boat service for both freight and passengers is operated from Selkirk to Wanipigow River via Lake Winnipeg to the west. A graded road, passing through Bissett, extends across the south part of the area starting at the boat landing on Wanipigow River outside the west boundary of the area. Air transportation is available from Lac du Bonnet. During the winter months tractor trains transport freight from Pine Falls.

TOPOGRAPHY AND DRAINAGE

Topographically, the region is similar to most Precambrian Shield terrain. Areas of rock outcrop, few with relief of more than 125 feet, are separated by low ground covered by a mantle of glacial drift or muskeg. The larger streams and rivers in most places have wide drift-filled valleys and in many places are bordered by wet swamps. The smaller streams, on the other hand, in part flow over rocky stream-beds or through narrow channels bordered by rock.

Drainage within the area is westward into Lake Winnipeg. The northern part is drained by a number of sluggish streams. Many tributaries flow out of extensive wet swamps and muskeg. In this part of the sheet about half the ground is underlain by muskeg, the other half by rolling granite hills from which nearly all growth has been burned. The main river in the area, Wanipigow River, is not easily navigated except with empty canoes.

Along its east-west extension log jams are so abundant as to make travel difficult. In its north-south reach, the water is shallow, and the gravel river-bed is extensively grown in with grass and weeds.

About the only way of travelling around the northern half of the area is by aircraft. Small aircraft can land on Leaf Lake, Longbranch Lake, Amkeg Lake, the western Dual Lake, and Brule Lake. The streams between these, and to other lakes, are all unnavigable.

Travel in the south part is greatly facilitated by several roads and trails.

Growth within the area consists mostly of spruce, pine, poplar, and birch; underbrush is largely alder and willow. In burned-over parts of the region, dense small spruce and pine second-growth is widespread.

Game consists mostly of bear and moose. Fish are not plentiful, the most common being jack-fish.

PREVIOUS WORK

A survey of the work done up to and including 1932 may be found in "Geology and Mineral Deposits of a Part of Southeastern Manitoba", by J. F. Wright, Geol. Surv., Canada, Memoir 169. Most of this work was of a reconnaissance nature and covered a much wider area than the one under consideration.

In 1936 the Geological Survey of Canada commenced further studies in the area. A. W. Johnston conducted a reconnaissance survey of a region including the Wanipigow River area, (Map 428A, 1936, scale one inch to four miles). One mile to the inch mapping by C. H. Stockwell included the region south of the Seventh Base Line, (Geol. Surv., Canada, Map 810A). In addition, a detailed survey on a scale of 500 feet to the inch was done on eight map-areas in the southwest part of the area (Geol. Surv., Canada, Memoir 210).

PRESENT WORK

The present survey was conducted during a four month period from May 16 to September 13, 1949. The geology was mapped on a scale of two inches to one mile. Traverses were run by pace and compass, precise locations being determined on vertical aerial photographs. The photographs used are numbered and their positions are located on the accompanying map. The traverses were run 1200 to 1500 feet apart in the volcanic and sedimentary portions of the area and as much as 2500 feet apart in the large areas of granite. Additional work in the area east of Rice Lake and south of the road closed the traverse interval to 600 or 700 feet.

A comparison of the accompanying map with the Wanipigow Lake area, Map 48-2 of the Mines Branch, Manitoba, made by the writer in 1948 will reveal several discrepancies between the two along their line of junction, longitude 96° 45'. The discrepancies are largely in the location of contacts. The geology of Wanipogow Lake sheet was plotted on a rather inaccurate base map and without the use of vertical aerial photographs. A new base map and vertical aerial photographs have since become available for this region. It can be stated with confidence that positions of determined contacts are accurate to within 200 feet or less on the present map.

Certain other changes in map units appear on the present map. It is believed that these changes result in a more correct interpretation of the geology of the area. These will be discussed further in the description of rock types.

Areas of rock outcrop are shown on the present map in the parts of the area underlain by sedimentary and volcanic rocks. In the parts underlain by granitic rocks, most of the area is well-exposed rock, and so the areas of swamp or overburden are shown.

The writer was efficiently and capably assisted in the field by D. S. Kerby, D. C. Chunn, and A. Yates, all of the University of Manitoba.

GENERAL GEOLOGY

All the consolidated rocks within the Wanipigow River area are of Precambrian age and consist of interbanded volcanic and sedimentary types intruded by large masses of basic to acid intrusives. Following previous nomenclature the volcanic-sedimentary types are called the Rice Lake group and are presumed to be early Precambrian. Considerable effort was directed toward separating lithological units within this group, and petrographic examinations have shown that the divisions used in the field are well justified.

Intrusive rocks range in composition from gabbro to granite, in texture from extremely fine to extremely coarse grained, and in structure from massive to highly gneissic.

A younger sedimentary formation, the San Antonio formation, unconformably overlies the Rice Lake group and intrusive rocks.

The accompanying table of formations illustrates the classification of rocks found within the area:

TABLE OF FORMATIONS

ARCHAEAN or PROTEROZOIC	San Antonio Formation	Feldspathic quartzite, conglomerate.
	Unconformity	
	Intrusive Rocks	Quartz-feldspar porphyry, felsite; Quartz diorite, granodiorite, oligoclase granite, albite granite, microcline granite; Gneissic granitic rocks, granite gneiss, part injected with considerable pegmatite, part containing numerous basic inclusions.
		Intrusive Contact
		Diabase, trap;) Part complex Gabbro, diorite, quartz diorite;) intrusives
	Intrusive Contact	
ARCHAEAN	Rice Lake Group	Quartzite, slate, tuff; Rhyolite breccia and tuff; Porphyritic andesite and dacite breccia trachyte breccia, (agglomerate); Andesite porphyry, basalt porphyry; Arkose, conglomerate, tuff; Andesite, basalt, chlorite schist; Rhyolite, rhyolite porphyry, trachyte, some breccia.

DESCRIPTION OF ROCK TYPES

Rice Lake Group

The oldest exposed rocks in the area, the Rice Lake group, consist of interbanded basic to acid flows, pyroclastic rocks, and sediments. Many of the volcanic flows are porphyritic, and pyroclastic types are abundant. The sedimentary rocks, conglomerate, arkose, tuff, quartzite, and slate, occur in two bands in apparent conformity with the volcanic rocks.

Rhyolite, Rhyolite Porphyry, etc. (1)[1]

Rhyolite and rhyolite porphyry flows underlie the other rocks of the Rice Lake group. Some phases of these acid rocks contain little quartz and approach trachyte in composition. Porphyritic phases are nearly as abundant as equigranular phases. Subordinate rhyolite breccia is included in this unit.

In hand specimens the rhyolite is very fine grained, hard, dense and cherty. It is light green in colour but weathers either to a greyish- or orangey-cream, commonly with a chalky lustre. In the rhyolite porphyry, abundant small plagioclase phenocrysts are dotted throughout the groundmass. In places, especially at the east boundary of the sheet, thin porphyritic flows alternate with fine equigranular ones giving the rock a pronounced banding which has been accentuated by shearing. Elsewhere the thicker massive flows exhibit blocky fracturing.

Although most of the rhyolite is light coloured, many bands of dark grey to black rhyolite and rhyolite porphyry are found near the east border of the sheet. These black flows may be distinguished from basalt by their typical bleached chalky weathered surface, siliceous and translucent lustre, and lower specific gravity. The darkening is due to finely disseminated magnetite.

The minerals in the rhyolite and porphyry consist of acid plagioclase, quartz, biotite, and chlorite, and abundant saussurite and sericite as alteration products; accessory minerals are discreet grains of epidote, apatite, magnetite, pyrite, and carbonate. Some specimens contain grains of hornblende.

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1 Numbers in parentheses are those of the map units used on the accompanying map.

South and east of Little Beaver Lake on the west side of the area, are outcrops of well-foliated quartz-biotite-feldspar gneiss, which is light grey in colour, highly foliated, and has a granular texture. The band of gneiss extends north of Little Beaver Lake and then west into the Wanipigow River area, where the writer, in 1948, classified these rocks as sedimentary gneisses because of their close resemblance to similar rocks of undoubted sedimentary origin along the Manigotagan River. However, further examination southeastward along the strike shows a visible gradation to less altered and finally to quite unaltered rhyolite porphyry. Intermediate between the massive rhyolite porphyry and gneiss are rocks whose groundmass is identical with the gneiss but which still contain recognizable feldspar phenocrysts.

It should also be mentioned that the contact of this band with the granite is misplaced about 1500 feet south on the Wanipigow Lake sheet; the correct position is that shown on the present map. Further, because of insufficient outcrops, the gneiss band was incorrectly shown as pinching out on the former map, rather than just thinning.

Andesite, Basalt, Chlorite Schist (2)

Several flows of medium- to dark-green or black andesite and basalt overlie the rhyolite. Most of this rock is highly schistose, in fact is largely chlorite schist. Pillow structures were observed in one place in the band on the north shore of Rice Lake. Elsewhere it is not certain that some of the chlorite schist does not represent sheared basic intrusives; although no coarse textures were observed in the chlorite schist, some of the diabase and gabbro, where highly sheared, is fine grained. The schistose rocks have a soft, rotten, weathered surface, and under the microscope are seen to be composed of a fine-grained streaky mixture of chlorite, saussurite, and fine feldspar and numerous small anhedra of epidote, lenses of carbonate, and much finely disseminated magnetite.

Arkose, Conglomerate, Tuff (3)

This unit underlies part of Rice Lake, and is exposed on several of the islands and east and west of the lake. The most striking member of this unit is the conglomerate, which contains well-rounded, smooth, pebbles of quartz-feldspar porphyry, rhyolite, trachyte, and quartz, in a medium-grained arkosic groundmass. Where pebbles are lacking, the rock is an arkose, commonly not visibly bedded, and distinguished with difficulty from porphyry. However, lenses of conglomerate within this rock leave little doubt as to its origin.

In other places the rock is well bedded, and in one or two spots it was possible to determine northward-facing tops by grain gradations. Some specimens, which have broken, angular feldspar and quartz grains, closely resemble tuffaceous phases of the rhyolite breccia (6). Some of the conglomeratic rocks, likewise, contain angular fragments and resemble rhyolite breccia. It may be that this whole unit represents a rhyolite tuff-breccia band, part of which was deposited under and sorted by water.

Andesite Porphyry, Basalt Porphyry (4)

North of Rice Lake a band of andesite porphyry as much as 2000 feet wide extends parallel with the lake and forms a high rolling ridge for a distance of about $4\frac{1}{2}$ miles. A second, narrower band about 400 feet wide occurs just north of the first. Parts of the porphyry are massive, but in general it is somewhat schistose, and in places highly so, the phenocrysts being squeezed out into flat ellipsoidal forms. In places the rock has a brecciated appearance, and is probably a flow breccia, as the fragments make up nearly all the rock and are identical with the minor groundmass.

The andesite porphyry has a medium-green colour on the fresh surface and weathers either to a similar colour or else to a lighter green with an orange tinge. The most conspicuous feature of the rock is the presence of abundant well-formed plagioclase (andesine) phenocrysts, some of which show moderately strong zoning. These phenocrysts are set in a fine- to medium-grained groundmass of feldspar, flaky chlorite, and saussurite, and disseminated magnetite, accessory apatite and leucoxene. Some specimens contain minor amounts of carbonate and hornblende. Others contain fine-grained quartz in the groundmass, and a few contain small quartz phenocrysts. The latter specimens are classified as porphyritic dacite.

Basalt porphyry is best developed in a mass east-southeast of Rice Lake. Some phases of this mass are andesitic in composition, but rarely, if ever, dacitic. The basalt porphyry is a conspicuous rock. Typically, it exhibits a peculiar speckled texture, owing to the presence of milky-white plagioclase phenocrysts in a dark-black basaltic groundmass which is finer grained than that of typical andesite porphyry. The plagioclase phenocrysts, strongly zoned labradorite, are remarkably fresh, and the groundmass, consists of small rods of feldspar and blades of pale-green chlorite. Ragged grains of hornblende may be present. Other minerals present are epidote, apatite, ilmenite, titanite, leucoxene, and magnetite, the latter peppered throughout the groundmass. The odd grain of quartz and/or carbonate is observed in thin sections.

Ordinarily the porphyry masses just mentioned would be considered intrusive. However, the presence of flow (?) breccia within the porphyry itself and the presence of abundant porphyry fragments in the overlying agglomerate (both these features in the body north of Rice Lake) suggest an extrusive origin.

Porphyritic Andesite (Dacite, Trachyte) Breccia (5)

Pyroclastic volcanics immediately overlie the andesite porphyry north of Rice Lake. Fragments of andesite porphyry, dacite porphyry, and trachyte are embedded in a dark- to medium-green chloritic groundmass. Most of the fragments are measured in inches, but in places they are a foot or more in diameter. Where foliation is very pronounced, the fragments have been stretched into long lenticular streaks, commonly an inch wide but as much as a foot long. Generally, however, they are only about twice as long as wide. Fragments of andesite porphyry appear to be most abundant in the breccia close to the contact of the mass of underlying porphyry.

Grains of feldspar in the groundmass are generally broken up and mixed with a fine aggregation of abundant saussurite and chlorite; commonly the rock has been sheared to a powder.

Rhyolite Breccia (6)

Progressing northwards towards Wanipigow River high rolling ridges of rhyolite breccia are encountered. Rhyolite porphyry flows and thin tuffaceous beds are interbanded with the breccia. The assemblage is generally distinctly foliated, and like the underlying intermediate agglomerate the fragments are squeezed and stretched out into lenticles. On the weathered surface the breccia and tuff have a light-cream colour with a tinge of orange, and characteristically exhibit a pronounced ribbed structure, each ridge or rib being an inch or so wide. Light-coloured fragments of rhyolite porphyry are embedded in a medium-grained clastic matrix of the same composition. The groundmass consists of a mixture of broken albite grains, strained quartz, saussurite, and chlorite. Some of the feldspars are partly altered to sericite or saussurite. Hornblende and carbonate were seen in some of the thin sections examined. Other accessories are pyrite, clinozoisite, apatite, and zircon.

Bands of tuff appear to have the same composition as the groundmass of the breccia.

Quartzite, Slate, Tuff (7)

This unit, the uppermost of the Rice Lake group, occurs along the valley of Wanipigow River. South of the river outcrops are scarce, and thus the southern contact is not determinate. However, it is inferred that the north contact of the quartz-feldspar porphyry (13) is marked by the edge of the drift-filled river valley (the porphyry outcrops in a high ridge ending abruptly at the valley-edge). Hence, if there are no members between the porphyry and the sediments, the contact is probably along the scarp formed by the porphyry.

The quartzite is a uniformly fine-grained, in part almost cherty, light-cream weathering, hard, well- and thinly-bedded rock composed of a mosaic of fine clear quartz, biotite, sericite, and clinozoisite with no visible feldspar. Bedding is apparent by variations in the amount of biotite and sericite on the one hand and clinozoisite on the other.

Cross-bedding and grain gradation are absent, thus tops of beds could not be determined.

Beds of light-green arkose or tuff occur in isolated outcrops. These are composed of a clastic mixture of quartz, plagioclase, sericite, chlorite, and carbonate, and accessory apatite, saussurite, and leucoxene. The grains have been sorted to some extent.

Especially along the river, narrow bands of thin, fissile black slate are interbedded with the quartzite. In one place where thin leaves of slaty material separate bands of quartzite, the quartzite contains abundant small discreet anhedral carbonate grains, some bands containing up to 50 per cent carbonate.

In the western part of the drift-covered valley of the river intense magnetic deflections were noted which are probably due to an extension of the iron formation which was found interbanded with the volcanics and sediments along the strike in the Wanipigow Lake area to the west.

Intrusive Rocks

Intrusive rocks ranging from gabbro to granite occur within the area. Cross-cutting relations and contact effects indicate that the more basic rocks are older than the granitic ones. Indications found in the area to the east previously led to the tentative conclusion that the basic intrusives were younger than the granitic intrusives[1].

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[1] G. A. Russell: Geology of the Wallace Lake Area, Manitoba; Manitoba Mines Branch, Prelim. Rept. 47-1, 1948

Further, it is believed that all the basic rocks are associated with the same period of igneous activity, and likewise that all the granitic rocks are related in origin, despite the fact that considerable variations in composition are found. This is discussed further below.

Large areas of granitic rocks are highly gneissic, and parts of the gneiss contain abundant basic inclusions. Dykes of pegmatite and aplite cut certain granites.

Gabbro, Diorite, Quartz Diorite (8)

The four occurrences of rocks of this category vary considerably and will be discussed separately.

The first large body, east of Rice Lake and south of the road, intrudes older rocks of the Rice Lake group and is in turn intruded by quartz diorite (12) on the south.

The rock, although greatly altered, nonetheless appears for the most part to be of fairly uniform gabbroic composition. Texturally, however, it is not so uniform. Some phases are coarse equigranular, others are spotted and have a fine chloritic groundmass, and still others are only medium grained and closely resemble, if they are not identical with, the diabase (9). However, because of the erratic distribution and the merging of one type into the other it is impossible to map these phases separately.

Originally these rocks were composed of pyroxene and plagioclase, remnants of which are found in some thin sections. Owing to widespread alteration they are now almost completely altered to fibrous green hornblende, ragged chlorite, and saussurite. Some sections contain no identifiable plagioclase. Others contain well-formed laths of zoned labradorite and hornblende. Discreet anhedral grains of epidote are common. Magnetite is generally abundant in the gabbro,either as disseminated grains or less commonly as large crystals. Considerable magnetic deflection was noted along traverses across the gabbro.

Dykes of intrusive porphyry and some granite definitely cut this gabbro mass. Near the contact of the gabbro and the quartz diorite (12) to the south, the quartz diorite contains irregular inclusions of darker material, which are believed to be remnants of gabbro. Also, large white masses of saussurite have apparently been produced in the gabbro near the contact.

In the southwest quarter of the area near the west boundary a folded sill of gabbro extends from the Wanipigow Lake area. In the report on the Wanipigow Lake area, the writer expressed the opinion that this rock was recrystallized basalt and called it "pseudo-gabbro"[1]. However, this rock is identical with some phases, especially the spotted ones, of the first-described body, and is now considered intrusive.

At the east boundary of the area, a complex body of basic to intermediate rock extends from Wanipigow River northward to Leaf Lake. The mass is surrounded on both sides by granitic rocks, and is the "Wanipigow diorite" of Russell. This band of basic rock has numerous compositional and textural varieties. The following types have been observed even in one outcrop: (a) whitish-grey coarse-grained quartz diorite composed of plagioclase, saussurite, quartz, pyroxene, and biotite; the ferromagnesian mineral content of this rock is low, about 15 to 20 per cent; (b) medium-grey coarse-grained gabbro composed of labradorite, clinopyroxene, and granular epidote, and minor carbonate, quartz, sericite, and magnetite; this rock is quite massive and fresh and the ferromagnesian content is about 40 per cent; (c) fine-grained black amphibolite, composed of a mass of uralitic actinolite, granular epidote, and subordinate flakes of chlorite and biotite and only the odd small grain of plagioclase; (d) medium-grained black gabbro, composed of fibrous actinolite, fine plagioclase, granular epidote and clinozoisite, and some chlorite and magnetite.

Where observed in one outcrop, the whole assemblage presents an irregular blotchy appearance, the various types in part merging into one another. Elsewhere the different phases occur in large bodies. The complexity of this large mass is considered to be due to assimilation by reaction between intrusive granite and earlier basic rock. It might be mentioned here that quartz diorite similar to that in this body is also found in some places where the granite contains many basic inclusions. Reference to this will be made later.

The fourth occurrence of basic rocks is north and east of Little Beaver Lake. Most of this rock is finely foliated and recrystallized, and is characterized by fine needles of hornblende, and is in part injected by granite. This rock was called "hornblende-plagioclase gneiss" on the Wanipigow Lake sheet and was considered to represent recrystallized basalt. Further observation during the summer of 1949 revealed the presence of typical gabbro and diabase in this band as well as the foliated hornblende gneiss, and the whole mass is thus considered intrusive.

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[1] J. F. Davies: Geology of Wanipigow Lake Area; Manitoba Mines Branch, Prelim. Rept. 48-2, 1949.

Some of the hornblende gneiss has been granitized by the introduction of quartz and plagioclase and the development of abundant granular epidote. This granitization accentuates the banding, and the rock is similar to bleached basic inclusions within granitic gneiss.

In addition to the larger units, numerous small sill-like bodies of gabbro and diabase intrude the quartzite north of Wanipigow River. These bodies are too small to map separately.

Diabase, Trap (9)

These finer-grained basic rocks are in part at least somewhat later than the coarser-grained ones. The diabase dykes are typically the same as diabasic phases of the first occurrence of gabbro described above. The terms 'diabase' and 'trap' are used in a textural sense, the grain size becoming progressively finer. Trap dykes are seen to cut the gabbro (8) east of Rice Lake.

Stockwell mapped a large mass of this rock as basalt in the area south of the road east from Rice Lake. However, both texturally and compositionally, this mass is identical with the trap dykes, many phases even being diabasic. Further, no evidence of flow structure is found, nor does the rock yield by schisting under deformation but rather fractures like the diabase and trap. This may be of considerable importance in regard to occurrence of veins as will be shown later.

Granitic Rocks (12) and Gneisses (10, 11)

Rocks of granitic character range in composition from quartz diorite to microcline granite, in texture from equigranular to coarsely porphyritic, and in structure from perfectly massive to highly gneissic. In general it appears that the intrusives south of the main belt of volcanics and sediments are dominantly quartz diorite in composition and fairly massive. This is also true of the body northwest of Little Beaver Lake. The large batholithic body north of Wanipigow River shows considerable variation from quartz diorite to microcline granite; intermediate oligoclase granite and albite granite are abundant phases. Further, in conjunction with this body are developed large areas of gneissic granite and stratiform granite gneiss, in part containing abundant basic inclusions. Dykes and irregular masses of pegmatite and aplite are more abundantly associated with this northern area of granitic rock than with the southern bodies of quartz-diorite. Contacts between granite (12), granite gneiss (11), and granite gneiss containing basic inclusions (10) are of necessity arbitrarily defined and only approximate in position.

Notwithstanding the obvious difference between quartz diorite on the one hand and microcline granite on the other, there are good reasons for believing that these and other types are all related in origin, and they are accordingly grouped as one. Firstly, the presence of microcline seems significant. Even the quartz diorite contains a few grains of microcline. Other phases such as the oligoclase granite and albite granite, granodiorite, and quartz monzonite, generally have abundant microcline which suggests a relation with the microcline granite. Secondly. the composition of the plagioclase varies from andesine to albite. Thirdly, all compositional types have striking porphyritic phases. Fourthly, characteristic blue quartz eyes are found in all phases. Also it is definitely known that the quartz diorite southwest of Rice Lake is older than the San Antonio formation. The presence of microcline in the San Antonio sediments suggests that the microcline granite, or one of the other microcline-bearing granites is also older than the San Antonio formation.

On map 48-2, Wanipigow Lake sheet, two types of quartz diorite were distinguished, one a fresh massive grey rock, the other pinkish somewhat altered slightly foliated quartz diorite containing bluish quartz eyes. It was suggested that these two probably belonged to the same period of intrusion. On the present map it was impossible to map these separately, as in most places gradation from one type to the other is the rule, and it is believed that foliation, alteration, and colour of the second type all have the same significance; the pinkish rock is the result of late-stage alteration of the fresh grey one, the alteration involving the production of saussurite, "pinking" of feldspars by hematite dust, and late crystallization of the quartz eyes.

Typical quartz diorite consists of zoned plagioclase crystals, in places phenocrysts, generally altered to some extent to saussurite; hornblende, in part altered to chlorite and epidote; strained lenticular aggregates of quartz grains (eyes); and magnetite, apatite, sphene, and some interstitial microcline as accessory minerals. Biotite is present in places but is nowhere abundant. The rock varies in colour from grey to pinkish to a buff-orange in the most altered specimens, the latter colour due to intense saussuritization.

In the more acid types, such as oligoclase and albite granites, the more sodic plagioclase is altered to sericite rather than to saussurite, and the ferromagnesian mineral is biotite instead of hornblende. Pink and grey phases of identical composition can be seen side by side in a single outcrop. Most specimens contain some interstitial microcline. In some specimens microcline is about one-half as abundant as plagioclase; such a rock is called granodiorite. In still others, quartz monzonite, microcline exceeds plagioclase. Where microcline greatly exceeds plagioclase the rock is a typical microcline granite, commonly fresh, massive, and porphyritic. Common accessory minerals in all the above types are apatite and sphene as in the quartz diorite.

For the most part all the above rocks are fairly massive or only faintly foliated, and unaltered except for some development of sericite along cleavage planes of the feldspar crystals.

Surrounding the batholithic body of granite in the centre of the area are various impure, hybrid gneissic granites, granite gneiss (11), and areas with basic inclusions (10). Those granites in which a strong secondary foliation is developed but which are little contaminated are termed gneissic granite. The mineral content of these is essentially the same as that of the granite, but a pronounced granulation and squeezing of grains is apparent. Granite gneisses, on the other hand are those in which a fine stratiform structure or coarse banding is present. Secondary foliation may be either absent or present. A peculiar feature of much of the granite gneiss is the presence of large phenocrysts, randomly oriented and unbroken, yet the rock shows this fine stratiform structure owing to the presence of thin trains of biotite. The more coarsely banded granite gneiss is characterized by parallel injections of lighter granitic material into somewhat darker bluish grey, resembling a lit-par-lit gneiss. Most of the gneiss contains some blades of amphibolite, commonly bleached by granitization.

Abundant basic amphibolitic inclusions in the gneiss characterize unit (10). These inclusions may be large blocks, wide bands, narrow ribbons, or very thin blades. The amphibolite almost invariably has a fine foliation and appears to be the same as the hornblende gneiss near Little Beaver Lake. Some bands have been partly granitized with the resultant bleaching to a fine light-grey sedimentary-looking rock,but no definite sedimentary inclusions were found in the gneisses. Another feature of these inclusions is that in places where the granite is fairly massive yet contains inclusions (hybrid rocks of this type are included in the gneisses), the granitic rock has a darker colour, and usually an intermediate plagioclase, and is in reality a quartz diorite similar to some phases of the complex basic intrusive body (8) south of Leaf Lake. The darkening is due to an increase in the content of hornblende and biotite.

Dykes and irregular masses of pegmatitic granite commonly intrude both the granite gneisses and the granite of the large mass north of Wanipigow River.

Quartz-feldspar Porphyry, Felsite (13)

Included within this unit are various porphyritic dyke rocks.

South of Wanipigow River a wide dyke of quartz-feldspar porphyry forms a long,high east-trending ridge. The porphyry is a light-cream weathering rock, pale green on the fresh surface, and is characterized by abundant bluish quartz eyes and small feldspar phenocrysts. Phenocrysts are sufficiently numerous to call the rock a granite porphyry. Large strained quartz eyes and small phenocrysts of sericitized albite are set in a fine matrix of quartz, albite and numerous minute chlorite flakes and epidote grains. Accessory minerals are carbonate, zircon, apatite, and sphene. The rock is either massive or foliated.

Numerous dykes of porphyry and felsite cut the Rice Lake group and the basic intrusives. Some of the dykes are granite porphyries like that described above; others are quartz diorite porphyries.

Typical quartz diorite porphyry is characterized by large commonly zoned andesine phenocrysts and striking blue quartz eyes. Phenocrysts may form as much as 50 per cent of the rock and are commonly intensely altered to saussurite. The groundmass consists of fine quartz and feldspar and patchy grains of hornblende altering to chlorite. Epidote, apatite, and magnetite are also present. The rock is readily recognized in the field by the presence of the large white plagioclase phenocrysts in a fine dark-grey to black matrix.

Light coloured, finely porphyritic and non-porphyritic felsite dykes also cut the gabbro, diabase, and trap. These dykes closely resemble the rhyolite and rhyolite porphyry flows, but their intrusive relationship is well illustrated in places. Slightly darker intermediate felsite dykes similar to the light acid ones are also found. Many of the dykes contain much fine pyrite, and some are associated with small pyrite-bearing quartz stringers.

Probably all these dyke rocks were derived from the granitic masses, some phases of which they closely resemble. The common occurrence of quartz eyes is considered diagnostic.

San Antonio Formation (14)

Quartzite, felspathic quartzite, and minor conglomerate of the San Antonio formation unconformably overlie the rocks of the Rice Lake group and the granitic rocks. The unconformable relationship with the volcanic-sediment group is apparent from areal mapping, and the actual unconformity with the granite was observed in the Wanipigow Lake area.

The quartzite is a medium-grained poorly bedded greenish-grey or pink rock composed of medium-grained subangular quartz and lesser plagioclase and microcline in a fine groundmass of granular quartz and sericite. Reddish or pink varieties contain quartz grains surrounded by films of hematite. A few pebbles of volcanic rocks, granite, and quartz were seen in places.

Tops of the sedimentary beds can be determined from cross-bedding. The rock is rarely schistose to any degree but, being poorly stratiform and in thick massive beds, is more subject to fracture. Secondary cleavage is in some phases developed at a small angle to the bedding, which also assists in determining tops.

STRUCTURAL GEOLOGY

FOLDING

The rocks of the Rice Lake group appear to have been folded into an approximately east-trending anticline the north limb of which lies within the map area. Top determinations within this group are difficult and few, and it is not certain that isoclinal folding is not present. Where determined, tops face north in the direction of dip. These few observations were made in the conglomerate-arkose (3) east of Rice Lake. It has already been pointed out that the andesite porphyry just north of the lake is overlain by agglomerate and breccia containing more abundant andesite porphyry fragments near its south contact. This would also seem to indicate northerly-facing beds.

Dips within the sediments and volcanics are generally steep and commonly close to vertical. In places dips as low as 30 degrees have been recorded, but most are more than 60 degrees. Direction of dip is almost invariably north.

The general east-west trend of the Rice Lake group is modified somewhat by the presence of broad arches, the convex sides of which face either north or south. Thus, west of Rice Lake the rocks strike somewhat north of west, gradually curve around to west at the lake, and east of the lake strike northeast. This northeast trend gradually straightens out again into an east-west trend direction a few miles west of the east boundary of the sheet.

Folds within the granite gneisses are parallel with those of the rocks of the Rice Lake group where the two are in contact. Further north, the gneisses surrounding the large body of massive granite have been folded into a broad whorl. The pattern of folds in the gneisses appears to indicate that the folding took place in conjunction with the intrusion of granite and the granitization.

The rocks of the San Antonio formation were folded during a period of deformation later than that responsible for the folding of earlier rocks. The formation has been folded into an east-west syncline the north limb of which is overturned, as tops face south whereas dips are north. In general,dips in the San Antonio rocks are low, about 40 degrees,but in places may be as high as 70 degrees.

SHEARING, FAULTING, FRACTURING

Few faults with visible displacement were observed in the rocks of the Rice Lake group. However, shear zones are common. East of Rice Lake the large diabase and trap body is faulted against gabbro. The apparent displacement on the fault seems to be large, but it has not been established definitely. If it is correct to assume that the diabase is a phase of the gabbro, a small vertical uplift of the southeast block would account for the cutting-off of the diabase.

Shear zones are developed in two distinct sets. One strikes northeast, the other northwest,and both generally have steep northerly dips. Other shears parallel the bedding and contact. Most of the shears in the area carry vein quartz.

Widespread schistosity is developed in the less competent members of the volcanic-sedimentary group - bedded and banded rocks, tuffs, quartzites, breccias, and parts of the rhyolite and rhyolite porphyry that have flow banding. Thick, massive beds of arkose and thick flows of cherty rhyolite are generally devoid of schistosity. Incompetent basalt and andesite are generally highly schistose. The schistosity in the Rice Lake group strikes about parallel with the bedding and contacts, and dips either parallel or almost parallel with the dip of the bedding. Pebbles and fragments in the clastic rocks are deformed into lenses and streaks.

The more competent rocks, rather than yielding to deformation by schisting, have fractured. Much of the cherty rhyolite exhibits a peculiar blocky fracture, in some places in zones. Diabase, and more particularly fine trap, is also characterized by zones of fracture. In addition to these recognizable shear and fracture systems, it is probable that the numerous north-south porphyry and felsite dykes occur in old tension fractures.

Faults, shear zones, and pronounced schistosity are lacking in the San Antonio formation. The rocks of this formation are poorly bedded and fairly massive. However, secondary cleavage making a small angle with the bedding is developed in places. A few small fracture zones filled with vein quartz and angular inclusions of the country rock were seen. The fractures have little persistence and readily die out. It is not known how the folding of the San Antonio rocks has affected the attitude of the deformation pattern in the older, previously folded, Rice Lake group.

ECONOMIC GEOLOGY

Gold deposits were first discovered in the Rice Lake area in 1911. Most occur in rocks of the Rice Lake group or in intrusives into them. A few, of no commercial significance, have been found in the San Antonio sediments.

Although veins are widespread and numerous, many of them are small discontinuous lenses which yield erratic assays of gold. The San Antonio mine on Rice Lake is the only producing mine in the map-area.

During the summer of 1949 a number of claims were staked for nickel on the basic rocks in the vicinity of Leaf Lake.

GOLD

Most of the shear and fracture zones in the Rice Lake group contain vein quartz. Such zones are abundant, but many are small and have proven to be insignificant. A large number of such quartz lenses occur within the andesite porphyry north of Rice Lake but are not shown on the map. The more persistent zones occur within massive, unbanded rocks, in which strong localized shears and fractures developed rather than in those banded and less competent rocks in which deformation has resulted in widespread schistosity. Thus, most of the larger veins occur in or along the contacts of diabase and trap. Massive, thick, cherty rhyolite flows should be equally favourable to the development of suitable structures, but those which are banded should be less so. Some pronounced fracture zones have been noted in the cherty rhyolite,but only a few veins were seen.

It seems that the competency of the diabase with respect to the enclosing rocks has been an important factor in localizing favourable vein structures. It has been noted that the veins in the San Antonio mine occur where the diabase sill reaches its maximum thickness, and further that the veins rapidly die out in passing from the diabase into the sediments above and below. It might further be pointed out that the veins in the diabase and also those north of it in the andesite porphyry occur where the structure is arched convex southwards. Whether or not a minor structure such as this has been a factor in localizing fractures is not known with certainty, but it is worth considering as other gentle arches occur within the area. Another feature of the veins that seems to be indicated is that higher values are found at the intersections of shear or fracture zones. Although the emphasis has been on structural control, especially that of the diabase, it may be that this basic rock was favourable to the precipitation of alkaline gold-bearing solutions whereas other rocks equally favourable from the structural viewpoint, e.g. cherty rhyolite, were not chemically favourable.

In most of the veins of the area, non-metallic gangue minerals include quartz and buff carbonate (ankerite). Quartz is by far the more abundant. Pyrite is the common sulphide mineral. Visible gold is widespread but erratic in distribution. The quartz in many of the veins is splintery and brecciated, indicating some deformation after its deposition. Wall rocks are altered to sericite,chlorite, and carbonate. Commonly abundant pyrite has been introduced into the wall rocks as well.

Most of the veins of the San Antonio mine lie within the diabase which is a north-dipping sill-like body in the Rice Lake arkose. Some felsite dykes intermediate in composition cut the diabase but are older than the veins.

In the San Antonio mine both northwest and northeast trending veins occur. The northwest trending veins strike parallel or almost parallel with the walls of the diabase in which they lie. Most of the veins are close to vertical in attitude whereas the diabase sill dips to the north, and the veins pinch out at the upper and lower contacts of the sill, and new veins occur at lower elevations down the dip of the sill. The northeast veins form large angles with the sill and dip about 60 degrees northwest.

The two types of veins differ in structure. The northwest set is characterized by branching stringers of quartz, many of which strike across the general trend of the fracture system. In other places the stringers form a regular stockwork. The veins are typically fracture zones which show the results of brecciation. Walls and angular inclusions of country rock are altered to albite, carbonate, and sericite, and are impregnated with disseminated pyrite.

The northeast trending veins occur in shears which have chloritic walls. Commonly the quartz forms a main banded vein and small parallel stringers occur in the wall-rock schist. Mineralization is much the same as that of the northwest veins, but wall-rock alteration is much less intense.

Northeast of Rice Lake, several veins occur along and near the contact of the same diabase sill as that in which the San Antonio veins lie. Another small diabase body occurs a few hundred feet south of the point where this sill terminates.

A northeast trending vein lies within this body. The vein was drilled previously by Sannorm Gold Mines, Limited, and further drilling was completed during the summer of 1949. The results of this work are not known.

Three miles east of Rice Lake and a mile south of the road, several veins are found on the "F Group" of claims. The vein shown on the map striking east of north is as much as 30 feet wide and more than 500 feet long. It occurs in diabase intruded by granite and consists of vein quartz and disseminated pyrite. This vein intersects the northwest trending fault. The vein was drilled, and it is reported that more encouraging assay results were obtained from samples taken at the intersection of the two shears.

NICKEL

During July, 1949, several groups of claims were staked on nickel prospects within the gabbro-diorite complex around Leaf Lake and east of the map-area. None of these showings was examined by the writer, but specimens donated to him show pentlandite disseminated throughout the rock. No chalcopyrite was seen in the specimens examined.

The basic rock in which the pentlandite occurs is very similar to the large body of gabbro-diorite on the west boundary of the Wanipigow Lake sheet, which is worthy of examination.

Attention is drawn to the fact that all these basic rocks contain considerable magnetite in places, and that any magnetic anomalies obtained should be interpreted with caution.