



Province of Manitoba

DEPARTMENT OF MINES AND NATURAL RESOURCES

MINES BRANCH

PUBLICATION 50-9

GEOLOGY
of the
COUNSELL LAKE and WILMOT LAKE AREAS
Granville Lake Mining Division
Manitoba

by
T. A. OLIVER

Winnipeg
1952

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Province of Manitoba

DEPARTMENT OF MINES AND NATURAL RESOURCES

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INTRODUCTION

LOCATION AND ACCESS

The Counsell Lake and Wilmot Lake areas, each approximately 165 square miles in extent, are located in the Granville Lake division, northern Manitoba. The Counsell Lake area is bounded by latitudes $56^{\circ} 30'$ and $56^{\circ} 45'$ north, and longitudes $101^{\circ} 00'$ and $101^{\circ} 15'$ west; the Wilmot Lake area by latitudes $56^{\circ} 30'$ and $56^{\circ} 45'$ north, and longitudes $101^{\circ} 15'$ and $101^{\circ} 30'$ west. Counsell Lake lies about 12 miles south of the Lynn Lake mining district. The area may be reached by an airplane flight of 100 miles from the railway terminus at Sherridon, Manitoba.

PREVIOUS WORK

Both areas are located on the west half of the Granville Lake sheet, which was mapped on a scale of 1 inch to 4 miles by D. L. Downie in 1935. The results of this work are incorporated in map 343A of the Geological Survey of Canada, published in 1936. The east half of the Granville Lake sheet was mapped by J. F. Henderson in 1932 and G. W. H. Norman in 1933; the results of this work may be found in the Geological Survey of Canada, Summary Report 1933, Part C, and map 344A published in 1936.

PRESENT WORK

Field work was carried out during the summer months of 1949 and 1950. In general, traverses were made at intervals of 1500 feet, and the results were plotted on a scale of 2 inches to 1 mile. Across extensive swamps or areas of granitic rocks, however, the interval was somewhat wider. Location of outcrops was facilitated by the use of aerial photographs, the centres of which are indicated on the accompanying maps. These photographs may be obtained from the National Air Photographic Library, Ottawa. Areas in which the outcrop density is over 75 per cent are bordered by solid lines on the maps. Larger

regions of swamp and muskeg are also indicated.

ACKNOWLEDGEMENTS

It is a pleasure to acknowledge the capable field assistance which was rendered by C. K. Caldwell, N. M. Ediger, and L. S. Binda in 1949, and by H. I. Davies, D. MacDougall, J. D. Feir, and S. Watowich in 1950. All of these men were geology students at the University of Manitoba.

TOPOGRAPHY AND DRAINAGE

Like much of the Canadian Shield, relief in the area is low. The most rugged region is located south of the Laurie River, near the west end of McGavock Lake, where hills of granitic and metamorphic rocks reach heights of 250 feet. In the Counsell Lake area fairly rugged hills of granite in the south and volcanics in the north occur.

Most of the region is drained by the Laurie River into Granville Lake, an enlarged part of the Churchill River. Counsell Lake and Story Lake are drained by a series of lakes and creeks to the southeast into Granville Lake. In general, the lakes are not connected by navigable streams, but by rapid, shallow creeks which have rocky bottoms or by sluggish creeks that flow through swampy areas. Many of the lakes owe their shape to the underlying rock structure; this is most clearly seen in the southeastern part of the Counsell Lake area where the lake shores in many places are parallel with the foliation in the granitic rocks. Where outwash deposits are widespread the lake shores are very irregular, as shown in the northwestern part of the Wilmot Lake area.

SURFACE CONDITIONS

Much of the area is covered by muskeg, glacial deposits, and water. A belt that strikes northwest through the centre of the Counsell Lake area is particularly swampy and almost devoid of exposures; the northwestern part of the Wilmot Lake area is similarly barren, because of a thick cover of sand deposits.

The most widespread glacial deposits consist of accumulations of unstratified sandy material, which were washed out of the wasting glacial ice. Small recessional moraines occur

in several places throughout the area. Two well-developed eskers are located in the Wilmot Lake area; they trend roughly south. Most of the glacial striae noted strike 10 to 15 degrees west of south.

Most of the trees in the area are spruce. Jackpine, the next most abundant type, grows on the sandy ridges; tamarac is abundant only in swampy regions. Birch, poplar, alder, and willow are of minor occurrence. The only timbering operations in the region have been carried on east and southeast of Story Lake, where excellent stands of spruce occur. Deadfall is not extensive, but locally it made traversing difficult, particularly south of McGavock Lake.

GENERAL GEOLOGY

GENERAL STATEMENT

All rocks in the area are Precambrian in age. The oldest rocks, a series of interbedded volcanics, pyroclastics, and sediments, extend from Barrington Lake to Laurie Lake. This series is overlain by a series of clastic sediments which extend from Sickle Lake to Laurie Lake. Locally these layered rocks have been highly metamorphosed by subsequent intrusions.

The younger series of sediments was originally named the Sickle series by Norman¹ from the section at Sickle Lake to the east. The older volcanics were therefore called pre-Sickle. Bateman² made a detailed study of the older volcanics and sediments in the McVeigh Lake area, a small part of which appears on the northeastern corner of the Counsell Lake area, and named them the Wasekwan series. Stanton³ used the term Kisseynew-type gneiss for a group of metamorphic rocks south of the Laurie River; similar types occur in the Wilmot Lake area and are apparently derived from the metamorphism of Sickle sediments.

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- 1 Norman, G. W. H.: Granville Lake District, Northern Manitoba; Geol. Surv., Canada, Sum. Rept. 1933, pt. C, 1934.
 - 2 Bateman, J. D.: McVeigh Lake Area, Manitoba; Geol. Surv., Canada, Paper 45-14, 1945.
 - 3 Stanton, M. S.: Dunphy Lakes Area, Northern Manitoba, Manitoba Mines Branch, Map and report 48-4, 1949.

The stratigraphic relations between the Wasekwan volcanics and the Sickle sediments are not clear. Study of pillow lavas in the northwest corner of the Counsell Lake area suggested that the tops of the volcanics are to the north. No structures for determining tops in the Sickle sediments were found, but the sequence of sedimentation from coarse conglomerate grading into finer sediments to the south, as well as evidence from the Sickle Lake area, suggests that the tops are to the south. If these inferences are correct, the Wasekwan volcanics must have been strongly folded before the deposition of the Sickle sediments.

All intrusive rocks south of the Sickle sediments are considered to be post-Sickle in age. The intrusives of gabbroic and dioritic composition north of the Sickle series may be pre-Sickle in age.

The general geology of the region is given in the following table of formations.

TABLE OF FORMATIONS

P R E C A M B R I A N	Intrusive rocks	<p>Basic dykes</p> <p>Graphitic granite, pegmatite</p> <p>Gneissic biotite granite, aplitic granite, undifferentiated granitic gneisses of igneous and sedimentary origin, sheared granite</p> <p>Hornblende diorite, biotite-hornblende-quartz diorite, minor gabbro and quartz monzonite</p> <p>Hornblende gabbro</p>
	Sickle series	<p>Conglomerate, sandstone, arkose, greywacke, quartzite, impure quartzite, argillaceous sediments; metamorphosed and granitized equivalents.</p>
	UNCONFORMITY	
	Wasekwan series	<p>Basic volcanics and derived hornblende schist and gneiss; tuff, agglomerate, pillow lavas; quartzite, impure quartzite, greywacke</p>

WASEKWAN SERIES

The Wasekwan series in this area is made up of a complex assemblage of basic volcanics, pyroclastics, sediments, and metamorphic rocks. Stratigraphic relations between different parts of the series have been obscured by faulting, possible folding, and the lack of exposures on the western side of the Wilmot Lake area.

For descriptive purposes, the series has been divided into three mappable units: one composed mainly of basic volcanics, one of sedimentary rocks, and one a mixture of volcanics, pyroclastics, and sediments. Contacts between these units have been arbitrarily drawn, depending on the apparent predominance of the above types; the contacts are gradational.

The greater part of the Wasekwan series trends across the northern part of the area. North of Counsell Lake the series is composed of basic volcanics with minor interbedded pyroclastics and sediments; towards the west, the percentage of volcanics decreases until, in the vicinity of Wilmot Lake, the series is predominantly sedimentary. The thickness of the section apparently increases from east to west.

Smaller zones of the Wasekwan series occur southeast of 'A' Lake and east of 'B' Lake. Apparently these zones have been displaced relatively south along a fault that trends through the centre of the 'A' Lake-'B' Lake basins. These isolated parts of the Wasekwan series could not be correlated with the more extensive volcanics to the north.

The numerous contacts between Wasekwan volcanics and igneous rocks are generally marked by a zone of mixed rocks, i.e., alternating outcrops of volcanics and intrusive types, lit-par-lit zones and inclusions of volcanics in the intrusive rocks.

The different rock types in the Wasekwan series are described in more detail below.

Basic Volcanics (1)

Most of the volcanics in the area were originally andesites and basalts, but these have been recrystallized to

hornblende gneisses and schists (greenstones, greenstone schists). These rocks are green and generally weather to a dark-green colour; commonly they are spotted white owing to the presence of plagioclase. Some of these recrystallized volcanics are massive, but in most exposures the hornblende shows a distinct preferred orientation which may be so well developed that the schists split into tabular blocks parallel with the schistosity. Thin beds of sediments and pyroclastics are interbedded with the volcanics.

Locally the volcanics have been recrystallized so intensely as to resemble a medium-grained diorite or amphibolite. As these igneous-appearing rocks occur as pods or lenses in the finer-grained volcanics, no attempt has been made to differentiate them on the map. Exposures of diabase occur but are not extensive.

Examination of several thin sections showed that the volcanics are composed of roughly equal amounts of hornblende and untwinned plagioclase. Hornblende occurs as poikiloblastic grains in a finer-grained groundmass. Small veinlets of calcite are common.

Interbedded Flows, Pyroclastics, and Sediments (2)

Directly north of the Sickie conglomerate in the north-west corner of the Counsell Lake area, a complex mixture of volcanics, pyroclastics, and sediments occurs. About half this assemblage consists of recrystallized basic volcanics as described above; the remainder is composed of agglomerates, fine banded tuffs, and quartzites.

The thickness of individual flows or beds is highly variable; the basic volcanics are from 5 to 30 feet thick, but the other types are generally only 1 foot to 5 feet thick.

Thin agglomeratic beds occur in several places. The fine-grained matrix is light green and it weathers to a light greyish green. The composition of the matrix appears to be that of an intermediate flow. Round bombs from 4 to 8 inches in diameter are scattered throughout the fine-grained matrix. Flow lines in the matrix curve around the bombs indicating that the bombs were dropped into a molten flow.

Pillow lavas occur in a few places in the area. Both the fresh and weathered surfaces are light to dark green. The pillows range in length from 6 inches to 3 feet and most are sheared out into cigar-shaped or irregular ellipsoids which are of little value in determining the top of the flow. In one place, however, relatively undeformed pillows, 2 feet long, indicate that the top of the flow is to the north.

Sedimentary Assemblage (3)

The sediments in the Wasekwan series are chiefly impure quartzites and greywackes, some of which are considerably metamorphosed. Individual beds range in width from a fraction of an inch to several feet. Wasekwan sediments may be readily distinguished from the Sickie sediments by their darker colour, finer grain size, and interbedding with volcanics.

In the Counsell Lake area the Wasekwan sediments are chiefly fine-grained impure quartzites which are light to dark grey and weather a dark grey. Some fine-grained tuffs are interbedded with the quartzites; these are difficult to distinguish from the quartzites, but appear to be more finely laminated and to weather to a lighter colour. A few small exposures of pebble beds occur. In general, metamorphism of the sediments in this particular area is slight, and has resulted in the production of biotite and hornblende aligned parallel to the bedding. Thin section examination of a typical quartzite showed it to contain about 80 per cent quartz and 20 per cent biotite and hornblende.

In the Wilmot Lake area, the Wasekwan sediments have been subjected to a much higher degree of metamorphism and are represented by many different rock types. The predominant type is a hornblende-biotite-quartz-plagioclase gneiss or schist. It is greenish black on the fresh surface, and weathers to a dark green colour. It is fine- to medium-grained and locally has been sheared so as to resemble an augen gneiss. Many of the exposures break into thin slabs parallel with the bedding owing to the perfect alignment of biotite and hornblende. Thin section examination of several sections showed that the rock contains 30 to 40 per cent hornblende and biotite, which occur as large grains, in a fine-grained granulated groundmass of quartz and untwinned plagioclase.

A higher degree of metamorphism has resulted in the production of garnetiferous, staurolitic, and sillimanitic varieties (3a) of the above. The most common of these metamorphic varieties is the garnetiferous type. Pink garnets, most no larger than an eighth of an inch in diameter, may make up as much as 10 per cent of the rock; they occur as porphyroblasts with hornblende, biotite, or both, set in a granulated groundmass of quartz and untwinned plagioclase. Staurolite-biotite-quartz-plagioclase schists were found in two localities; the staurolite occurs as diamond-shaped porphyroblasts up to half an inch long. Sillimanite schists are rare and were found in only one exposure. The sillimanite occurs as well-oriented needles up to a quarter of an inch long in a sandy matrix of quartz and oligoclase.

As noted above, shearing in the rocks of this area has been common, and locally intense. An extreme degree of shearing has resulted in the production of sericite and chlorite schists. Dark fine-grained argillites occur in a number of localities; the best exposures are northeast of 'C' Lake. A number of exposures of medium- to coarse-grained amphibolites and hornblende-plagioclase gneisses occur on the western edge of the Wilmot Lake area. Some of this material may be of intrusive origin but probably most of it is of volcanic origin.

SICKLE SERIES

The main body of Sickle sediments occurs as a broad arch that trends northwest across the centre of the Counsell Lake area and southwest across the Wilmot Lake area. At the western edge of the Wilmot Lake area, the sediments have been compressed into a series of folds that plunge to the east as shown by Stanton in the Dunphy Lakes area to the west. The small amount of data obtainable fitted Stanton's interpretation, which was based on much better data.

The northern part of the series has, in general, not been strongly metamorphosed, but to the south, particularly in the vicinity of granitic intrusions, much of the series has been completely reconstituted. All the Sickle sediments in this region, with minor exceptions, originally had the composition of an impure quartzite or arkose; the present apparent diversity is simply the result of recrystallization and addition of material.

An unconformity has been placed between the Wasekwan series and the Sickie sediments, although no contacts between the two were observed. The local occurrence of coarse conglomerate at the base of the Sickie series strongly supports this interpretation.

Conglomerate (4)

Conglomerate is exposed at several places in the area. The thickest and coarsest beds occur north of 'A' Lake. Short disconnected lenses occur east of Wilmot Lake. The fairly thick zone just south of Wilmot Lake is actually a mixture of conglomeratic and quartzitic sediments. If exposures were more numerous in this particular area, the conglomerate would probably be shown to consist of short disconnected lenses.

The nature of the groundmass and the variety of pebbles are fairly constant, whereas the size and percentage of pebbles are highly variable. In general, the groundmass resembles a sheared medium-grained pink to grey arkose or quartzite. Most of the pebbles are vein quartz, quartzite, chert, or felsite. Felsite has been used as a name to include the fine-grained buff or pink pebbles. A few fine-grained dark pebbles are probably of volcanic origin. Only a few granite pebbles were found.

Both the size and quantity of pebbles vary considerably in the thick conglomeratic zone north of 'A' Lake. In the southern and western parts of the zone, the pebbles have an average diameter of 2 to 3 inches, a maximum diameter of 6 inches, and make up 10 to 20 per cent of the rock, whereas near the northeastern edge the pebbles have an average diameter of 6 inches, a maximum diameter of 18 inches, and make up 50 to 60 per cent of the rock. The thinner pebble beds south and east of Wilmot Lake contain 10 to 15 per cent pebbles which have an average diameter of 2 to 3 inches.

The elongation of smaller pebbles in many of the exposures indicates that the conglomerate has undergone considerable shearing since its consolidation. Most of the larger boulders have retained their original shapes. The groundmass has a highly sheared appearance. South of Wilmot Lake shearing has locally been so extreme that the pebbles have been completely obliterated.

A number of thin sections of the groundmass were examined, and a study of these supports the conclusion that the groundmass has the composition of an impure quartzite or arkose. One section is composed of 50 per cent biotite, sericite, and chlorite, and 50 per cent quartz. Another contains 30 per cent biotite and muscovite, 30 per cent quartz, and 40 per cent feldspar. Quartz grains and aggregates show all stages of granulation, being set in a fine-grained quartz-feldspar groundmass which has undoubtedly been crushed to its present size. Micaceous minerals have "flowed" around the larger quartz grains on a microscopic scale in much the same manner that the micaceous groundmass has "flowed" around the large pebbles on a megascopic scale.

Feldspathic Quartzites (5), Including Some
Derived Metamorphics (5a)

Fine- to medium-grained feldspathic quartzites and arkoses (5) constitute the bulk of the Sickle series in this region. In most exposures these sediments have not been recrystallized to any important degree, although locally they have a sheared appearance. These sediments are gradational into coarser-grained, micaceous, gneissose or schistose arkoses and quartzites which have been mapped as a separate unit. The variability of grain size appears to be a function of the distance between the sediments and the granitic intrusives.

The sediments in this unit are chiefly feldspathic quartzites and arkoses, but minor amounts of greywacke and pure quartzite occur. Sediments coloured yellow, pink, red, brown, and grey occur in different localities, but the predominant colour is a light greyish brown. The rocks in this unit are relatively compact compared with the micaceous arkoses and quartzites. Several thin sections of the different varieties of sediments were examined and were found to be similar in appearance; the most variable feature is the relative amounts of quartz and feldspar. The feldspar content varies from less than 10 per cent to more than 50 per cent. Oligoclase is the most common feldspar in the rocks, but orthoclase, microcline, and perthite also occur. The ferromagnesian content varies from 5 per cent to 25 per cent; the average sediment contains about 15 per cent. Biotite and hornblende are the chief ferromagnesian minerals; biotite is usually more abundant. Muscovite may make up to 10 per cent of the rock. Magnetite-rich bands are common in some of the well-laminated sediments.

Pebble beds in the feldspathic quartzites are fairly common. The gradational nature of the contact between conglomerate and quartzite is well illustrated south of the thick conglomerate zone in the vicinity of 'A' Lake. There pebbles of granitic composition are scattered sparsely throughout the sheared arkosic or quartzitic groundmass; the pebbles make up no more than 1 or 2 per cent of the rock and average about 2 inches in diameter. An interesting feature in the groundmass is the occurrence of perfect crystals of quartz and orthoclase as much as 2 inches long. The groundmass appears to be identical with that of the conglomerate to the north except that small grains of blue cordierite were found in a few places.

Metamorphic rocks (5a) within the quartzites are not abundant; the best exposures occur directly north of 'D' Lake. There quartzites and impure quartzites are interbedded with metamorphosed argillaceous sediments. Some of the argillaceous sediments have been transformed into micaceous schists which break into tabular blocks parallel with the stratification. Beds of garnet-mica-actinolite schist are fairly common and contain garnets up to one-quarter inch in diameter. Other types are hornblende-mica schists and actinolite schists which contain needles of amphibole up to an inch long. Thin sections of all of these rock types are alike in that they consist of a groundmass of finely crushed original constituents, quartz and feldspar, and larger grains of the metamorphic minerals, garnet, biotite, and hornblende. The width of beds varies from inches to several feet. In all the schistose rocks the schistosity is parallel with the stratification.

Another definite zone of metamorphic rocks within the feldspathic quartzites occurs along the north edge of the sediments on the eastern side of the Counsell Lake area. This zone is apparently the result of injection of granitic magma along foliation planes in the sediments. About equal amounts of igneous and metamorphic rocks are present in the zone, including gneissic granite, garnetiferous sandstone, and garnet-hornblende-quartz-plagioclase gneiss.

Micaceous Quartzites and Arkoses (6), Gneissose and Schistose varieties

The main bulk of these sediments is located on the western side of the Wilmot Lake area. These sediments are gradational into the quartzites and arkoses to the north, but

are coarser-grained and more micaceous. In general, they are a light-grey to pink colour, and weather grey. These sediments are gradational into the coarser-grained "granitized sediments" described below.

Gneissose and schistose varieties (6a) of the above occur chiefly around the border of the granite plug southeast of Wilmot Lake. The schistosity is parallel with the stratification, and is locally so well developed that the rock is easily split into thin tabular plates. The parting planes are commonly made up of muscovite which has a high silver sheen in reflected light. Examination of several thin sections showed that the rock is composed of about 35 per cent muscovite and biotite, and 65 per cent quartz and feldspar. The micas occur as long, well-oriented flakes in a fine crushed aggregate of quartz and feldspar.

The thin band of sediments between the two granite plugs in the Wilmot Lake area consists of a greater variety of rock types than any other part of this unit. In addition to the arkoses and quartzites, there are dark biotite-quartz-plagioclase and hornblende-biotite-quartz-plagioclase gneisses (6b) which are also of sedimentary origin. Fine-grained granitic dykes are common.

Granitized Sediments (7)

Highly metamorphosed sediments which are probably granitized equivalents of the Sickie sediments occur in the southwest corner of the Counsell Lake area and along the southern edge of the Wilmot Lake area. These rocks are intimately associated with graphic granite and pegmatite which may have been forcibly injected into the rocks while they were in a highly plastic state or may have been actually "sweated" out of the sediments during the metamorphism (Plate I B). In numerous exposures the sediments are highly contorted and drag-folded on the weathered surface. The area shown on the map as granitized sediments actually contains as much as 25 per cent graphic granite and pegmatite.

On the light-grey to pink weathered surface the most characteristic feature is the presence of elliptical white muscovite knots up to 2 inches long (Plate I A). The knots contain variable amounts of sillimanite, apparently formed from the breakdown of muscovite. These knots twist back and forth across the weathered surface, possibly outlining the trace of former bedding planes. Large flakes of muscovite occur in the absence of the knots.

In general, these rocks are friable and have a coarsely granular texture. The composition appears to be about the same as that of granite; in fact, only the granular texture serves to distinguish the granitized sediments from the more compact granite farther west. Examination of several thin sections showed the average composition to be about 30 per cent muscovite and biotite, 30 per cent quartz, and 40 per cent feldspar.

The coarse granular texture is probably the result of recrystallization of medium-grained arkosic sediments under the influence of hydrothermal solutions which emanated from the granite plug around which the granitized sediments occur. The granite may have been the source of the large quantities of pegmatite associated with the sediments.

Throughout the area mapped as granitized sediments, little change in the character of the rocks is evident, although towards the western edge of the Wilmot Lake area the rocks are finer-grained and do not show the characteristic development of knots. Original differences in lithology were probably slight or have been obliterated by the solutions which permeated the sediments.

On both the west and north boundaries of the granite the granitized sediments are gradational into more normal sedimentary rocks; these normal sediments along the north boundary contain some finely laminated, slightly granitized arkoses and apparently lense out to the east. A small lens of unmetamorphosed sediments occurs wholly within the granitized sediments just east of Bones Creek. These sediments are dark finely laminated greywackes and locally contain magnetite-rich layers.

Biotite-Hornblende-Quartz-Plagioclase Gneiss (8)

In the southwest corner of the Wilmot Lake area a group of metamorphic rocks occur which may be conveniently classified as dark gneisses and light gneisses. The greater part of the unit is part of a large drag-fold around the periphery of the granite plug south of McGavock Lake. The average dark gneiss is a biotite-hornblende-quartz-plagioclase gneiss, but all gradations between biotite-quartz-plagioclase gneiss and hornblende-plagioclase gneiss occur. The rock is medium-grained, granular, and weathers to a dark grey colour. Thin

section examination showed that the content of ferromagnesian minerals varies from 20 to 35 per cent, either biotite or hornblende being predominant. These gneisses appear to be derived from sediments of the Sickle series.

High-grade metamorphic facies occur within the drag-fold structure. The most common variety is a garnet-biotite-hornblende-quartz-plagioclase gneiss (8a) which shows considerable variation in grain size. Particularly coarse gneisses are located along the western shore of McGavock Lake, just south of the Laurie River. Garnet porphyroblasts up to 2 inches in diameter were found in a coarse groundmass of hornblende and quartz. More commonly, however, the garnets occur as small clear pink grains and may make up to 40 per cent of the rock. Metamorphic facies containing cordierite also occur near the southwest end of McGavock Lake; in most places the cordierite occurs as small clear blue grains but locally it is in grains as much as 2 inches long.

Another fairly high-grade zone of metamorphic rocks occurs around the periphery of the granite plug southeast of Wilmot Lake. This zone occurs around the western and northern edges of the granite body, and it appears to increase in width towards the east. Many different rock types occur within this zone, including chlorite schist, anthophyllite schist, hornblende-plagioclase gneiss, biotite-hornblende-quartz-plagioclase gneiss, and garnet-biotite-hornblende-quartz-plagioclase gneiss. The sedimentary origin of the zone is indicated by the preservation of the original stratification in a number of exposures and the quartzitic appearance of the gneisses which are not so highly metamorphosed. The zone is believed to be the result of contact metamorphism of the Sickle sediments by the granite intrusive.

MIXED ROCKS (A)

Three large zones in the region have been mapped as mixed rocks. Two of these are in the Wilmot Lake area, one north of 'E' Lake and one north of McGavock Lake. The other one occurs in the vicinity of Counsell Lake. Small zones of mixed rocks occur at almost every contact between Wasekwan volcanics and intrusive rocks, but they have not been mapped separately.

The zone of mixed rocks north of 'E' Lake (Aa) is not well enough exposed to be described accurately, but in general

it appears to consist of large inclusions of Wasekwan volcanics and sediments in the hornblende-quartz diorite. The intrusive rock appears to be more basic in the vicinity of the inclusions, indicating assimilation of the country rock.

A much better exposed zone of mixed rocks (Aa) occurs around the south and west shores of Counsell Lake. This zone was originally part of the volcanic band that strikes southeast from 'A' Lake. Granite, pegmatite, and quartz dykes and stringers have invaded and metamorphosed these volcanics. The zone decreases in width eastwards from Counsell Lake until it disappears completely south of 'F' Lake. The percentages of the different rock types are difficult to estimate, because some large outcrops are almost wholly volcanics with minor stringers of granite whereas other large outcrops are almost wholly granite with minor inclusions of volcanics.

The composition of adjacent bands of the volcanics is variable, and probably reflects original differences in composition. One band a foot wide may be almost pure hornblende whereas a band alongside it may contain 60 to 70 per cent plagioclase. Much of the amphibolitic material is gneissic, but massive phases do occur. Grain size is highly variable; in places the hornblende crystals are as much as one-quarter of an inch long.

Southeast of Counsell Lake the volcanics have been recrystallized so as to resemble a coarse-grained diorite or gabbro. Perhaps some of this material is of intrusive origin, but evidence against this was found in a number of exposures where all gradations between finely and coarsely recrystallized flows may be seen. Examination of thin sections of this pseudo-gabbro showed it to contain 70 per cent hornblende, 10 per cent albite in large untwinned grains, and 20 per cent of an intergranular mixture of quartz and albite.

The granite is gneissic and commonly has a highly sheared appearance. The weathered surface is pink to grey, and is characterized by resistant lenticles of quartz from one-half to one inch long which stand up on the weathered surface. The granite is composed of about 30 per cent quartz, 10 per cent biotite, 35 per cent orthoclase, and 25 per cent plagioclase.

As stated before, the amount of granite intruded into the volcanics is highly variable. In places it has been injected

only along pre-existing foliation planes in the volcanics; in other places it has been injected irregularly so as to isolate portions of the volcanics and leave them as inclusions with an area of 1 or 2 square feet. Quartz stringers and pegmatite dykelets occur throughout the zone of mixed rocks, forming a complex network in places.

A complex zone of mixed rocks (Ab) occurs along the western edge of the granite plug just north of McGavock Lake. This zone includes hornblende-plagioclase gneiss, amphibolite, Sickle sediments and granitized equivalents, a variety of metamorphic rocks, pegmatite, and biotite granite. Rock types change abruptly from outcrop to outcrop, and the foliation within the zone makes no recognizable pattern (Plate II A).

The hornblende-plagioclase gneisses and amphibolites are fine- to medium-grained dark-grey to black rocks, which are locally recrystallized enough to resemble a fine-grained diorite. In places they are interbedded with fine-grained quartzites. These rocks have been locally intruded by large quantities of graphic granite and pegmatite. Examination of a number of thin sections of the gneiss shows that it consists of about 60 per cent hornblende, 30 per cent plagioclase, and 10 per cent quartz.

The light pink to grey arkoses and quartzites in this zone are apparently Sickle sediments, and some have been metamorphosed to a granitic-looking rock that is barely recognizable as a sediment. Like the granitized sediments on the east side of the granite plug, these rocks are intimately associated with stringers and lenses of pegmatite and granite. In places these sediments have been converted to garnetiferous and sillimanitic gneisses.

The granite within the mixed zone is probably equivalent to that in the main part of the plug. This similarity, the high percentage of pegmatite, the confused pattern of the foliation in the centre of the zone, and the roughly elliptical pattern of the foliation around the edge of the granite and mixed zone, all indicate that the mixed zone represents the roof of an elliptical granite plug which has been forcefully injected into it. If the hornblende-plagioclase gneisses are Wasekwan volcanics, as they appear to be, it would mean that they have been carried upwards from considerable depths by the granite.

INTRUSIVE ROCKS

Intrusive rocks ranging in composition from hornblende gabbro to graphic granite occur in the region. Most of the granite is definitely post-Sickle in age, as it cuts the sediments and metamorphoses them. The gabbroic and dioritic bodies in the northern part of the area are post-Wasekwan in age, but whether they are pre- or post-Sickle could not definitely be determined.

In the Counsell Lake area the gabbro, diorite, and coarse-grained granite could be interpreted as being separate injection phases from a differentiating magma. The three granitic plugs in the Wilmot Lake area are probably related to a large underlying batholith; whether they are genetically related to the more basic rocks is not known. An unknown but substantial percentage of the granitic rocks in the region is the result of extreme granitization.

A few basic dykes represent the last intrusive activity in the area.

Hornblende Gabbro (9)

Two elliptical bodies of intrusive hornblende gabbro occur in the Counsell Lake area, one directly east of 'B' Lake and the other one at about the centre of the north boundary of the area. Both are small, the south one is about one-eighth of a square mile in area, and the north one is about three-quarters of a square mile. They are similar in composition although the one to the south seems to be slightly more basic than the other one. These bodies were probably not derived from the extreme alteration of basic volcanics like the pseudo-gabbro southwest of Counsell Lake because finely recrystallized volcanics can not be traced into coarser phases as in the pseudo-gabbro. It is noteworthy, however, that all the bodies are situated near the edge of a band of Wasekwan volcanics.

The hornblende gabbro is medium- to coarse-grained. It is dark green in colour on the fresh surface and weathers to a somewhat lighter green spotted with white patches of plagioclase. The composition is variable; the average is probably about 60 per cent hornblende, 40 per cent plagioclase, but some phases contain as much as 80 per cent hornblende whereas others contain as little as 40 per cent. Small grains of milky-white or blue quartz make up a small percentage of the rock. Some of the plagioclase resembles orthoclase owing to a reddish colour caused by iron stain. Thin section examination shows that the feldspar

is coarsely twinned andesine-labradorite, which is packed with alteration products of clinozoisite and albite in small grains. A few grains of pyrite and chalcopyrite are scattered throughout the rock.

At the eastern border of the 'B' Lake intrusive a sharp contact between the hornblende gabbro and hornblende-quartz diorite was found, but the relative ages of the two types could not be determined. In places the hornblende gabbro is intruded by an intricate network of granitic stringers.

Diorite, Quartz Diorite (10)

Intrusives of dioritic composition occur in the northern part of the area. North of Wilmot Lake the intrusive is a hornblende-quartz diorite, with minor gabbroic phases, whereas in the Counsell Lake area the intrusive grades from a hornblende diorite to a biotite-hornblende-quartz diorite. Isolated exposures of hornblende gabbro and biotite-quartz monzonite indicate the variability in composition within the intrusive. Small areas of what appear to be contaminated intrusive rocks related to the diorite occur north and south of 'B' Lake.

The hornblende diorite (10a) is a dark medium-grained equigranular rock which weathers to a dark-grey colour. It is composed of about 35 per cent hornblende and biotite, hornblende being dominant, and 65 per cent dark-green feldspar. Most specimens contain some quartz; in places, the quartz content approaches 15 to 20 per cent, and the rock is therefore a quartz diorite. The feldspar is oligoclase-andesine and is considerably altered to saussurite. Gabbroic phases occur, particularly near the borders of the Wasekwan volcanics; this relationship suggests that assimilation of the volcanics may have played an important part in the production of the different types of diorite.

The change from hornblende diorite to biotite-hornblende-quartz diorite (10b) in the Counsell Lake area is gradational from north to south. The quartz diorite is much lighter in colour, and weathers to a light grey. It is gneissic, medium-grained, and contains only 10 to 15 per cent mafic minerals, the composition of which is variable. Generally, however, biotite predominates over hornblende. The feldspar is saussuritized oligoclase. The quartz content varies from 5 to 30 per cent. In places the rock contains a small amount of orthoclase,

and probably approaches quartz monzonite in composition. Although no contacts were found, there is a sharp break between this biotite-hornblende-quartz diorite and the massive pink granite along its southern border.

Contaminated phases of diorite (10c) occur north and south of 'B' Lake. The rock has a dark-green colour and weathers dark grey. It is gneissic and highly sheared in places, and does not look like a normal intrusive rock. The composition as determined from thin sections is about 60 per cent saussuritized oligoclase-andesine, 25 per cent hornblende and biotite, and 15 per cent quartz. In places the quartz is highly crushed and sheared. An exposure of this rock which has an extremely sheared appearance occurs about 10 feet below the base of the Sickie conglomerate.

Granite (11)

The greater part of the granite in the region occurs south of relatively unaltered Sickie sediments. Towards the south, the percentage of granite increases, and the sediments appear highly metamorphosed; in fact, much of the granite in the area is probably the result of extreme metamorphism of the Sickie sediments.

An intrusive body of distinctive gneissic biotite granite (11a) is located just north of the east end of McGavock Lake. Solutions from this elliptically-shaped plug have metamorphosed and granitized the sediments around its periphery. Large isolated blocks of Wasekwan volcanics, surrounded by metamorphosed Sickie sediments, occur at the western end of the plug; these volcanics are far south of the main Wasekwan assemblage, and their position here indicates that they have been carried upwards by forceful injection of the granite plug.

Another body of granite which appears to be identical with the above is located north of the plug; it is intrusive into pink aplitic granite in the south and forms a long "tongue" into the aplitic granite in the north. The granite is medium-grained, pink on both fresh and weathered surfaces, and commonly gneissic. Examination of a number of thin sections showed the average composition to be 35 per cent quartz, 35 per cent potash feldspar, 25 per cent oligoclase ($An_{15}-An_{20}$), and 5 per cent biotite.

A well-defined body of massive to gneissic fine-grained aplitic granite (11b) occurs southeast of Wilmot Lake. Large exposures of identical granite occur on the eastern side of the Counsell Lake area. The aplitic granite has been mapped as a continuous zone, but the lack of exposures east of 'D' Lake makes this interpretation questionable. The rock is pink on both fresh and weathered surfaces, and commonly shows only a faint gneissosity. In places, particularly along the contact between the granite and Sickle sediments, it resembles a fine-grained quartzite. Inclusions of hornblende-biotite-plagioclase gneiss a few feet long occur in several places in the granite. Examination of a number of thin sections of the aplitic granite shows that the average composition is 40 per cent quartz, 35 per cent potash feldspar, 20 per cent oligoclase (An₁₀-An₁₅), and less than 5 per cent biotite.

The origin of much of the gneissic granite (11c) in the region is uncertain; it may be intrusive or sedimentary. A good example of gradation of igneous gneiss into sedimentary gneiss occurs in the granite plug at the southwest end of McGavock Lake. The nose of the plug is made up of gneissic granite which appears to be igneous, but towards the east, this igneous granite grades into granitic gneisses which still show evidence of a sedimentary origin. Lit-par-lit gneisses and injection gneisses commonly occur within the region of sedimentary gneisses (Plates II B, III A and B). Thin section examination shows no appreciable differences between the composition of the igneous and sedimentary gneisses. The average composition is 35 per cent quartz, 35 per cent oligoclase (An₁₅-An₂₀), 20 per cent potash feldspar, and 10 per cent biotite and hornblende.

The gneissic granite on the east side of the Counsell Lake area shows considerable variation in texture and composition. Thin section examination shows that locally it has the composition of quartz monzonite. It is medium-grained, and weathers to a light-pink or grey colour. Locally, the granite contains dark gneissic inclusions which weather to a "salt and pepper" appearance. Near the south end of 'G' Lake these inclusions make up as much as 60 per cent of the rock. Farther south, the inclusions decrease in quantity and the granite is distinctly banded in appearance. The bands show differences in colour, composition, and texture; some are rich in biotite and weather to a dark colour, whereas others are almost free of dark minerals and weather to a pink or grey colour. The texture ranges from fine- to medium- to coarse-grained across the strike. Most of the granite has well-developed foliation owing to the alignment

of biotite which appears as wavy lines on the weathered surface and in places is crumpled into small drag folds. Most of this granite is cut by small dykes of pegmatite. The banding in the granite may be due to the preservation of an original sedimentary stratification and, if so, much of this granite is of sedimentary origin.

Locally the granite has been highly sheared; this feature is most apparent along the south shore of 'H' Lake and west of Counsell Lake. The sheared granite is characterized by long lenticles of quartz, which stand above the general weathered surface.

A well-defined body of massive granite (lld) occurs north of the Sickle sediments in the vicinity of Story Lake. This granite has a red colour and weathers to a bright pink. It is medium- to coarse-grained. The composition is the same as that of the gneissic granite except that there is only about 1 to 2 per cent biotite. A distinctive feature is the presence of large aggregates of quartz grains up to half an inch long; these are generally covered with iron stain, so that they appear as large red blotches on the fresh surface.

Much graphic granite and pegmatite (lle) occur west of 'G' Lake; their intimate association with the granitized sediments has been described above. The pegmatites in the region have a simple mineralogical composition, being chiefly composed of quartz and potash feldspar. Locally they have been greisenized or tourmalinized, so that they now consist of quartz and muscovite or quartz and tourmaline.

Basic Dykes (12)

Isolated outcrops of what may be a highly altered basic dyke or sill occur south of 'H' Lake and 'J' Lake. This could possibly be a strongly metamorphosed pendant in the granite, however. On the fresh surface the rock is light green, and it may be stained yellowish brown owing to the presence of limonite. The rock is made up of a felted mass of amphibole needles up to one-eighth of an inch long. In places brown ellipsoidal features up to one-half inch long are present in this amphibolitic ground-mass; these probably represent original pyroxene crystals altered to secondary minerals. South of 'H' Lake the dyke is highly

sheared and resembles a micaceous schist. Magnetite is sparsely scattered throughout the rock. In thin section the rock is seen to be composed of long tremolite needles in a fine-grained quartz-mica groundmass. The ellipsoidal features mentioned above appear to be large irregular areas of serpentine and magnetite.

South of 'H' Lake and east of 'J' Lake large outcrops of granular hornblende-plagioclase gneiss occur close to the dyke. The gneiss does not have an igneous texture, and it may represent large inclusions in the granite.

North of 'H' Lake small outcrops of what appear to be a small dyke, possibly a lamprophyre, occur. The rock is fine-grained, dark, and has a sheared appearance. Thin section examination shows that it is a hornblende-biotite-plagioclase-quartz gneiss.

STRUCTURAL GEOLOGY

FAULTING

The main fault in the region is located near the western edge of the Counsell Lake area and apparently extends south of the map area along a long, straight section of the Laurie River, a total distance of 30 miles. It strikes almost due north through the depression occupied by Bones Creek and curves to the northeast through the basins of 'A' Lake and 'B' Lake. This fault has displaced the Sickle conglomerate on the west in a northerly direction relative to the volcanics on the east side of it. Further south, proof of any displacement along the fault is lacking.

The existence of a fault that strikes northeast through the 'G' Lake basin has been inferred from the fact that the coarse granitized sediments on the west side of the lake are not found on the east side. The linear appearance of 'G' Lake and of the lake northwest of it is also strongly suggestive of a fault. The relative movement could not be determined.

A fault striking north of west along the south shores of 'H' Lake and 'K' Lake is indicated by a number of outcrops of sheared granite near these shores. The cumulative effect of

this fault and the 'G' Lake fault is noticeable in the wedge between the two just south of 'H' Lake where many of the outcrops are highly sheared in appearance.

Existence of a fault at the extreme west end of McGavock Lake is inferred from the apparently sharp break between Sickle sediments north of the lake and high-grade metamorphics south of it.

FOLDING

The Wasekwan series may have been folded before deposition of the Sickle series, and the separate volcanic units in the Counsell Lake area may possibly be limbs of folds. The general lack of structures to determine the directions of tops and ignorance of the relative ages of these units makes speculation regarding large scale structures fruitless. However, scant evidence of folding in the volcanics was found in the northwest corner of the Counsell Lake area. There the tops of the Wasekwan volcanics are to the north, whereas the tops of the Sickle sediments are to the south, indicating that the volcanics were overturned before deposition of the sediments.

Folding in the Sickle sediments appears to be chiefly the result of forceful injection of granitic bodies into them. The best example of this relation occurs around the granite plug southeast of Wilmot Lake, where the bedding in the sediments matches the curved pattern of the foliation in the granite perfectly. The pattern of the gneissosity in the granitized sediments around the granite plug just north of McGavock Lake shows the same relationship, but there the match is not so perfect. A similar relationship exists at the extreme west end of McGavock Lake, where metamorphic rocks are folded around the nose of a granitic intrusive. Several small folds plunging to the east also occur within the Sickle sediments along the western border of the Wilmot Lake area.

ECONOMIC GEOLOGY

Interest in the region was stimulated by the discovery of nickel-copper ore in the Lynn Lake district directly north. Since then, however, interest has waned somewhat and a number of claims have been allowed to lapse. No prospectors were met during the summer months of 1949 and 1950.

One of the chief aims of prospectors in the region has been the discovery of gabbro or norite intrusives similar to the Lynn Lake intrusive. Two bodies of hornblende gabbro were located in the Counsell Lake area, but no important sulphide mineralization was detected in the neighborhood of them. Their small size makes it appear unlikely that large nickeliferous deposits would be associated with them.

In general, the granitic rocks and the Sickle sediments do not appear to be favorable host rocks for mineral deposits, although a few slightly mineralized quartz veins were found south of Wilmot Lake in sheared conglomerate. The best prospecting areas in the region are underlain by Wasekwan volcanics. Many of the exposures of volcanics in the Wilmot Lake area are highly sheared and are shot through with carbonate stringers. Grains of pyrite and chalcopyrite are scattered sparingly throughout these stringers.

Small prospect pits were found in several localities. A small amount of trenching has been done on a quartz vein 2 feet wide north of Wilmot Lake; the vein is intrusive into metamorphosed Wasekwan sediments. The vein is slightly mineralized. Near the southeastern end of 'B' Lake a quartz vein 4 feet wide, bounded by 2 feet of mineralized wall rock, has been discontinuously stripped for a distance of 40 feet. Pyrite and chalcopyrite are scattered sparingly throughout the vein and wall rock. Stripping and diamond drilling have been done on some quartz veinlets in the volcanics at the southwest end of 'B' Lake. Samples taken from these prospects were assayed, but they showed no appreciable content of gold or silver.

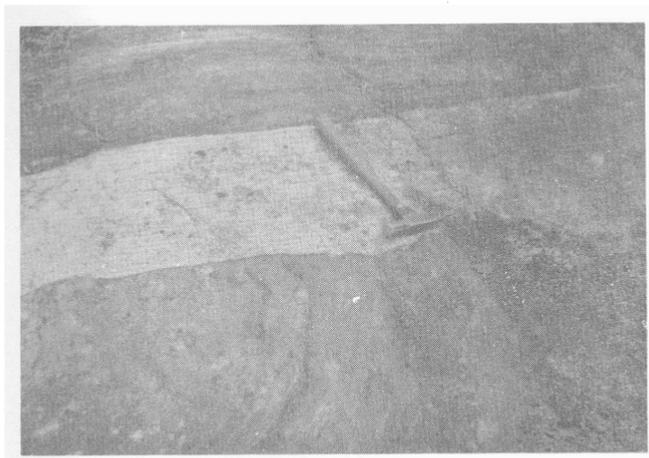
Considering the abundance of drift, muskeg, and water, it is possible that economic mineral deposits exist in the area but cannot be discovered by ordinary prospecting methods. This is especially true of the area between Wilmot Lake and 'E' Lake, where small mineralized veins are fairly common in the few exposures which were found.



A. Muscovite knots in granitized sediments. (Page 13).



B. Showing intimate relationship between granitized sediments and permatite. (page 13).



A. Hornblende-plagioclase gneiss cut by pegmatite in mixed rocks (A_6). Note the different trend of foliation on opposite sides of the dyke. (Page 17).



E. Lit-par-lit gneiss south of Laurie River. Light bands are granitic, dark bands are biotite-hornblende-quartz-plagioclase gneiss. (Page 21).



- A. Injection gneiss south of Laurie River. Light bands have granitic composition, dark bands are biotite-hornblende-quartz-plagioclase gneiss. (Page 21).



- B. Similar to A.