Province of Manitoba

DEPARTMENT OF MINES AND NATURAL RESOURCES

MINES BRANCH

PRELIMINARY REPORT AND MAP

48-3

GEOLOGY OF THE

ENGLISH BROOK AREA

RICE LAKE DIVISION

Manitoba

by

G. A. Russell

Winnipeg

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CONTENTS

ENGLISH BROOK AREA

INTRODUCTION

LOCATION AND ACCESS

The English Brook area comprises approximately 187 square miles in the Rice Lake mining division of eastern Manitoba. The map-area is a 15-minute topographic sheet 11 miles by 17 miles and is bounded by latitudes 51° 00' and 51° 15' north, and longitudes 96° 00' and 96° 15' west. The geographic centre of the area is a point on the Wanipigow River about two miles upstream from Currie's Landing and is 96 miles northeast of the city of Winnipeg.

Aircraft are obtainable at Lac du Bonnet, Manitoba, and they can land on and take off from Wanipigow Lake, English Lake and Tukhanen Lake. Manigotagan Settlement is located on Lake Winnipeg at the mouth of the Manigotagan River and can be reached by boat from Winnipeg. From Manigotagan a good road leads to Currie's Landing from which point routes of access to other portions of the area are indicated on the map.

TOPOGRAPHY AND DRAINAGE

In general, the topography is typical of the Canadian Precambrian shield, consisting of rocky or drift-covered hills alternating with swamps and drift-covered depressions.

The relief, while not exceptional, is more extreme along a line extending from Clangula (Goldeye) Lake to the north shore of Wanipigow Lake and is believed to be due to two factors. First, the massive intrusive rocks have been more resistant to weathering, and second, several pronounced shear zones, which extend through the area, have been planes of weakness, along which, weathering has cut deeply to form narrow, sharp valleys, many of which have blocky talus slopes. In mapping near valley walls or rocky cliffs it is important to distinguish between true outcrops and rock exposures that might be the exposed portion of large, partly buried blocks.

The most pronounced topographic feature in the area is the marked depression along the course of the Wanipigow River. North from the river the land surface rises about 100 feet in a series of steps and flats for about two miles, until the main shield elevation of 850 to 875 feet above sea-level is reached. From this point to the north boundary of the map-area the land surface is essentially level with minor dissections. South from the Wanipigow River the land surface rises more abruptly than on the north side, to an elevation of about 840 feet above sea-level. It maintains this elevation to the south boundary of the map-area, and it is affected only slightly by the course of the Manigotagan River.

Minor topographic features of the area are (1) a pronounced depression along the granite gneiss-greenstone contact south of the Wanipigow River (the site of the winter road), (2) a narrow, deep, (up to 100 feet) depression along the course of English Brook where it bears southwest, (3) a high ridge north of the quarries at Clangula Lake, and (4) a distinctly elevated, deeply dissected broad ridge along the trend of the intrusive rocks (7), in the east central portion of the area, north of the Wanipigow River.

Drainage from the area is westward to Lake Winnipeg. The Wanipigow River flows through the central part of the area, and with its tributary stream, English Brook, it drains the central and northern parts of the map-area. The Manigotagan River, with one tributary stream, Barker Creek, drains the south-central and southern parts of the map-area.

PREVIOUS WORK

A general description of the English Brook area is included in "Geology and Mineral Deposits of a Part of South-eastern Manitoba", by J. F. Wright; Geol. Surv., Canada, Memoir 169, 1932 (re-printed 1938). Descriptions of prospecting activity in the area, up to 1932, may be found in that report.

The English Brook area is part of a large area in which A. W. Johnson did reconnaissance mapping in 1936. Map 429A, prepared from that work, on a scale of one inch to four miles, issued by the Geological Survey of Canada, includes the English Brook area.

PRESENT WORK

The present work was done during the summer field season of 1948. The geology was mapped on a scale of one inch to half a mile using mineral claims maps NE 1 and SE 1, 62-P of the area, issued by the Mines Branch, Winnipeg. Control for field mapping was by pace and compass.

Areas of muskeg and drift are outlined on the map; intervening areas are almost entirely rock outcrop.

Subsequent to the completion of field work, vertical aerial photographs became available, and from these a non-restituted radial-line-plot base map was compiled. The only ground control available for this base map was the Seventh Base Line. Two points on this line were distinctly visible on the photographs. When the distance between these two points on the base map was checked with the actual surveyed distance, the error was found to be negligible.

The geological data from the field map was transferred to the much more accurate and complete map compiled from the aerial photographs. For this reason, the boundaries of geological formations must be assumed to be only approximate, although a check and re-plot of some traverses from field notes indicated as close an agreement of traverse topography and map topography as could be expected by pace and compass methods.

All traverses originating on the Wanipigow River, as well as the river outline, were tied in by transit and stadia survey to survey point E-5 on the Seventh Base Line.

Vertical aerial photographs of the area may be purchased from the National Air Photographic Library, Ottawa.

The writer was capably assisted in the field by C. M. Allen, D. K. McIvor, and D. Cordingley, of the University of Manitoba.

GENERAL GEOLOGY

GENERAL STATEMENT

All the rocks of the area are presumed to be Precambrian in age. The volcanic and sedimentary rocks and their derived gneisses are correlated with the Rice Lake Group as defined by Stockwell in the Rice Lake area to the east (Geol. Surv., Canada, Memoir 210).

Geologically the area may be divided into four prominent units. The first unit is a belt of sedimentary and volcanic rocks extending along the Wanipigow River from Wanipigow Lake to the west boundary of the sheet. This belt has an almost constant width from Wanipigow Lake to Currie's Landing. Westward from the landing, the south contact turns southward to cross the Manigotagan River just above the first falls at Poplar Falls. The north contact, from Currie's Landing westward is obscured by swamp and overburden.

The second unit is a large area of quartz-hornblende gneisses and hornblende-plagioclase gneisses with some gabbro, east of English Lake. The rocks of this unit are complexly folded and have been intruded by dykes (and possibly other bodies) of basic rocks. The gneisses also have "conformable" basic phases and it was impossible to differentiate the basic rocks in the field.

The third unit is a belt of intrusive rocks lying just north of the Wanipigow River sedimentary-volcanic belt. In the eastern part of the area, the north contact of these intrusive rocks is marked by the English Lake volcanic unit.

The fourth unit constitutes a "matrix" for the other units and consists of an extremely complex series of granitic rocks (4, 5, and 9), which occupy the north one-third and the south one-third of the area.

TABLE OF FORMATIONS

QUATERNARY		Gossan, in part nickeliferous
		Glacial drift-sand, gravel, boulder-till, and blue clay
Unconformity		
ARCHAEAN or PROTEROZOIC		Aplite, quartz-feldspar dykes and veins; some pegmatite; predominantly pink to red
		Sharp contacts in part
		Trap, amphibolite, peridotite, pyroxenite (?)
		Intrusive Contact
		Hornblende-quartz diorite, diorite, gabbro, pyroxenite (?)
		Granite, quartz diorite; gneissic varieties
		Intrusive Contact
ARCHAEAN	Rice Lake Group	Sedimentary division: quartzite arkose, slate, and tuff
		Volcanic division: rhyolite, andesite, basalt; ellipsoidal and amygdaloidal equivalents; agglomerate and breccia; metamorphic equivalents: quartz-hornblende gneiss and hornblende-plagioclase gneiss

WANIPIGOW RIVER SEDIMENTARY-VOLCANIC UNIT (1), (2), (3)[1]

The lithological characteristic of the rocks of this unit are indicated in the Table of Formations. The belt along the Wanipigow River represents a series of volcanics and sedimentary rocks which have been tightly compressed into isoclinal folds having a shallow plunge of about 30 degrees to the east. Traverses across the belt from south to north show first a band of tuffaceous to quartzitic rocks characterized by definite laminations of varying thickness (average one-quarter to one-half inch), with which are interbanded some layers of quartz-hornblende gneiss and dark-green greywacke. Next is a series of typical volcanic rocks varying from massive fine- to coarse-grained andesite and basalt at the south, to amygdaloidal and ellipsoidal greenstones and agglomerate. The last three named rocks are exposed mainly along the south shore of the Wanipigow River, west of the narrows. On the north shore of the Wanipigow River the rocks are all thinly laminated crenulated tuffaceous rocks. Northward from the river, outcrops show a gradual transition from tuffaceous beds (dark greyish-green) to quartzite (greyish-brown). This transition begins with the appearance in the tuffs of thin quartz-rich layers. These become more numerous and thicker until the rock is essentially a quartzite with occasional thin slaty or cherty bands. Beds of massive quartzite, with thinner incompetent beds of complexly folded slate (tuff?) are nearly continuous to the south contact of the intrusive rocks. However, between the intrusives and the quartzites, outcrops on several traverses showed the presence of a narrow band of andesitic to basaltic lavas.

In the above rock sequence, one fairly persistent band of rhyolite is exposed about a quarter of a mile north of the winter road. Other occurrences of rhyolite (possibly some cherty-tuff) were noted in the quartzites north of the Wanipigow River just west of Wanipigow Lake, and on the south shore of Wanipigow Lake at the east boundary of the sheet, where the rhyolite is also interbanded with quartzite and arkose.

ENGLISH LAKE VOLCANIC UNIT (1)

The general lithological character of this unit is given in the Table of Formations. Specifically, the following phases were recognized. First, a gneissic rock, with bands of marked uniformity in thickness and continuity, with the overall composition of a diorite or gabbro. Bands of three mineralogical compositions were noted, one consisting of 50 per cent plagioclase and 50 per cent hornblende, a second consisting of 90 per cent hornblende and 10 per cent plagioclase and a third consisting of 90 per cent plagioclase and 10 per cent hornblende.

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[1] Numbers in parentheses correspond to those of the map-units used on accompanying map.

The second phase is a gabbroic rock consisting of about 60 per cent hornblende and 40 per cent plagioclase. In most places this phase is massive, but in some places it has a poorly defined foliation. Mineralogically it is very similar to the gneissic bands of 50 per cent plagioclase and 50 per cent hornblende mentioned in the preceding paragraph.

The third phase has a distinctly sedimentary appearance and was noted chiefly in the northwestern part of the unit along the south shore of English Lake. The rocks have a sugary texture and contain thin quartz-rich bands or lenses. Undulating foliation is shown by aligned hornblende and biotite.

GRANITIC ROCKS NORTH AND WEST OF ENGLISH LAKE (5A), (9)

Fundamentally, this unit has three phases, none of which are sharply defined. The first phase is a white to greyish white granitic rock with varying amounts of biotite and/or hornblende. It is nearly massive but in most places shows faint orientation of ferromagnesian minerals. The presence of plagioclase feldspar is indicated by twinning lamellae which are visible in hand specimens. In much of this rock, biotite is the most abundant dark mineral, but in some specimens from the north side of English Lake, the dark minerals were seen to be a mixture of biotite and hornblende, and even individual larger grains of ferromagnesian mineral were found to be a mixture of biotite and hornblende. This rock varies from granite to quartz-diorite in composition.

The second phase is a granitic foliate in which the degree of development of foliation varies from almost none to very strong, and in some places the foliation gives way to an actual banding. In the strongly foliated granitic rocks, numerous strike and dip determinations have indicated well-defined anticlinal and synclinal "folds". The very weakly foliated rocks of this second phase are in every way similar to the first phase described in the preceding paragraph. The "contacts" between the first and second phases occur over varying distances, and the transition from nearly massive to strongly foliated or laminated is marked in many places by the appearance of numerous coarse generally elongated grains of quartz. Along the west boundary of the map-area about three miles north of Clangula Lake, sedimentary remnants, consisting mainly of coarse-grained quartzite and arkose, are seen in well-foliated granitic rocks. The degree of the foliation in the granitic rocks increases towards the sedimentary remnants in all places.

The third phase is distinguishable from the other phases on the basis of colour only. Texturally, structurally, and mineralogically, the rocks of the third phase are identical with those of the first and second phases, i.e. nearly massive and strongly foliated respectively. However, the colour of the rocks of the third phase is from light pink to dark red. "Contacts" between the pink to red phases and the grey or greyish-white phases are gradational. In nearly every area of this third phase, there is some relation between the pink coloration and structure. The latter may be either a series of closely spaced joints or the axial regions of "anticlines" and "synclines" in the granitic rocks. In traversing it was noted in many places that at the centre of the areas of pink coloration, as marked by intensity of colour, there were numerous pink or red pegmatitic quartz-feldspar veins.

In summary, the granitic rocks north and west of English Lake consist of a background made up of varying proportions of the second phase, well-foliated to laminated granitic rocks and sedimentary remnants, enclosed in the first phase, grey to white biotite and/or hornblende bearing granitic rocks which are usually massive but grade to well-foliated. Superimposed on this background mixture are areas of the third phase (pink-coloured rocks of the first and second phases in most places accompanied by pink, quartz-feldspar veins and occurring along pronounced structural directions such as fractures or along "fold" axes).

On the map this part of the area is shown as (5A), a complex of (4) and (5), containing areas of the third phase mentioned above (9).

GRANITIC ROCKS -- SOUTH THIRD OF MAP-AREA (4), (5)

There are two distinct phases of this unit. The "contact" between the two phases is located about one-half mile north of the Manigotagan River. It nearly parallels the river from the east boundary of the map-area to a point east of Skunk Rapids, then turns south and eastward and finally turns back on a south-westerly course to the south boundary of the area. The first phase of this unit of granitic rocks (designated mainly by (5) on the map) is a mixture similar to a combination of the first and second phases of the granitic complex north and west of English Lake. It consists of a nearly massive biotite-granite, in most places containing microcline feldspar. The perfection of foliation in this granitic rock increases towards the numerous sedimentary remnants in it. These remnants vary in size from wisps one-eighth of an inch wide by two or three inches long to well-defined areas two or three hundred feet wide and several hundred feet long. Northwest of the first rapids east of SP 1 on the Manigotagan River it was possible to trace the sedimentary rocks into the granitic rocks without break. The first pronounced change in the sediments is the appearance of widely scattered grey, euhedral grains of feldspar in the fine-grained sedimentary layers and the appearance of more numerous grey feldspar grains in the coarser grained layers. Westward, going towards the granitic rocks, the grey feldspar grains become more abundant especially in certain layers of the sedimentary rocks and finally the sedimentary formations finger-out in the granitic rock, only small remnants and wisps of the sediments remaining. The wisps and small remnants, and the foliation in the granitic rocks and the bedding in the sediments show complete continuity. Some of the remnants have the shape of drag folds and the attitude of these conform with the attitude of drag-folding in the adjacent sedimentary formations.

A persistent characteristic of the area of weakly foliated granitic rock (5) north of and along the Manigotagan River in the central and eastern part of the map-area is the presence of a small amount of cinnamon-brown garnet.

Near the east boundary of the sheet, well-defined dykes of (5) were found cutting the bedding planes of dark, greenish-brown to greyish-brown tuffs. The contacts were extremely sharp with no evidence of blending and no evidence of any alteration of the tuffs.

The second phase of the granitic rocks in the south part of the area is indicated on the map by (4). This phase is also a complex with various components as irregular bands which are approximately parallel to the well-defined foliation which is an outstanding characteristic of (4). The foliation is seen to be slightly north of west in the eastern part of the area, nearly due west in the central, and slightly south of west in the western part. This regional foliation is also parallel to the trend of the formations of the Wanipigow River sedimentary-volcanic unit.

Going north from the Manigotagan River in the eastern part of the area, one crosses nearly massive biotite granite to quartz diorite (5). Near the "contact" of (5) and (4), the first change noted is a gradual increase in the degree of perfection of the foliation until at the "contact", 500 to 1,000 feet wide, there is a very marked increase in the development of foliation. Accompanying this marked increase in foliation is the appearance of abundant coarse grains of quartz which are clearly defined on a weathered surface. The quartz grains are elongated parallel to the foliation but the amount of elongation is variable. In some places in strongly foliated rocks some quartz grains are only slightly elliptical; in other places some of the grains are from four to five centimeters long and two or three millimeters wide. In the latter places the groundmass of the grains has a pale greenish-yellow to grey colour and is much finer grained.

The next change noted was the appearance of a well-foliated granitic rock characterized by a grey to buff colour and consisting of numerous, closely packed diamond- to eye-shaped grains of feldspar (ratio of length to breadth is about 3 : 1), averaging about two-fifths of an inch in length. The long axes of these grains are aligned and give the rock its foliation. In the interstices between the feldspar grains are ferromagnesian minerals, biotite and/or hornblende, and quartz.

Northward to the south contact of the Wanipigow sedimentary-volcanic unit the rock is mineralogically the same. Structurally and texturally there are alternate bands of well-foliated rocks and massive rocks. In several places the rock is distinctly different from the alternating massive and foliated bands being extremely well-foliated and laminated fine-grained granitic material containing abundant lenses of quartz up to two inches long and one-eighth of an inch wide. Near the contact with the sedimentary-volcanic unit, the amount of this fine-grained material increases and the contact can best be described as a zone.

The outstanding characteristics of the rocks designated as (4) are the presence of zoned feldspar grains and the lack of microcline feldspar which characterizes (5), and the presence of the grains of quartz, much having a faint blue colour, which are prominent on weathered surfaces. Blue quartz was also noted in the following:

a. In some of the pink feldspar-quartz pegmatite dykes.

b. As dykes and veins in the rocks designated on the map as (1, 4, 5). The quartz frequently contained a few irregular patches of pink mineral and in one place an euhedral grain of pink feldspar.

c. As rounded phenocrysts in the porphyritic rhyolites.

d. As coarser grains marking the bottom of sedimentary beds on the west shore of Wanipigow Lake.

e. As local disseminations along fractures in the intrusive rocks (7).

f. As disseminated grains, accompanied by pyrite, in bleached and altered quartz diorite immediately north of the peridotite-quartz diorite contact east of the English Brook Gold Mining Company Limited property.

In the granitic rocks just to the south of the Wanipigow River sedimentary-volcanic belt, one or two dykes of feldspar-porphyry were noted but did not constitute a mappable unit with only pace and compass control.

The granitic complex north and west of English Lake contains areas of pink to red coloration which are usually related to some structure. The granitic complex in the south third of the map-area is similar in this respect. Likewise, the pink coloration is most intense in the vicinity of pink, quartz-feldspar pegmatite dykes and some pink aplite dykes which in many places are in the centre of the areas of pink coloration. Where the pegmatite dykes and pink coloration occur in conjunction with large sedimentary remnants, black tourmaline is developed in the sedimentary remnants, in the strongly foliated granitic rocks adjacent to the sediments, and in the pegmatite dykes. In general, the areas of pink coloration and pegmatite dykes conform to the regional foliation of the granitic rocks, but in some places both dykes and coloration are associated with closely spaced parallel or intersecting fractures at a considerable angle to the regional foliation. "Contacts" outlining the areas of pink coloration are gradational.

GREY QUARTZ-FELDSPAR DYKES (6)

Grey quartz-feldspar dykes are well exposed on the south shore of the Manigotagan River at the east boundary of the map-area, and on top of a very prominent hill about half a mile east of the east boundary. They are also fairly abundant in the southeast corner of the area. Similar grey pegmatitic quartz-feldspar dykes were noted in two other places. One of these is just south of Harding Creek near the northeast end of the granitic rocks (5) at that point. Another occurrence is on the northwest side of English Lake about three-quarters of a mile west of the north end of the lake.

SUMMARY OF GRANITIC ROCKS

It is obvious from the foregoing descriptive notes that these rocks are extremely complex. A geological survey of the present type must of necessity be considered as a reconnaissance owing to lack of sufficient survey control and approximate survey methods (pace and compass). Any attempt to mark out smaller geological units than have been set out in this report is not justified by the principles of comparable accuracy. Likewise, the study of a few selected thin sections of such a complex contributes very little. The main geological problem of the area is a detailed study of the intrusive rocks, and the relation of these to mineral deposits in the area.

HORNBLENDE-QUARTZ DIORITE, DIORITE, GABBRO (7)

The main part of this unit, designated by (7) on the map, is located north of and in contact with the Wanipigow River sedimentary-volcanic belt and is bounded on the north by the English Lake volcanic unit, from the east boundary to English Brook, and by the granitic complex west of English Brook. The unit is marked, topographically as a distinctly elevated area. In addition to this topographic prominence, which is visible on a clear day from a position near the middle of Wanipigow Lake, it is also marked by having within its borders the most pronounced relief in the area. A traverse north from the Wanipigow River from a point about two miles west of Wanipigow Lake, shows a gradual rise in the ground surface as the sedimentary-volcanic belt is crossed. Then the ground rises to elevations of as much as 100 feet above river level in a short horizontal distance. This sharp rise occurs as the area of the contact between the intrusive rocks and the sedimentary-volcanic belt is crossed. After entering the area of intrusive rocks, a few narrow depressions with steep, sheared, rock walls mark the course of shear zones in the intrusive rocks. These shear zones strike generally about south 80 degrees east and are nearly vertical. In one or two places the difference in elevation between ridge crests and valley bottoms exceeds 100 feet, and vertical rock cliffs as high as 88 feet were measured. Talus piles, some with blocks up to 15 feet in diameter, were noted to be resting on glacial deposits at the foot of rock cliffs. In other places it was readily apparent that previously more extensive talus piles have been partly buried in glacial debris.

Northward from the highest elevation attained by the hills formed by intrusive rocks (7), the ground surface slopes to the north and finally levels off in the extensive swamp- and drift-filled depression which marks the course of the peridotite (8c). On the north side of this depression the ground surface rises almost vertically in steep rock cliffs which mark the south limit of the gneisses of the English Lake volcanic unit. This abrupt escarpment exceeds 100 feet, vertically in some places, and in a discontinuous manner, marks the north contact of the intrusive rocks (7), right to the west boundary of the sheet.

From the above description it is clear that this mass of intrusive rocks (7) is distinguishable from the other rocks of the area owing to the prominent topographic features and relief which shear zones that intersect it, and its varying resistance to weathering, have created. In addition this rock mass is also characterized by a uniform well-jointed structure and a uniform medium- to coarse-grained texture. There are no remnants, and any foliation is strictly confined to the shear zones. The mass does vary in mineral composition, but the outlining of the variations was not justified by survey control available.

Mineralogically, the intrusive rocks (7) consist of plagioclase feldspar and hornblende, usually with a small amount of quartz, and they probably have an overall composition of quartz diorite to gabbro. The feldspar is grey to buff and shows distinct twinning lamellae in hand specimen. On many of the sheared rock walls of valleys, the feldspar grains are pink to red. This pink to red coloration fades out gradually away from the cliffs and on the ridge crests, between valleys, the feldspar is grey or buff.

North of the Wanipigow River in the western part of the area, the rocks (7) are represented mainly by coarse-grained diorite containing pink-coloured feldspar grains. Many outcrops in this area, particularly southeastward from the quarries east of Clangula Lake, are covered with a thin layer of angular rock fragments which are stained a light yellowish brown. This rusty material supports a peculiar, spiky type of grass which grows sparsely over the gossan areas and was noted elsewhere only around the gossans near the quarries at Clangula Lake.

In the introduction to this section of the report it was stated that the north boundary of the intrusive rocks (7) in the eastern part of the area, was difficult to map for several reasons, chief of which was the similarity in appearance in hand specimen between some rocks of the intrusive group (7) and some rocks of the volcanic unit (1) with which they are in contact.

Traverses northward from the Wanipigow River, in the eastern part of the area, crossed the typical coarse-grained massive intrusive rocks (7), and a marked change was noted as the gneissic rocks east of English Lake were approached. Outcrops indicated an increasing basicity going northward, and finally the rock was essentially an amphibolite. To determine the contact between hornblende-plagioclase gneisses, which have some amphibolitic bands, and an intrusive which is essentially an amphibolite, is a difficult matter, particularly on scattered outcrops in the extensive swamp areas which occur in the vicinity of the contact. On one outcrop the definitely intrusive nature of some of the amphibolite was indicated by the presence of banded inclusions of hornblende-plagioclase gneiss (bands nearly parallel to those of the wall rocks), in the amphibolite, and by small pointed apophyses of amphibolite into fractures in the adjacent gneisses.

Also, in this general area of the contact between the hornblende-rich gneisses and the intrusive amphibolite, peculiar bands, lenses, and streaks of a sugary grey mineral were noted. Microscopic examination of this material shows the sugary grey mineral to be thoroughly recrystallized clear inclusion-free grains of plagioclase feldspar having sharply defined twinning bands. It is quite possible that in future work this sugary grey plagioclase may serve to distinguish wall rock from intrusive.

A traverse northward from Wanipigow Lake along the east boundary of the sheet crossed fairly well defined rock types as far north as the swamp- and overburden-covered area just north of the prospect symbol shown on the map. From this point northward, the traverse crossed a heterogeneous assemblage of rock types varying from granitic rocks (4) to basic rocks (amphibolites) in all degrees of admixture, irregularly cut by pink aplite dykes, pink feldspar-quartz pegmatite veins, lenses and streaks of pink spotted milky blue quartz, and trap dykes. Any measure of continuity of a particular rock type was not noted until a point about three and one-half miles north of the lake was reached. At this point the hornblende-plagioclase gneiss phase of the English Lake volcanic unit was encountered.

TRAP (8a), AMPHIBOLITE (8b), PERIDOTITE (8c)

The intrusive rocks (7) are intruded in the central part of the mass by dykes of trap and amphibolite. Two sets of trap dykes were noted, one set striking at south 80 degrees east, parallel to the direction of the major shear zones. The other set strikes a few degrees east of north and has nearly vertical dips, although one dyke of this set was found to have a dip of about 20 degrees east.

The peridotite (8c) is the most distinctive rock in the area, and is readily identified by its characteristic weathering products - red stained or spotted greenish to greenish-grey surfaces - and by the fact that wherever the rock has been sheared the resulting schist is a serpentine or talc-schist, which in places has an appreciable amount of white or pinkish-white carbonate. Peridotite was first encountered on a traverse north from the Wanipigow River at a point about one mile east of the property of the English Brook Gold Mining Company Limited. Subsequently the extensive exposures east of Clangula Lake were mapped. The course of the narrow zone in which peridotite occurs east of English Brook, is marked by a pronounced drift- and swamp-filled depression and a creek. West of English Brook outcrops of peridotite or the presence of typical reddish soil indicated the continuity of the belt. One other small outcrop of peridotite was noted north of the Wanipigow River in the western part of the area. The peridotite occurred only on the north face of the outcrop and was altered to serpentine. A few small angular fragments of malachite-stained quartz were found lying on the surface of this outcrop.

The peridotite at the abandoned quarries east of Clangula Lake has been sheared and altered to a serpentine rock. Fractures show some magnetite, carbonate, and quartz, and in some places a bright green mineral which contains nickel and is probably a nickel silicate. Southwest of the quarries, separated from the main mass of the peridotite, is another mass of serpentine rock. Still another occurrence of sheared, serpentine-rock carrying small amounts of nickel sulphide (millerite) was shown to the author by Mr. J. Papineau. This occurrence is located north and east of the quarries.

Due south of and southeast of the quarries, outcrops of coarse-grained amphibolite were noted. Most of the rock in this area is the coarse-grained diorite which is characterized by pink-coloured plagioclase feldspar. A narrow dyke of red aplite cuts the amphibolite.

The pyroxenite, composed mainly of hypersthene, in which the copper-nickel bearing sulphides at English Lake occur is a very distinctive rock and is readily distinguished, when fresh, from the much more abundant amphibolite. The pyroxenite is coarse-grained, has a brownish-black to greyish-brown colour (amphibolite is greenish-black), and contains uniformly disseminated very fine-grained pyrrhotite and magnetite, in addition to the local concentrations of coarser grained chalcopyrite and pyrrhotite. Around the outer contact, the pyroxenite grades to a soft talcose rock. Thus the pyroxenite and the peridotite are the only rocks in the area which have produced serpentine or talc when altered or sheared.

The high hills north of the quarries at Clangula Lake consist of strongly sheared typical quartz diorite to diorite (7). A very deep, narrow depression between this hill and the next hills to the north, has some outcrops of amphibolite, much of which has been changed to chlorite-schist. Immediately north and slightly west of this depression the ridges are made up of granitic rocks (4) showing excellent foliation and lamination and abundant coarse grains of bluish quartz.

PINK APLITE DYKES, QUARTZ-FELDSPAR DYKES, OLDER GRANITIC ROCKS (9)

These rocks are indicated on the map by the cross-hatched legend and the number (9). Much has already been said about them because of their close association with other features, mainly the occurrence of areas of pink coloration. Rocks of this group have been found intruding all other rocks in the area, but of course it is realized that all pink aplites and pegmatites in the area are not necessarily of the same age.

The main minerals of these rocks are quartz and pink feldspar. Some black tourmaline was found in these rocks within the complex of granitic rocks and sedimentary remnants north of the Manigotagan River. The quartz may be either transparent glassy, or grey or milky blue in colour. All proportions of quartz and feldspar have been noted, varying from 95 per cent quartz with isolated grains or crystals of pink feldspar, to 95 per cent feldspar with quartz between the grains or intergrown with feldspar. In the quartz-rich rocks the quartz was predominantly the milky blue variety, whereas in the feldspar-rich rocks the quartz was mainly light grey or white.

On the map a prospect is indicated just south of the most easterly peridotite outcrops. The showing consists of quartz veins and lenses in chlorite-schist. At the east end of this showing, a lens of muscovite-bearing, quartz-pink feldspar pegmatite occurs. Near this lens of pegmatite the shear zone has some lenses of pink-spotted milky blue quartz. Several pegmatite dykes with small amounts of muscovite were also noted near the south end of English Lake just east of and north of the sand beach on the east shore.

Some of the quartz-pink feldspar pegmatite veins contain rare specks of chalcopyrite. On the west shore of English Lake on the point where the shoreline makes a sharp turn to the northwest towards the only pronounced bay on the lake, some typical pegmatitic material occurs. Crystals of pink to buff feldspar showing excellent graphic intergrowths of quartz were seen, and in the centre of one of these crystals was a grain of chalcopyrite, half an inch square.

GLACIAL DRIFT

No detailed work was done on the glacial deposits. Distinct terracing in these deposits was noted along the course of English Brook and also around the shore of English Lake.

GOSSAN

Extensive areas of dark, reddish-brown gossan overlie certain parts of the serpentine rock at the quarries at Clangula Lake, where a pale, yellow-green "unweathered" serpentine rock has been exposed by quarrying. The remainder of the serpentine rock, characterized on a freshly exposed surface by a light-grey or greenish-grey colour, does not weather to the dark, reddish-brown gossan.

The coarse-grained diorite between Wanipigow River and the quarries east of Clangula Lake, in some places produces a light, yellowish-brown gossan.

While traversing the course of English Brook, upstream from the second portage, it was noted that the muck in the stream bed had a faint reddish-brown colour. The muck reverted to its normal dark-black colour before the sand flats were reached.

STRUCTURAL GEOLOGY

One of the most prominent structural features in the area is the folded belt of volcanics and sediments in the general vicinity of the Wanipigow River. These rocks occur in isoclinal folds some of which, on the north side of the river, are overturned. The sedimentary formations consist of alternating, structurally strong and weak beds (quartzites, slates, and tuffs).

The strong competent beds maintain a uniform trend across the area, whereas the weak beds have been intricately crumpled into local folds, which in many places cannot be measured for strike and dip because of lack of any pattern.

Two major shearing directions are present. These shearing directions agree well with the directions of the two sets of trap dykes. One shearing direction strikes about south 80 degrees east and dips from vertical to steeply north or south. This shearing direction is most abundant in the area bounded by the winter road on the south and the north contact of the intrusives (7, 8) on the north. The aerial photographs of this area show clearly the depressions and abrupt cliff faces due in part to this shearing direction and in part to the amphibolite and trap dykes and the peridotite belt which trend parallel to the shearing direction.

A second but minor shearing direction strikes about north 45 degrees east, indicated by a few topographic depressions and some trap dykes and quartz veins, as well as by actual shears.

Along the south bank of English Brook, at the first portage upstream from the Wanipigow River a fault strikes north 40 to 45 degrees east and dips from 20 to 35 degrees to the southeast. The fault consists of from three to eight feet of mashed and broken rock with minor shearing along the walls. The continuation of this fault to the northeast and to the southwest is obscured by overburden.

There is a possibility that the Manigotagan River, in its generally northwestward stretch between Engineer Rapids and the next rapids downstream, may follow a shear zone. A six-inch dyke of yellowish-green to greyish-green quartz porphyry, striking parallel to the river, was noted on the south shore of the Manigotagan River near the mouth of Barker Creek. Attempts to locate this dyke east of Engineer Rapids and north of the river, were unsuccessful. On the north shore of the river, just west of the mouth of Barker Creek, a quartz stockwork occurs in bleached and altered yellowish-green to greenish-grey brecciated granitic rock.

Subsequent to the completion of preliminary field work and during the compilation of the base map from the vertical photographs, a distinct break was noted striking directly into the Manigotagan River at Engineer Rapids and parallel to the stretch of river downstream from the rapids. Another parallel break was also seen on the photographs. It is emphasized that these breaks were not picked up in traversing even though their estimated position was noted and careful search made where they should be on the traverse lines. On the map those breaks which have been located from the photographs are designated by the word <u>PHOTO</u> at several places along their strike.

ECONOMIC GEOLOGY

PRECIOUS METALS

Except for one or two occurrences in the rocks (1) east of English Lake, the most abundant evidences of ore mineralization were along the shear zones and the trap and amphibolite dykes (8) which run parallel to and within the intrusive rocks (7) on a strik of about south 80 degrees east.

Most work has been done at the property of the English Brook Gold Mining Company Limited, now abandoned, the shaft of which is indicated on the map about two miles west-northwest of the west end of Wanipigow Lake. The showings consist of quartz veins in shear zones in medium- to coarse-grained hornblende-quartz diorite (7). The quartz-bearing shears lie parallel to, and some cut into, a trap dyke south of the shaft, which parallels the strike of the showings. Ore minerals consist of pyrite, chalcopyrite and arsenopyrite. A grab sample of sheared trap with abundant arsenopyrite gave a trace of gold and no silver. This checked with panning of the gossan which failed to show any "colours". The sample and the material for panning were taken from a pit about 600 feet east of the shaft. Eastward and westward from the English Brook Gold Mining Company Limited shaft, numerous quartz-bearing shear zones with pits and trenches on them were noted. The sulphide minerals noted were pyrite and chalcopyrite. During the present survey, arsenopyrite mineralization in quartz-bearing chlorite schis was found at the first portage on English Brook, on the north shore of the narrows between the first and second pool. A grab sample gave a trace of gold and no silver.

A large amount of surface work and some diamond drilling has been done on a north-striking quartz-filled shear zone in the folded gneisses (1), at a point about three-quarters of a mile slightly north and east of the second portage on English Brook. This showing is reached from Currie's Landing by following the Quesnel Road as far as the cabins, and a good trail from there. The road and trail are shown on the map. The trail continues past the showings and has been brushed and cleared to the sand beach at the south end of English Lake. The quartz vein and shear zone dip to the east at about 30 degrees and from the present mapping they are seen to occur on the nose of an eastward plunging syncline. Sulphide minerals consist of pyrite and chalcopyrite; visible gold has been reported. In the summer of 1948 some surface work was done on the strike on the vein north from the main showing.

Another showing on which considerable stripping and rock trenching have been carried out is located about one-quarter of a mile west of the east boundary of the area at a point about four miles north of Wanipigow Lake. White sugary quartz veins up to thirty feet wide, sparsely mineralized with pyrite occur in an east-west shear zone in gabbro (1).

About three-quarters of a mile east of the point where Harding Creek enters English Lake, several pits have been excavated on quartz-bearing shear zones. Sulphide minerals consist of pyrite, chalcopyrite and some molybdenite. It is reported that tellurides have been noted in this vicinity, but no details of their occurrence could be obtained.

Just inland from the sand beach where the trail from Quesnel Road reached English Lake, pits have been put down on a quartz-carbonate vein which is associated with a quartz-muscovite-pink feldspar pegmatite dyke. Some pyrite and chalcopyrite were noted.

Numerous other small pits and strippings were noted in other parts of the area in volcanic and sedimentary rocks, and in the intrusive rocks (7) eastward and westward from the property of the English Brook Gold Mining Company Limited.

BASE METALS

During the field work a small occurrence of copper-nickel bearing rock was found on the south shore of English Lake about 3,000 feet northeast of the mouth of Harding Creek. The rock in which the chalcopyrite and pyrrhotite (probably some pentlandite) are disseminated is a coarse-grained dark brownish-black pyroxenite Thin sections show considerable hypersthene. The sulphide-bearing pyroxenite outcrops for 200 to 300 feet along the shore. It was traced inland for about 100 feet at the midpoint of its length. The contact was then followed northward and southward by stripping moss or thin drift where necessary, and was found, in both cases, to curve back to the lake shore. Thus the exposure is a semi-circular mass with a radius of about 100 feet.

The outer margin of the pyroxenite consists of a soft, talcose rock. It has been noted above that of the rocks in the area only peridotite and pyroxenite shear or alter to talc rocks.

The sulphides do not show the same concentration in all parts of the pyroxenite, although very fine-grained sulphides are distributed fairly uniformly throughout the mass. Samples of unoxidized sulphides were obtainable, without drilling and blasting, only at the lake shore. Assays were made on several grab samples, the highest result being 1.26 per cent copper, 0.86 per cent nickel and 3.54 per cent sulphur.

The gabbroic portion of the intrusive rocks (7) which outcrops about one mile west of the second portage on English Brook contains scattered rusty spots. In one place this rust was due to fine-grained disseminated pyrrhotite. One of the peculiarities of this rock is that it weathers, along joints, to a granular rubble of grains varying from the size of a pea to dust.

In the vicinity of the quarries half a mile east of Clangula Lake, several areas of reddish-brown to yellowish-brown soil cover the bedrock which is serpentinized peridotite. Along the quarry walls it was noted that the rusty soil lies above those portions of the bed rock that were characterized by a pale yellowish-green colour. The grey-coloured portions of the serpentinized peridotite were not covered by rusty soil. A sample of the reddish-brown soil taken at the start of the first tram line cut from the old wharf gave an assay of 6.8 per cent iron and 0.26 per cent nickel.

Several large glacial boulders lie on top of the red gossan or extend down into it for a few inches. At the base of one of the boulders a small excavation was made with a pick to determine whether there was any other material between the boulder and the red soil. It was found that the boulder was bedded firmly into the red soil with no other material present. The occurrences of red soil are located in a valley bearing about south 80 degrees east, one-quarter to one-half a mile wide and formed by a high ridge to the north and generally higher land to the south.

It is suggested that the valley in which the red soils occur received a comparatively thin mantle of drift owing to the trapping of the lower, heavily debris laden portion of the glacial ice by the high ridge and notable relief immediately north of the valley. When the glacier retreated the melt waters were at one time concentrated in the valley and washed much of the finer material away leaving only scattered boulders perched on top of freshly exposed serpentine rock. Subsequent to the retreat of the ice, the serpentine rock has weathered to a depth of from six inches to as much as ten feet.

Numerous joints and shear planes in the serpentine rock are characterized by a bright grass-green colour. Samples of some of this material gave assays showing up to 0.70 per cent nickel and 0.13 per cent chromium. The nickel is probably present in the form of a silicate. A complete set of vertical channel samples has been taken of the quarry walls and several pits were put down for sampling purposes, to determine the nature of the residual soil and to get a better idea of the distribution of the nickel.

Some magnetite occurs with the serpentine rock mainly as veinlets in it or as crystals studded over the surface of open fractures. West of the map-area, on the west shore of the Wanipigow River south of Clangula Lake, the peridotite shows some banding and surface ribbing owing to local concentrations of magnetite which are more resistant to weathering than the magnetite-poor layers. A grab sample of this rock gave 0.48 per cent chromium.

NON-METALLICS

An attempt was made some years ago to mine the serpentine rock at Clangula Lake for ornamental stone, but the rock was found to be too friable for this use.

The most easterly occurrence of peridotite in the area, east of English Brook Gold Mining Company Limited, was characterized by veinlets of cross fibre serpentine and some pink carbonate stringers. It appeared to be less altered and more massive than the rock at Clangula Lake.

ADVICE TO PROSPECTORS

PRECIOUS METALS

Inasmuch as the most abundant evidences of ore mineralization are found in the intrusive rocks (7), it is suggested that the ore mineralization is related to these intrusives or to some intrusive later than these rocks. In this connection it should be noted that small amounts of chalcopyrite were found in three or four places in the pink feldspar of the late pegmatite dykes (9). Also, blue quartz veins and dykes, which in many places appeared to be associated with the late pink feldspar-bearing rocks were found to accompany ore mineralization in two places, first in altered, bleached quartz diorite (7) just north of its contact with the peridotite one mile east of English Brook Gold Mining Company Limited and second, in some pits and trenches about one mile slightly south of east from the English Brook Gold Mining Company Limited. In the latter place, pink feldspar was present with the blue quartz at the east end of the showing. From the above evidence it is believed possible that the ore mineralization, exclusive of copper-nickel mineralization in pyroxenite, may be associated with the igneous activity which produced the late pink feldspar-blue quartz veins, dykes, and disseminations. It cannot be shown, at the present time, whether or not this igneous activity is a late phase of that which also produced the rocks grouped as (7) and (8). It is in connection with problems of this type that evidence as to the magmatic or metamorphic origin of the granites of the area is so vital.

Many exposures of intrusive rocks (7), particularly diorite and gabbro, are similar in field appearance to the rocks in which the only two producing mines in the region are located. It is regarded as more than significant by the author that, in spite of the abundant shear zones, quartz veins, fracture zones and "granite"-greenstone contacts in the area, the only two producing mines should be confined entirely within massive igneous rocks that are very similar in field appearance: the diabase of the San Antonio mine and the Wanipigow diorite at the Jeep mine.

A word of advice is necessary regarding the nature of shear zones in massive igneous rocks as compared with those in layered rocks such as volcanic flows and sediments. In layered rocks, structures have a tendency to be fairly continuous though often locally complex, owing to the fact that the planes of weakness, which are responsible for many of the structures, were in the rock to begin with. In massive medium- to coarse-grained igneous rocks, such as those classed as (7), shear zones are liable to be highly erratic, pinching and swelling, or tailing out over relatively short distances. Further, they are liable to change dip and strike frequently, making it difficult to project them for any distance. It might be noted that the ore at Butte, Montana, which is one of the greatest mining camps in the world, is located along a very complex shear pattern in a massive igneous rock that is midway between a granite and a quartz diorite. At Butte satisfactory mining was not possible until years of detailed mapping of the intricate shearing pattern had been completed.

BASE METALS

In prospecting for copper- nickel deposits in the English Brook area, as elsewhere, the most favourable locations are definitly limited to specific rock types. Shearing or faulting may have had some part in rearranging the distribution of the ore minerals but the latter are there, in the author's opinion, because they were in the rock when it was intruded. Thus the peridotite (8c) which is nickel bearing at Clangula Lake and the copper-nickel bearing pyroxenite at English Lake are the rocks to look for. The rubbly weathering gabbro (7), which contains scattered rusty spots due to small amounts of pyrrhotite, is believed to be worthy of prospecting

In general, the belt of medium to basic intrusive rocks is the most favourable for copper and nickel.