A PETROGRAPHIC STUDY

OF THE

SERPENTINIZED PERIDOTITES OF THE GRIFFIS LAKE

MAP AREA, QUEBEC

BY R.B. FULLERTON

This thesis is submitted in partial fulfillment
for a Master of Science Degree, McGill University,
May, 1951.

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ACKNOWLEDGMENTS

The writer wishes to acknowledge the aid and interest of Dr. J.S. Stevenson, of the Department of Geology, McGill University, W.F. Fahrig of the Geological Survey of Canada, and Miss Horsburgh, for her assistance in preparing the maps contained in this thesis.

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Chapter I.

INTRODUCTION

During the summer of 1950 the author was employed by the Geological Survey of Canada to assist in the geological mapping of the Griffis Lake Map Area, Quebec, on a scale of one inch equals one-half mile. This area is located in the central section of the Dyke Lake map sheet of the Geological Survey of Canada, and occupies an area of some 450 square miles (see Fig. 1 and 2). The area lies between latitudes 55°N. and 55°15'N, Longitudes 65° 30'W and 66°W, where it forms part of the upper drainage system of the Rivière De Pas. The area lies within the eastern concession limits of Labrador Mining and Exploration Company, Ltd., and is 45 miles north east of their base camp at Burnt Creek.

Access to the area is entirely by air. There are two stages of air transportation. The first stage is from Mont Joli, Quebec, on the south shore of the St. Lawrence, to the air strip in west central Labrador at Knob Lake, which is owned and operated by the Hollinger Ungava Transport Company. The second stage is made by float-equipped aeroplanes from Knob Lake to the Griffis Lake Map area. Travel in the area by the writer and the party was mainly by canoe.

PREVIOUS WORK

Geological information published prior to 1936 is extremely limited. The only government geological work that had been undertaken in this region prior to that time was a rapid reconnaissance survey across the southern part of the Dyke Lake sheet by A.P. Low, of the Geological Survey of Canada, in the early 1890's.

In 1929 W.F. James and J.E. Gill directed a geological and prospecting expedition into the Dyke Lake area. This party made some of the early iron ore discoveries in the area. Their geological mapping was confined to restricted areas in the vicinity of the iron ore showings which they had found. In 1933 J.E. Gill directed a small party into the area southwest of Shabogama Lake, in the extreme southwestern corner of the Labrador concession.

In 1936, Labrador Mining and Exploration Company, Limited, was formed, and the same year obtained a mining concession of some 23,000 square miles in Labrador. Geological mapping and prospecting was done during the summer seasons of 1936 to 1939, inclusive. Work was suspended for the next two seasons. In 1942 Hollinger Consolidated Gold Mines purchased control of the Company, and the M.A. Hanna Company of Cleveland participated on a minority basis. In the same year Hollinger North Shore Exploration Company Ltd. was formed to explore an area of 3,900 square miles, adjoining the Labrador Concession, to the northwest (1).

(1) Confidential Report Field Manual Labrador Mining and Exploration Company, Ltd.

In 1947 Quebec North Shore Labrador Railway Company was formed, and received a charter for the construction of a railway from Seven Islands to the iron ore area in the vicinity of Burnt Creek. This railway is at present under Construction.

From 1936 to the summer of 1949 all geological work in the area was done by Labrador Mining and Exploration Company Ltd., and Hollinger North Shore Exploration Company Ltd. In the summer of 1949 the Geological Survey assigned Dr. J.M. Harrison to work with, and assist, the various companies in their geological work, and during that summer he made a rapid reconnaissance trip through the Griffis Lake Map area, but none of the data collected was published.

In the Spring of 1950 the Geological Survey of Canada assigned W.F. Fahrig to the Griffis Lake area to map it on a scale of 1 inch = ½ mile. The western half of the area was mapped during the summer of that year, the eastern half to be completed in the summer of 1951.

Three months were spent in the field in the summer of 1950, from the 22nd of June to mid-September. One week of this time was spent, approximately, on the study of the serpentinized peridotites of the area.

This thesis contains work based on the study of 25 thin sections and hand specimens of the Serpentinized Peridotites of areas 1 and 2,* and 4 thin sections and hand specimens of the talc-carbonate zone. The work was done during the academic year of 1950-51 at McGill University.

* See fig 2.

Chapter II.

PHYSIOGRAPHY

General

The Labrador Peninsula is a high, rolling plateau, which rises somewhat abruptly within a few miles of the coast-line to heights of between 1500 and 2500 feet. The interior country is undulating, and is traversed by ridges of low rounded hills, that seldom rise more than 500 feet above the general surrounding level. From the barometer readings taken by A.P. Low (1) in 1894, on the upper Hamilton River and Lake Michikamau, near the central water shed, the altitude varies from 1600 to 1800 feet, and this may be taken as the general height of much of the interior of the Peninsula. Exceptions to these altitudes are the Sims Lake hills, with altitudes of 3200 and 2300 feet.

Griffis Lake Area

The area discussed in this thesis may be divided topographically into two sections. The first of these is the northern and western part of the area, where rolling hills and ridges predominate (Figs.3, 4, 5). These trend northwest-southeast, and die out towards the southern part of the sheet, but continue northwards. These hills and ridges are rocky prominences, smooth and rounded in general aspect but often craggy and steep-sided in detail. The lower slopes are often

(1) A.P. Low: Report on expl. in the Labrador Peninsula along the East Main Koksoak, Hamilton, Manicuagan, and portions of other rivers. Can. Geol. Survey Ann. Rept. 8, 1896.

Fig3 3. Hills East of McNeil Lake.

Fig.4. Hills North offLac LaPorte.

Fig.5. Barren drift covered Hill tops East of McNeil Lake.

heavily wooded with spruce, but, except for a few shrubs, their upper limits are usually barren. They are covered with a mixture of frost-wedged boulders, weathered rock, and, in places, a thin mantle of glacial drift. They average approximately 400-500 feet above the surrounding country. The glacial drift is found more on the summits of the lower hills, and consists of small to fairly large boulder-erratics of iron formation, quartzite and sandstone carried by the ice from the rock formations west and south of the area. Glacial striae are prominent on the hill tops, and indicate two directions of movement, a younger movement striking northeasterly, and an older movement striking southeasterly. The criteria for these determinations were obtained from a study of friction cracks (Fig. 6 and 7). The older set of glacial striae and friction cracks are formed mostly on the valley sides below the hill tops, suggesting that the ice flow was controlled in its early stages of formation by the topography, and therefore followed these valleys, but upon increasing in thickness of the ice, it flowed in a northeasterly direction, disregarding the previous topographic control.

In a recent paper, R.F. Flint (1) mentions the possibility of local ice cap formation in the neighborhood of 55° N Lat. and 67° W Long, about 45 miles due west of the Griffis Lake area, at an altitude of about 3000 feet (Fig. 2). This he

(1) R.F. Flint: Highland centers of former glacial outflow in northeastern North America. Bull. of Geol. Soc. of Am. 1951, Vol. 62, pp.31-34.

Fig.6. Glacial striae East of McNeil Lake.

Fig.7. Glacial striae East of McNeil Lake.

deduced from the study of aerial photographs and by plotting the radial pattern of eskers in this section. Flint thinks that this local ice cap, and others of similar nature, were formed after the final stage of the Laurentide ice sheet with radial flow, and produced various striations and other features which do not fit with the general Laurentide ice sheet movements.

The possibility of such a condition existing in the Griffis Lake area is not impossible, but, on the whole, I think that such conditions are unlikely, as the topography is of insufficient relief to support local ice caps; further, there is no evidence of cirques or any other topographic form suggestive of local ice accumulation.

The valleys between the hills and ridges are filled with glacial material that has caused damming, and the formation of small lakes, separated by short rapid-filled streams.

The southern section of the sheet is almost flat, with numerous swamps, ponds and lakes. It is mostly covered by glacial drift of varying thickness. To the east and north , the Griffis Lake area is a series of rolling hills of glacial drift, mostly sand.

Several small eskers were found in the eastern part of the sheet trending northwest - southeast, but they were small, short in length, and quite discontinuous.

Information gathered by the exploration companies has led them to believe that the centre of the Labrador ice cap was located near the western boundary of the Dyke Lake sheet (1).

(1) Confidential Report Field Manual Labrador Mining and Exploration Co. Ltd.

Because the ice had not travelled far, it contained a relatively small amount of rock fragments and boulders, and was thus not capable of producing the glacial erosion that has occurred further south and east, as mentioned by J.E. Gill (1) and A.P. Low. However, there is plenty of evidence of glaciation in the Dyke Lake sheet, and, although the main topographical forms are preglacial, the topography has been modified by ground moraines and other glacial deposits.

The drainage pattern of the northern and western part of the area is controlled by the structure of the rock, which strikes northwest - southeast. In the eastern and southern half of the Griffis Lake sheet the drainage becomes more dendritic as a result of damming by glacial drift.

(1) J.E. Gill: Wapussakatoo Mountains, Labrador
J.E. Gill: Geol. Soc. Am. Vol. 48.

Chapter III.

GENERAL GEOLOGY

The Griffis Lake area lies on the eastern margin of a major geological unit, known as the "Labrador Trough". This "Trough" trends northwest, and is known to be at least 400 miles long and to vary from 30 to 60 miles wide in the Dyke Lake sheet. The Labrador Trough consists of an intricately folded and faulted assemblage of relatively unaltered, fresh, sedimentary, volcanic and intrusive rocks of Proterozoic age, which lie uncomformably upon the older Ashuanipi Series of Grenville age. The term "Trough", as applied to this assemblage, is somewhat misleading, as it tends to imply a complete synclinal structure. Actually, the structure would be more accurately defined as a number of faulted segments of a synclinorium. The geology of the northwesterly and southeasterly limits of the "Trough" has been complicated by the intrusion of large igneous masses and their accompanying metamorphic effects. There is a definite suggestion that the "Trough" splits into two lobes in the southeast, one lobe trending easterly and the other trending southwesterly. The latter lobe may conceivably extend to the Huronian-type rocks in the vicinity of Lake Mistassini, about 300 miles to the southwest. In recent years considerable field work has been undertaken in the area northwest of the Dyke Lake sheet, but no geological information has been published. The "Trough" may extend much farther in this direction than is generally believed (1).

(1) Confidential Report Field Manual Labrador Mining and Exploration Co. Ltd.

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(1) Confidential Report Field Manual Labrador Mining and Exploration Co. Ltd.

TABLE OF FORMATIONS

The table of formations for the Dyke Lake Sheet is shown in Fig. 8, and their distribution in Fig. 2 (I).

Many of the stratigraphic relationships have not been established, but the succession given in Fig. 8 appears to satisfy more nearly the available geological data. The succession from the base of the Hamilton River Series to the Sokoman iron formation will undoubtedly prove to be essentially correct, although further detailed mapping may show the presence of additional members. It is known that there are several volcanic flows immediately above the iron formation, and it is reasonably certain that the Menihek slates lie above these lavas. There is considerable doubt regarding the relative stratigraphic positions of the Howse, Doublet, Murdoch and Laporte Series.

The distribution of the Hamilton River Series, the Ferriman Series, and the Menihek slates has been omitted owing to the complexity of their structures and their occurrence in a great many small areas.

This paper is mainly concerned with the Doublet Series, in which the serpentinized peridotites occur, and, for this reason, the Doublet Series and the surrounding Series (Ashuanipi Series, Laporte Series and Murdoch Series) will be considered in more detail.

DESCRIPTION OF ROCK SERIES

Ashuanipi Series (Grenville Type)

The Ashuanipi Series includes a great variety of sedimentary and igneous rocks, which form the basement complex. Upon this, the rocks within the "Labrador Trough" have been deposited. Essentially, the Series consists of sedimentary rocks which have been invaded by acid intrusives. Large masses of basic intrusives, mainly gabbros and anorthosites, are also present in appreciable amounts, but their origin is difficult to determine, and even more difficult to prove. This Series is readily recognized in the field by its complex nature and the presence of granitization, a characteristic feature of the Series.

The following rock types have been recognized:

1. Various intrusives, such as granites, syenites, anorthosites, diorites and gabbros, and also small dykes of pegmatite and aplite.

2. Rocks of sedimentary origin, such as para-gneiss and sohists

3. ~~On the~~ Ortho gneiss.

4. A possible fourth group of hybrid types, injection gneisses lit-par-lit types, which cannot be definitely classed as ~~on the~~ ortho gneiss or para-gneiss, would belong in this group.

Murdoch Series

There are a great many rock types within the Murdoch Series, and only the principal members will be described. Generally, the Series is characterized by chloritization. Locally, considerable mica may be present, and sericite schists are not unknown. Occasionally the chloritization has been so complete that the original features of the rock have been destroyed.

The most frequent rock group encountered in the Murdoch Series consists of pyroclastics. These vary from finely laminated tuffs to thick bedded agglomerates containing bomb-like fragments up to 2 feet in length. The fragments of the agglomerate may be angular, sub-angular, or even rounded. In the field, the mineralogical composition of the fragments does not appear to be greatly different from that of the matrix.

Lens-shaped beds of normal water-lain sediments are widely distributed through the pyroclastics. Altered graywackes, quartzites, slates and conglomerates have been recognized. Usually these beds are only a few tens of feet thick. The conglomerates are not nearly as continuous as the agglomerate beds, and are distinguished by the great variety of sub-angular boulders which they contain. Boulders of intrusive rocks, such as diorites, gabbros and granitic types, as well as boulders of intermediate and basic lavas, have been observed. The conglomerates usually grade into graywackes both along and at right angles to the strike.

Laporte Series

This Series lies east of Lac Laporte, and extends northeastward from the Lake. The Series consists of well bedded biotite-rich graywackes and green schists. The green schists are found along the western contact, where they form a band of variable thickness. They are predominantly chlorite and sericite schists.

The graywackes show a medium to coarse-grained texture. They are greatly folded into wave-like crenulations, and, in general, they dip eastward.

Howse Series

The Howse Series lies in the central portion of the "Labrador Trough". It extends from Marion Lake northwestward beyond the northern boundary of the Dyke Lake sheet.

Although the combined thickness of the volcanic and sedimentary members is only a few thousand feet, because of the many diorite sills which intrude these rocks, the Series occurs across a horizontal width of several miles. The Howse Series is of particular importance because of the base-metals that are found within it.

The Series is predominantly sedimentary, with a few minor volcanic members. Few of the sedimentary beds are thicker than 300 feet, and all of them show remarkable continuity along the strike. Practically all of the sediments occur in valleys, and the diorite sills form ridges between the sedimentary bands.

Many sedimentary types are represented. They include shales, slates, graywackes, quartzites and lenticular conglomerate beds. A few pillow-lavas and some fragmental flows are also found.

The most important member of the Series is a black carbonaceous shale, which is the host rock for most of the base-metal deposits found in the area.

Doublet Series

The Doublet Series underlies a large area along the northeastern margin of the "Trough". This Series consists predominantly of lavas, but several normal clastics, and some pyroclastics have been mapped, and within this Series lie the serpentinized peridotites.

Dense, greenish, pillow lavas are by far the most abundant rocks in the Series. The weathered surface may be dark gray, light brown or green. The pillows vary in length from a few inches to 25 feet. Occasionally the outer portion of the pillow is amygdaloidal. The pillow rims may be narrow or wide, and this feature is often useful in correlating the flows. The rims are usually more chloritic than the central portion of the pillows. These lavas are generally fresh in appearance, except where they occur adjacent to the serpentinized peridotite masses, and they then occasionally show serpentinization.

Fragmental flow breccias have been observed at several points. The fragments vary from 1/8 inch to 3 inches. They are angular to sub-angular, and are light weathering. The fragmental nature of the flow is normally not apparent on the fresh surface.

Several greenstone flows occur in the Doublet Series. These rocks are fine to medium-grained, and are gray or green on their fresh surface. The weathered surface is usually light brown, but may be greenish-gray.

Fresh massive, gray quartzites and gray shales, containing sandy beds, have been mapped at several localities. (1).

(1) Description of Series condensed from Confidential Report field Manual Labrador Mining and Exploration Co. Ltd.

Chapter IV.

STRUCTURAL GEOLOGY, GENERAL

The regional strike of the rocks within the "Trough" is northwest - southeast, and most of the strata dip to the northeast The rocks have been subjected to great stresses, and supposedly failed by folding and faulting. The folding has not been extreme, and most of the folds are open. Overturning has taken place in a few places. Dips vary from vertical to horizontal. The plunge of major structures and minor folds is usually less than 25°. However, the plunge of the folds is variable both in direction and degree, and it is not uncommon for the direction of the plunge to change several times within a mile along the fold axis. Drag-folding is common in all areas.

Within the "Trough" there are a great number of northwesterly striking thrust faults. The dip of these faults is northeasterly, with dips up to and greater than 60°, the average being about 50°. Only a small number of these thrust faults have been observed at the surface or have been intersected in drill holes. Their presence has been inferred, generally, from a distribution of rock formations which cannot be explained by folding. All of the observed faults are marked by a grayish white fault gouge. Shearing parallel with these faults is not prominent.

In the Griffis Lake area the Laporte Series is believed to be thrust-faulted against the volcanics to the west. Here there is no gouge visible, but prominent shearing parallel to the fault is seen. There are two other major fault zones in the area, and they are characterized by sheared schistose lavas and the presence of carbonate minerals. The smaller of these faults occurs along the axis of the anticlinal fold, of which the serpentinized peridotites are a part. In addition to faulting, the area has been folded into open folds plunging gently southwards, with the axial lines striking northwestward.

Chapter V.

THE SERPENTINIZED PERIDOTITES

General Features

The serpentinized peridotites of the Griffis Lake map area occur as sill-like bodies. The number 1 exposure is the largest, with an exposure width of from 5000-6000 feet, and a length of about 5 miles. It occurs in an anticlinal fold, which plunges southeast. The contact with the underlying gabbro is fairly sharp, but, as it is mostly covered by drift and boulders, it is not certain whether it is gradational or not. The number 2 exposure lies north and east of number 1. It is much smaller in size - about 1000 feet wide and 2 miles long. It shows a gradational contact with the underlying gabbros and a sharp contact with the overlying andesites.

The serpentinized peridotites are generally massive. There has been some fracturing near the central part of number 1 exposure along the anticlinal axis, and to the east of the axial line. This is probably related to the faulting along the axis of the fold, which affected the serpentinized peridotites by causing tension and shear fractures. These fractures have been filled with magnetite and serpentine.

The serpentinized peridotites may be divided into two main zones: 1. The serpentinized zone; 2. The talc carbonate zone. The serpentinized zone is characterized by an abundance of minerals of the serpentine group, the talc carbonate zone by the presence of talc and carbonate minerals. The serpentinized zone may further be subdivided into 3 minor zones: (a) an olivine-pyroxene zone; (b) a serpentine zone; (c) an actinolite zone. The olivine-pyroxene zone is identified by its black fresh surface, cuboidal nature of the weathered surface, and the presence of olivine. The serpentine zone is characterized by complete to almost-complete serpentinization by antigorite and serpophite of the original rock. The actinolite zone is the contact zone between the serpentinized peridotites and the gabbros, and is identified by the presence of abundant actinolite.

The gabbros overlie and underlie the serpentinized peridotites, and, because of a very characteristic knobby weathered surface, they have been called "knobby gabbros". These gabbros are underlain by andesite pillow lavas. (1). The pillows are of varying shapes, but generally afford good top and bottom features for the determination of strikes and dips.

A few pyritized black slate bands are found, which contain pyrrhotite, chalcopyrite and pyrite. Associated with these bands are very pronounced gossans, which appear from the air as rust brown areas. They are found as limonite deposits in valleys and small gulleys. They lie upon the glacial striated andisitic bedrock covering glacial faceted pebbles and boulders, and appear to be post pleistocene in age (Figs. 9 and 10).

(1) Andesite Pillow lavas: This term is a field classification term only.

Fig.9. Gossan deposits northwest of McNeil Lake of flat-lying beds of Limonite.

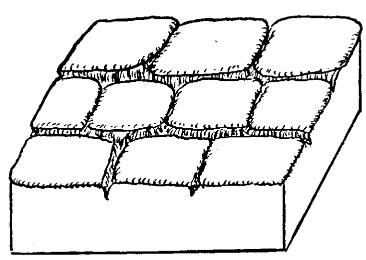
Fig.10. Gossan deposits of Limonite with glacial boulders in the foreground northwest of McNeil Lake.

PETROGRAPHY

Serpentinized Zone

Olivine-pyroxene Zone

The olivine-pyroxene member occurs in the eastern half of exposure number 1. The weathered surface is rust brown in color with a characteristic cuboidal weathering surface. This surface is due to differential weathering along minute fractures at right angles to one another (diag.). The fresh surface is a



Differential cuboidal weathering of the Olivine-pyroxene zone.

dark black green in color, and has a medium grained texture.

In thin section, rocks of the olivine-pyroxene member are a pale yellow green, with a medium-grained, inequigranular, hypidiomorphic texture.

Pigeonite is the principal pyroxene. It is identified by an index of 1.695 as determined by index oils, a 2V of 10-15°, and well developed pyroxene cleavage. The pigeonite grains have been altered to serpentine along their cleavage planes and around their crystal boundaries, with included magnetite freed by alteration of the pigeonite (Figs. 11 and 12). The larger pigeonite grains have a subhedral crystal outline, and often poikilitically enclose olivine grains. These olivine inclusions are $Fo_{80}Fa_{20}$ as determined by index oils. Enstatite with an index of 1.665 and parallel extinction, and augite ~~1 15~~ Fig. 15a, identified by pyroxene cleavage, + 2V of 55° and extinction of Z on C of 40° are present in minor amounts. These latter four minerals have also been highly serpentinized. Olivine grains of the same composition are also found outside the poikilitic intergrowths.

The alteration of the olivine grains outside the poikilitic intergrowths is more pronounced, and is characterized by a serpentine alteration ring around the remaining olivine grain as well as along the cleavage planes (Fig. 12). Many of these olivine grains have been completely serpentinized. Fresh olivine forms less than 1% of the olivine-pyroxene member. Fresh enstatite forms about 3%, and diopside less than 1%.

The serpentine minerals include antigorite, identified by its pale green color, fibrous structure and low relief. It is the most abundant mineral in the olivine-pyroxene zone, and occurs as fibrous aggregates and as well defined areas pseudomorphic after olivine and pyroxenes. The other serpentine mineral is seraphite (1), and is identified by its pale green color,

(1) Rogers & Kerr: Optical Mineralogy Pg.362

Fig.11. Pigeonite altered to Serpentine with secondary Magnetite from the Olivine-pyroxene zone area 1. 45x

Fig.12. Olivine with secondary Magnetite and Serpentine alteration around the Olivine grain and along the cleavage planes from the Olivine-Pyroxene zone area 1. 45x

massive structureless form and isotropism under crossed nichols. It occurs as cores surrounded by antigorite and as thin bands (Fig. 14). These two serpentine minerals form 50% of the Olivine-pyroxene zone.

Magnetite is scattered throughout the rock, and appears to have formed as a result of the serpentine alteration of the pyroxenes and olivine.

A mineral with a bright green color, small + 2V and isotropic under crossed nichols is present in minute amounts, and is probably garnierite (Fig. 15) (1). Another mineral, strongly pleochroic from pale yellow brown to golden brown, with + 2V of 15°, is also present, and is most likely xylotile (Fig.13) (1). A mineral showing the same pleochroism as the above xylotile, with a -2V of 25° and somewhat fibrous, is also found, and is probably bowlingite (2). These three minerals, garnierite, xylotite and bowlingite, are all found associated with the olivine, and are probably alteration products of that mineral. These colored minerals are present in less than 1%.

Heavy mineral separations were made on two samples from the olivine-pyroxene member of exposure number 1, using bromoform and methylene iodide. The rock was first crushed in a rotary crusher and then screened to a size of - 100 + 150 mesh. A magnet was used next on one of the samples to try ~~and~~ to separate the magnetite from the other minerals, but with little success. It

(1) Winchell & Winchell: Elements of Optical Mineralogy, part II, 4th ed., pg.379, pg. 380.
(2) Winchell & Winchell: Elements of Optical Mineralogy, Part II, 4th ed., pg. 399.

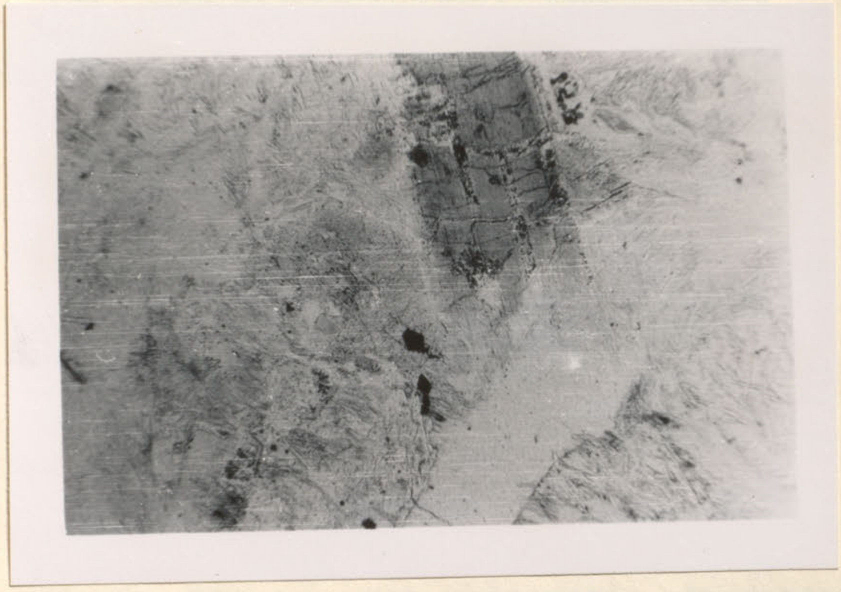


Fig.13 Xylotile grains with Magnetite from the Olivine-pyroxene zone area 1. 45x

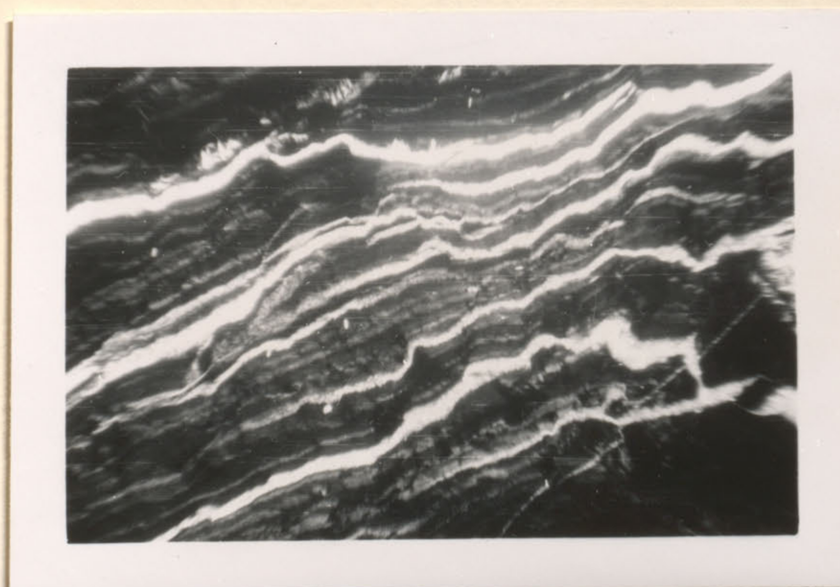


Fig.14, Banded Serpophite (dark) and Antigorite (light) under x nichols from the Serpentine zone area 1. 45x.

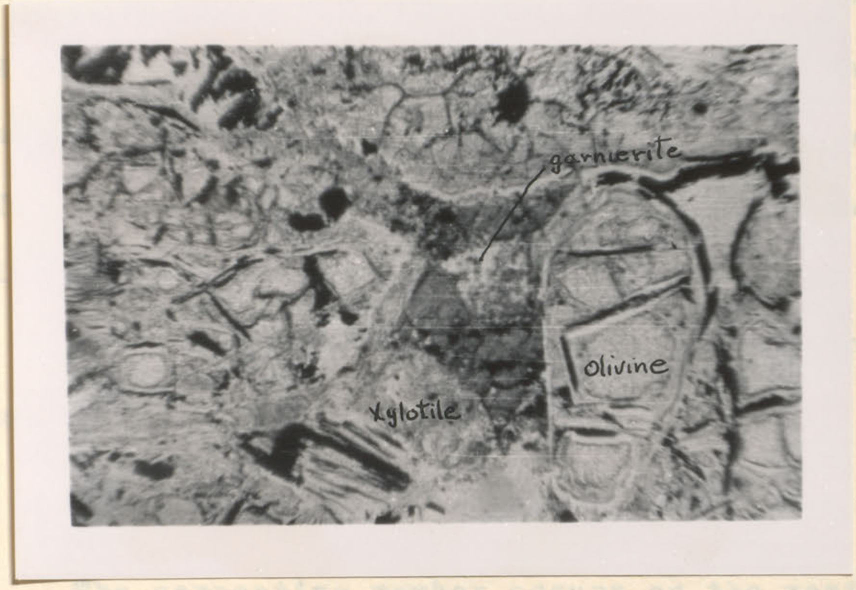


Fig.15. Olivine with Antigorite alteration rings and Garnierite and Xylotile grains from the Olivine_pyroxene zone area 1. 45x

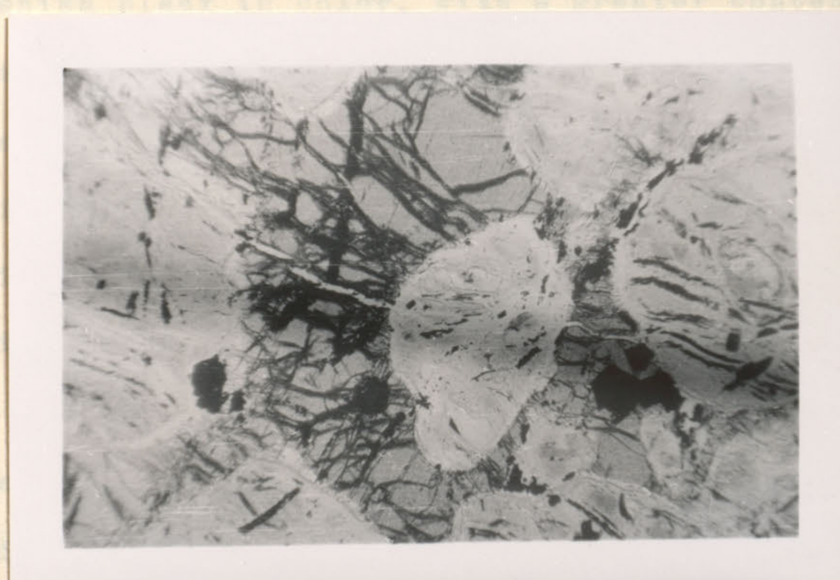


Fig.15a. Augite surrounding Olivine grains from the Pyroxene zone.area 1. 45x

was found that the serpentine minerals formed a mesh entrapping the magnetite and other minerals, and that when the magnetite was drawn off with the magnet the other minerals were caught with it. The second sample was treated first with bromoform, and secondly with methylene iodide, but no separation occurred. Again, it appears that the serpentine minerals formed a mesh, entrapping the other minerals.

Serpentine Zone

The serpentine member occurs on the western side of the olivine-pyroxene zone of exposure number 1 (Fig.14). The weathered surface is a rusty reddish brown color. Rock in this zone is distinguished from rock in the olivine-pyroxene zone by the absence of cuboidal weathering. The fresh surface of the rock is dark greenish black in color, with a greater content of green minerals than the olivine-pyroxene zone. Numerous mineralized fractures are found towards the western boundary of this zone; slickensides in these fractures indicate shearing. The fractures form no definite pattern. They have been filled with magnetite fibrous antigorite and serpophite (Fig.14).

In thin section, the rock of the serpentine zone is a pale green color, with a very fine-grained inequigranular allotriomorphic texture. The pyroxene grains often poikilitically endorse antigorite pseudomorphs of olivine. The pyroxene grains have also been highly altered to antigorite. The original pyroxene was probably pigeonite similar to that of the olivine-pyroxene group, but so little of it is left unaltered that it is difficult to identify. Much magnetite, the result of the serpentinization alteration is scattered throughout the rock, and amounts to about 7% of the serpentine rock member. The former presence of olivine is indicated by antigorite pseudomorphs after olivine. This form of antigorite is colorless to pale olive green in color.

Antigorite is the most abundant serpentine mineral occuring as a fibrous mass that forms 75% of the serpentine zone member. Scattered anhedral blobs of serpophite are also present, forming 4% of this member. Minor amounts of pennine are present; it is identified by its anomalous blue interference color, faint green pleochroism and parallel extinction.

The Actinolite Zone

The Actinolite Zone member occurs along the eastern contact of the number 1 exposure. The weathered surface is a buckskin color, and has a rough knobby-like surface. The fresh surface is a dark olivine green, with a coarse-grained texture.

In thin section the rock of the actinolite zone is a pale yellow green with a medium to coarse-grained inequigranular hypidiomorphic texture. As in the previous two zones, pigeonite is present but has been highly altered. The alteration is to a brown pleochroic hornblende, identified by its strong pleochroism, hornblende cleavage and - extinction angle of 25°. This hornblende is pseudomorphic after the pigeonite (Fig.16). Many of these brown hornblende grains are, in turn, altered to a fibrous actinolite mass. This actinolite mass (1) is recognized by its

(1) Rogers and Kerr: Optical Mineralogy, pg. 282.

fibrous form, negative biaxial character, and large optic angle (Figs. 17 and 18). Minor amounts of olivine similar in composition to that of the olivine-pyroxene zone member are present. These grains have been first serpentinized and then altered to actinolite. Evidence for this is seen in antigorite that replaces the olivine, and actinolite that replaces the antigorite. Olivine forms less than 1% of the actinolite zone member.

Brown hornblende forms 3% of the actinolite member, and very minor amounts of a green hornblende are also present. Pennine is found in larger amounts than in either of the two previous members, and amounts to approximately 10% of this member.

Colorless antigorite is the main serpentine mineral; Serpophite is minor in amount; magnetite, a result of the serpentinization of olivine and pyroxene, is scattered throughout the rock (Fig. 19)

The sequence of the olivine and pyroxene alteration is therefore as follows:

1. Olivine - serpentine - actinolite
2. Pyroxene - brown hornblende - actinolite

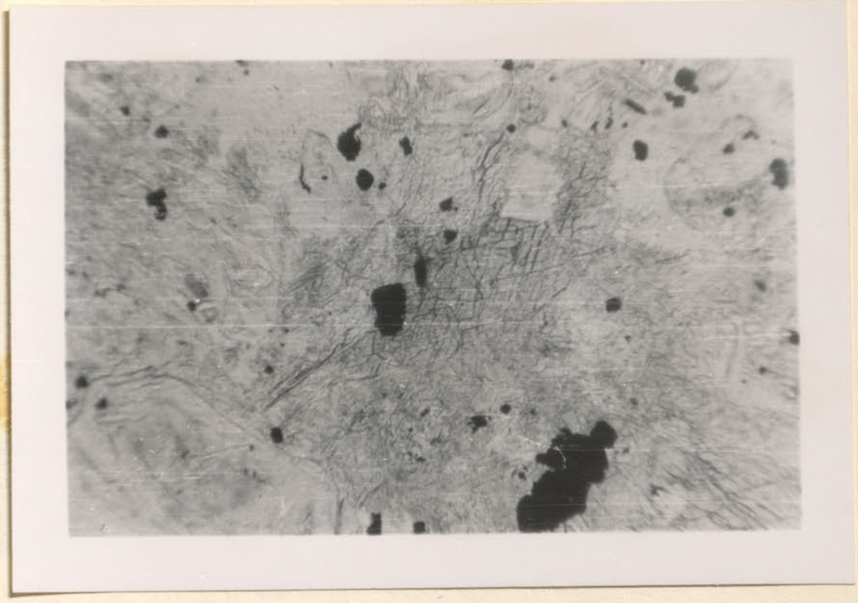


Fig 16. Browm Hornblende pseudomorphic after Pigeonite with Magnetite from the Actinolite zone area l. 45x

Fig.17. Actinolite grains under x nichols in the Tremolite zone area l. 45x.

Fig.18. Actinolite with magnetite in the actinolite zone area 1. 45x

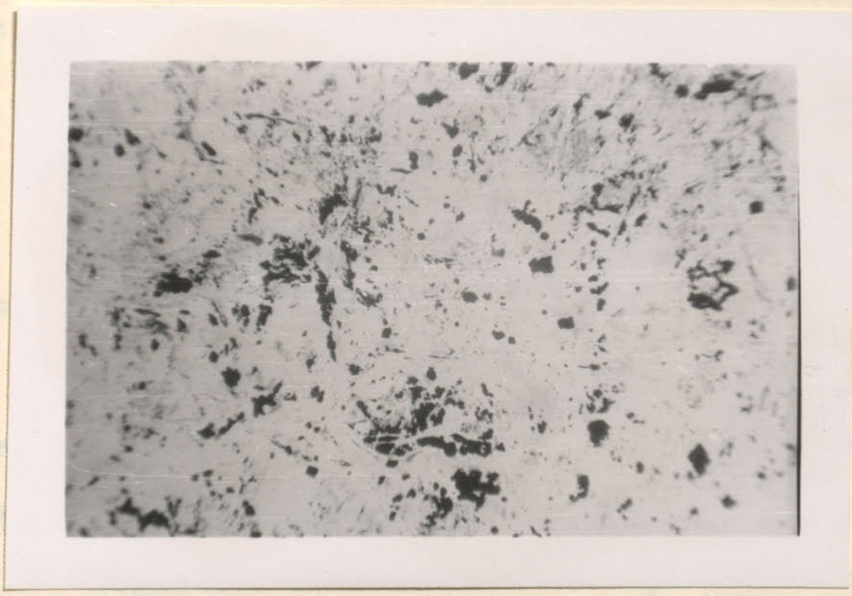


Fig.19. Scattered magnetite formed by serpentinization of olivine and pyroxene grains in the actinolite zone area 1. 45x

SERPENTINIZED PERIDOTITES of Area No.2

The Olivine-Pyroxene Zone

In the Griffis Lake map area the serpentinized peridotes of this zone occur over an outcrop width of 2500 feet, and are about 3 miles long.

The olivine-pyroxene member of this area is very similar to that of number 1 area, but a few differences are found. The cuboidal weathering feature, which is characteristic of the olivine-pyroxene zone of number 1 exposure, is absent in this exposure, but the weathered and fresh surface colors of the rock are the same.

Microscopic examination reveals that olivine similar in composition to that of area number 1 $(Fo_{80}Fa_{20})$ is present, but in smaller amounts. The pyroxene minerals are still the most abundant mineral. Pigeonite, similar in composition to that of number 1 area, is the dominant pyroxene. Augite is the other pyroxene mineral, and is identified by its high relief extinction angle of Z on C 40° and large + 2V of 60°. It is present only in minor amounts.

The serpentine minerals, forming 60% of this olivine-pyroxene zone member, are antigorite and serpophite. Very minor amounts of xylotite, bowlingite and garnierite are present.

Magnetite is scattered throughout the rock. Minor amounts of both pyrrhotite and pennine are present.

The Serpentine Zone

The serpentine zone member of area number 2 is a narrow band just west of the olivine-pyroxene zone. This serpentine member differs somewhat from the serpentine zone member of area number 1. As seen in thin section, most of the rock is a structureless mass of serpentine that appears almost completely isotropic under crossed nicols. The serpentine is principally serpophite, with a pale green color, but some colorless antigorite is also present. Pseudomorphs of pennine after a pyroxene are present. An amphibole is present and also some augite, but the alteration is so intense that their identifications are difficult. A few grains of a pyroxene mineral, which is probably pigeonite, are present, but the grains are highly serpentinized and difficult to identify.

Minor amounts of brown hornblende and actinolite are present. Magnetite is present, and is associated with the altered pyroxene and amphibole. It is limited in its distribution to the areas of the altered pyroxene and amphibole.

The Actinolite Zone

The actinolite zone member of area number 2 is located on its eastern contact with an andesite rock. It is almost identical with the actinolite zone of number 1 area, with olivine being altered to serpentine, and this serpentine altered to actinolite. Furthermore, the alteration of the pyroxenes has been the same, with the sequence as follows:

Pyroxene - brown hornblende - actinolite

Very minor amounts of a mineral have been found with a high relief, almost parallel extinction, and with a granular form that are probably epidote. Magnetite is also present as a result of the serpentinization alteration process.

THE TALC-CARBONATE ZONE

A talc-carbonate zone, from 1500 - 2500 feet wide follows along the anticlinal axis of the serpentinized peridotites of area number 1. At its southern end the zone swings eastwards through the serpentinized peridotites, into which it grades on either side. Farther eastwards it disappears into a drift-covered area, where it probably grades into the surrounding andesite lavas.

The talc-carbonate zone has been subdivided into four members on the basis of mineral content and position relative to the serpentinized peridotites of area number 1. These members are: 1. A western member located along the central section of the talc-carbonate zone between the two limbs of the serpentinized peridotite. This member contains no talc. 2. A southeast member located along the western border of the serpentinized peridotite at the southern end of the talc-carbonate zone, where it cuts through the serpentinized peridotite; this member contains talc. 3. A central member, which is in the central part of the talc-carbonate zone at its southern end, where it cuts through the serpentinized peridotites. This member is composed predominantly of talc and carbonate minerals. 4. An Eastern member found at the eastern edge of the talc-carbonate zone along its contact with the andesite lavas. This member contains much more feldspar than the other three members (Fig. 1).

The Western Member

The western member has a dark brown, earthy, weathered, surface, with solution pits up to ¼ inch wide and deep. The fresh surface has a pale grayish green color with large euhedral rhombic metacrysts up to ¼ inch in size, of a grayish white ankerite. These ankerite metacrysts weather at the surface to produce the pitting effect, and often contain limonite pseudomorphic after the ankerite. This ankerite was identified by index oil determinations, which gave indices of N_E 1.52 +, N_W 1.71. The ankerite has a fairly high content of iron, as shown by the limonite pseudomorphs at the weathered surface, and the presence of iron stains around some of the grains and along their cleavage planes, as may be seen in thin section. In thin section the ankerite metacrysts form about 45% of this member. Scattered flecks of a mineral that is isotropic under crossed nicols and pale yellowish white in reflected light is probably leucoxene. Associated with the leucoxene is a black metallic mineral that is probably ilmenite. These two minerals are present in minor amounts, and form less than 1% of the member.

The ankerite metacrysts are set in a fine-grained pale green ground mass of anhedral crystals, which consists of a more or less felted mass of chlorite, quartz and feldspar, with scattered grains of pyrite. The quartz was identified by its low relief and + uniaxial interference figure, the chlorite by the green pleochroism, and the feldspar by the carlsbad twining. The feldspar grains have a fairly large -2V, indices slightly greater than balsam, and are therefore probably of andesine composition. The exact determination of the feldspar optically is not possible, because of the extremely small grain size and the limited amount present.

The Southeastern Member

The southeastern member has a pitted dark grayish green weathered surface with pseudomorphs of limonite after ankerite, similar to the previously described western member. On the fresh surface conspicuous ankerite metacrysts up to 1/3 inch in size are present. This ankerite has a higher content of iron than the ankerite in the previous member. This is indicated by the presence of a rust stain around the crystal boundaries and along the cleavage planes, and by a higher relief. Higher indices of refraction were found, by the use of index oils, to be N_E 1.53, N_W 1.725 +. In addition to the ankerite metacrysts, scattered octahedral and pyritohedral crystals of pyrite are present, which weather at the surface to give pseudomorphs of limonite. The ankerite forms approximately 45% of this member. Minor amounts of magnesite, with indices of N_E 1.52 N_W 1.73, are present. Traces of a carbonate mineral, with indices greater than 1.80, are present, and are probably siderite.

Talc is abundant in this member, forming about 30% of it, and is identified in the hand specimen by its soapy feeling, and in thin section by its fibrous habit and high birefringence. It is associated with the carbonate minerals. Chlorite is present to the extent of about 10%. The talc and chlorite form the groundmass of the rock in this member.

The Central Member

The central member is composed almost entirely of carbonate minerals and talc. Ankerite, similar in composition to that in the previous members, is the most abundant carbonate, and forms about 80% of the rock. It has a lower content of iron than the Southeastern member, for only a few grains have iron stains along their cleavage planes. For this reason it is probably more closely allied with dolomite in composition. The grains range from 0.2 mm to 2.0 mm in size.

Talc forms about 10% of the rock in this member. It occurs in the talc and antigorite ground mass as a replacement of antigorite. Because of this alteration of antigorite to talc, the ground mass has a fine-grained felted, fibrous texture. Minor amounts of spherulitic chlorite are associated with the talc and antigorite, Small patches of limonite pseudomorphic after pyrite, are present and a few grains of pyrite are also present.

<u>The Eastern Member</u>

The eastern member has a rust brown, unpitted, weathered surface, and a grayish white fresh surface, with small black mafic minerals, giving the fresh surface a salt and pepper appearance. In thin section the rock has a fine-grained inequigranular texture. Half of the rock is a fine-grained anhedral mass of ankerite and dolomite, similar in composition to the previous members. The carbonates replace the feldspar grains. These are of andesine composition $Ab_6\ An_4$, identified by extinction angles of combined carlsbad-albite twinning of $+\ 10^{\circ}$. Andesine forms about 43% of this rock member. Minor amounts of quartz (about 2%) and chlorite (3%) are present. Leucoxene and ilmenite are present to the extent of about 2%.

Chapter VI.

PETROLOGY OF THE SERPENTINIZED PERIDOTITES

The Term "Serpentinized Peridotite"

Johannsen (1) has discussed the usuage of the term peridotite as follows:

> "The term peridotite was first used by Cordier. He regarded it as a rock composed of labradorite peridot, augite and ilmenite. In the sense of olivine-bearing, feldspar free rocks it was first used by Rosenbusch, and subsequently by all other writers".

The serpentinized rocks of the Griffis Lake map area have been classified as peridotites because they were originally composed entirely of olivine and pyroxene minerals. Later serpentinization has altered the olivine and pyroxene grains considerably, and thus the name "Serpentinized Peridotites" is used to describe them.

ORIGIN AND HISTORY OF THE SERPENTINIZED PERIDOTITES

There is considerable difference of opinion as to the origin of peridotites. According to Bowen (2), most rocks made up of orthorhombic pyroxene were formed as the result of local accumulations of crystals of one kind from a magma of complex constitution, and not directly from melts of their own composition. He regards the peridotites as rafts of solid crystals, containing no more interstitial liquid than that sufficent to permit of their injection. J.H. Vogt (3), though familiar with

(1) Johannsen, A: Petrography, Vol.IV, pg.401.
(2) Bowen, N.L. and Schairer, J.F: The System MgO-FeO-SiO_2, Am. Jour. Sci.,5th Series, Vol.XXIX, pp.151-217.
(3) Vogt, J.H; Videns-Skrifter, Christiania (Oslo) Kl I,1924, No.15, p.14.

Bowen's theory, insisted, because of field relations, that certain ultra mafic rocks are the products of ultra mafic magmas, and are not differentiation accumulations of a basaltic magma, as suggested by Bowen. Daly (1) agrees with Bowen, saying:

> "Crystal fractionation of basaltic magma has been responsible for many peridotitic bodies. Simple gravity seems to have been a sufficient cause of accumulation of the heavy silicates".

Because of the association of the serpentinized peridotites with the fairly thick series of Doublet lavas, the writer is of the opinion that the peridotite was probably derived by differentiation at the source of the Doublet lavas in their magma chamber. This is in line with Bowen's and Daly's ideas, but only the close association of peridotite and lavas can be used as evidence.

The serpentinized peridotites of the Griffis Lake area lack the more obvious features of flow rocks, such as pillow structures, flow structures and amygdaloidal structures. They have a coarse to medium-grained inequigranular texture, and are 400-500 feet thick. They thus appear to have been intruded as a sill of magma of ultra mafic composition, and consolidated slowly. Solutions from the residual liquids of this magma containing less water than normal hydrothermal solutions, called hypohydrous solutions by Hess (2), produced serpentinization of the peridotite, forming the serpentine zones adjacent to the olivine-pyroxene zone,

(1) Daly, R.A: Igneous Rocks and the Depth of the Earth, pg.551.
(2) Hess, H.H: The problem of Serpentinization and the Origin of certain Chrysolite Asbestos Talc and Soapstone Deposits, Ecom. Geol., Vol.XXVIII, pg.655.

and also serpentinizing the olivine-pyroxene zone. The area was then subjected to deformational stresses, which folded and faulted the serpentinized peridotite sill into its present shape.

Hydrothermal solutions from the parent magma chamber followed the shear zone along the anticlinal axis, altering the adjacent serpentinized peridotite progressively from the fracture zone outwards. This produced the talc-carbonate zone along the shear zone, and the actinolite zone outwards from the talc-carbonate zone.

The serpentinized peridotites of the Griffis Lake area have undergone two cycles of crystallization. The first cycle is characterized by pyrogenetic and hypothermal crystallization, and the second cycle by hydrothermal alteration (dia's.).

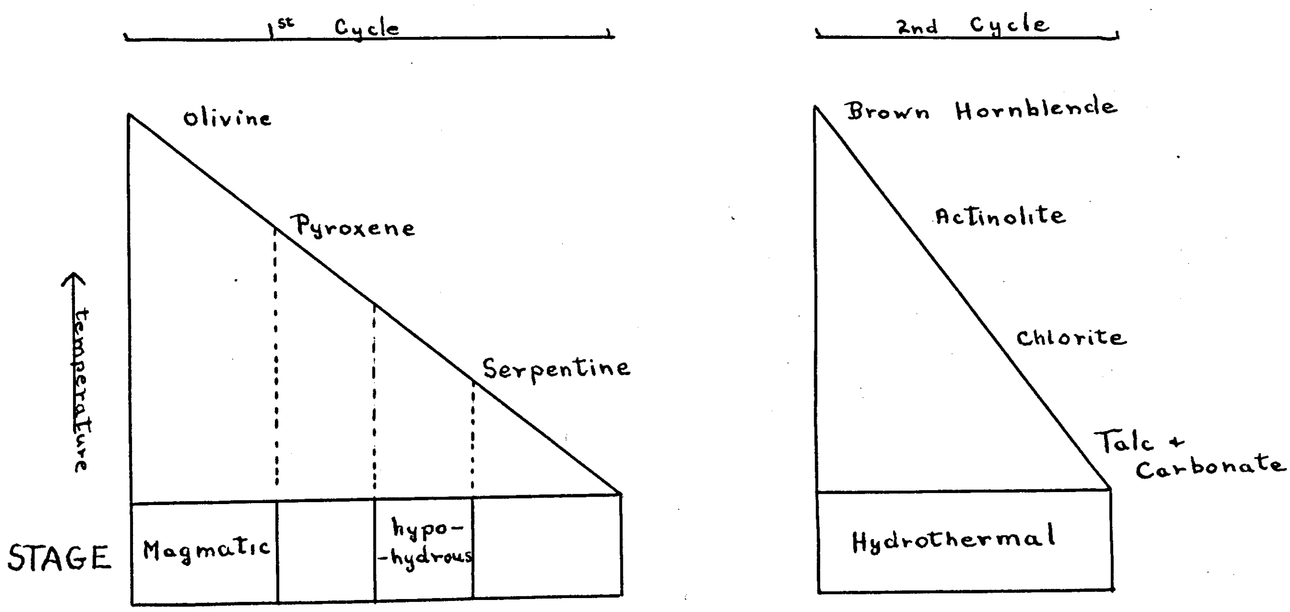


Diagram showing mineral succession for both the cycle of pyrogenetic and hypothermal crystallization and the later cycle of hydrothermal alteration with decreasing temp. (1).

(1) Hess, H.H: The Problem of Serpentinization and the Origin of certain Chrysolite, Asbestos, talc and Soapstone Deposits Econ. Geol. Vol. XXVIII.

In the magmatic stage of the first cycle the pyroxene grains are poikilitic, with inclusions of olivine, serpentinized olivine, bowlingite, xylotite and garnierite. The olivine grains have therefore crystallized first and the pyroxenes second. The olivine and pyroxene grains have then been attached by residual liquids present in the interstices between the grains. Altering the olivine and pyroxene crystals to serpentine, with the formation of magnetite as a decomposition product. This stage is called the serpentinization or hypohydrous stage. Evidence of these two stages is found in the olivine-pyroxene zone and serpentine zone of area number 1. At the end of the first cycle the serpentinized peridotites were probably completely consolidated.

Subsequent to this cycle of magmatic intrusion and serpentinization, the serpentinized peridotites were folded and faulted. Hydrothermal solutions entered along the shear zones and the second cycle, characterized by steatitization, commenced. The alteration produced by the hydrothermal solutions was confined predominantly to the eastern limb of area number 1 because of its relative stratigraphic position above the shear zone, the hydrothermal solutions rising into it.

Because of the presence of brown hornblende, actinolite and chlorite, the actinolite zone represents the high temperature phase of the steatitization processes. As the shear zone is approached the brown hornblende disappears, and chlorite and actinolite are predominant, indicating a decrease in temperature. Along the shear zone the predominant minerals are carbonates and talc, with a few grains of chlorite. This mineral assemblage represents the low temperature phase of the steatitization process. The order of crystallization in the second cycle with decreasing temperature has therefore been: 1. brown hornblende; 2. actinolite; 3. chlorite, talc and carbonates.

Theories of Serpentinization

Hess (1) concludes that serpentinization is an auto-metamorphic reaction whereby olivine crystals, immersed in a residual magmatic liquid consisting of a highly concentrated aqueous solution of silica, react with and completely absorb the latter to give a volume of serpentine almost exactly equal to that previously occupied by olivine plus liquid. Turner disagrees with this idea because of certain microstructural characters widely prevalent in serpentinized peridotites. He says (2):

> "In normal serpentinites, kernels of serpophite are set in an interlacing network of veinlets of fibrous chrysotile, which are usually interpreted as infilled cracks or as metasomatic replacements developed from cracks. On this assumption there must have been a stage when the rock consisted of residual olivine kernels enmeshed in a chrysotile network, to the exclusion of any liquid other than a possible intergranular film of small total volume. Serpentinization beyond this stage cannot be explained on the basis of the mechanism suggested by Hess".

Because the serpentinized peridotites of the Griffis Lake area do not show Turner's microstructural characteristics, the writer is of the opinion that the serpentinized peridotites have been formed by autometamorphic processes, where the residual solutions of magmatic origin have been more concentrated in one zone and have produced the serpentine zone, and have been less concentrated in such other zones as are characterized by the partly serpentinized olivine-pyroxene zone.

(1) Hess, H.H.: The problem of Serpentinization and the Origin of certain Chrysotile, Asbestos, Talc and Soapstone Deposits, Econ Geology, Vol.XXVIII, pg.634-657

(2) Turner, F.J.: Mineralogical and structural Evolution of the Metamorphic Rocks, Mem. 30, Geol. Soc. of Am., pg.131.

Hess (1) has given three main chemical reactions for the formation of serpentine:

(1) Forsterite $3Mg_2 SiO_4$ + SiO_2 + $4H_2O$ → Serpentine $2H_4 Mg_3 Si_2 O_9$

(2) Forsterite $Mg_2 SiO_4$ + Enstatite $Mg SiO_3$ + $2H_2O$ → Serpentine $H_4 Mg_3 Si_2 O_9$

(3) $3Mg_3 FeSi_2O_8$ + $6H_2O$ + O_2 → Serpentine $3H_4 Mg_3 Si_2 O_9$ + Magnetite $Fe_3 O_4$

Hess believes that reaction (1) accounts for practically all of the serpentine formed, and that reactions (2) and (3) contribute a small fraction of the serpentine. Because of the abundance of magnetite as an alteration product of serpentinization in the Griffis Lake serpentinized peritotites, the writer is of the opinion that reaction (3) of Hess's played a more prominent role than Hess attributes to it. The water for the serpentinization reactions has been largely derived from the ultrabasic magma itself, although some of it may have been derived from the surrounding Doublet Series of pillow-lavas.

A Theory of Steatitization

Hess (2) says there are two distinct types of deposits showing the characteristic hornblende, actinolite, chlorite,

(1) Hess, H.H.: The Problem of Serpentinization, Econ. Geol. Vol. XXVIII, pg. 652.
(2) Hess, H.H.: The Problem of Serpentinization and the Origin of certain Chrysotile Asbestos, talc and Soapstone Deposits, Econ. Geol., Vol.XXVIII, pgs. 634-657.

talc-carbonate stages of steatitization. One type is best represented by such rocks as the Virginia Soapstones, where the whole mass of the ultra basic has been altered through a number of mineral facies, with little or no change of chemical composition, the reaction taking place essentially in a closed system. In the second type of deposit, the solutions attack the ultrabasic along its margin and along fractures within it, producing an intense alteration, but not affecting very much the bulk of the intrusive. The reactions are essentially taking place in an open system. Concentration of pure talc may result from this type of alteration.

The talc-carbonate zone of the serpentinized peridotites of the Griffis Lake area is very similar to Hess's second type of deposit, because in it the alteration has occurred along a shear zone, and has not affected the bulk of the serpentinized peridotite to any great extent. The width of the talc-carbonate zone is 1500 feet, as against an exposure width of 5000 feet for the serpentinized peridotite on the eastern limb of area number 1.

Chapter 7.

SUMMARY AND CONCLUSIONS

In this paper the serpentinized peridotites of the Griffis Lake Map area have been described petrographically, and their petrology has been discussed. A brief description of the Dyke Lake Map area, abstracted from information in the possession of Labrador Mining and Exploration Company, Limited, was included to give the reader a general idea of the regional geology. The writer's conclusions are listed below in tabular form:

1. The serpentinized peridotites have been divided into two main zones on the basis of mineral content; (1) The serpentinized zone, characterized by an abundance of minerals of the serpentine group; and (2) The talc-carbonate zone, characterized by an abundance of talc and carbonate minerals.

2. The serpentinized zone is further subdivided into three minor zones on the basis of mineral content: (1). Olivine-pyroxene zone; (2). Serpentine zone, and (3). The actinolite zone. This zoning, though indistinct, can be seen in the field. The olivine-pyroxene zone has a relatively black fresh surface and a pronounced cuboidal weathering joint system as distinct from the other two zones. The serpentine zone and actinolite zone can rarely be distinguished in the field except for geographical position with

relation to the contacts and the olivine-pyroxene zone. The actinolite zone is located along the contacts of the serpentinized peridotites with the talc-carbonate zone and the underlying knobby gabbros. The serpentine zone lies between the actinolite zone and the olivine-pyroxene zone.

3. The talc-carbonate zone has been subdivided into four members on the basis of geographical position: (1) Western ~~Central~~ member; (2) South east member; (3) Central member, and (4) the eastern member.

4. The serpentinized peridotites appear to constitute an ultramafic differentiate from the same deep magma Chamber in which the Doublet Series of lavas originated.

5. Field relationships and distribution indicate that the serpentinized peridotites are intrusive sill-like bodies. They were intruded previous to deformation in the Griffis Lake Map area as a normal peridotite magma. Deformation produced a shear zone, along which hydrothermal solutions entered, altering the serpentinized peridotite to a talc-carbonate rock.

6. Thin section studies of the serpentinization zone show that the order of crystallization has been olivine, pyroxene, serpentine. The olivine and pyroxene minerals crystallized in the magmatic state, the serpentine minerals being the residual hypohydrous solution

alteration products. The magmatic crystallization and serpentinization are classed as the first cycle of crystallization.

7. Thin section studies of the talc-carbonate zone and actinolite zone indicate that these two zones have been produced by hydrothermal alteration of the serpentinized peridotite. The talc-carbonate zone is the low temperature phase, the actinolite zone the high temperature phase. The hydrothermal solution alterations form the second cycle of crystallization, and involves steatitization.

8. The serpentinization of the peridotite appears to be an autometamorphic reaction.

9. The talc-carbonate zone is similar to Hess's second type of deposit, where the hydrothermal solutions attack the ultrabasic along its margins and along fractures within it, producing an intense alteration, but not affecting the bulk of the intrusive to any great extent.

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Fig 1.

Fig.2.

Fig 8

Canada

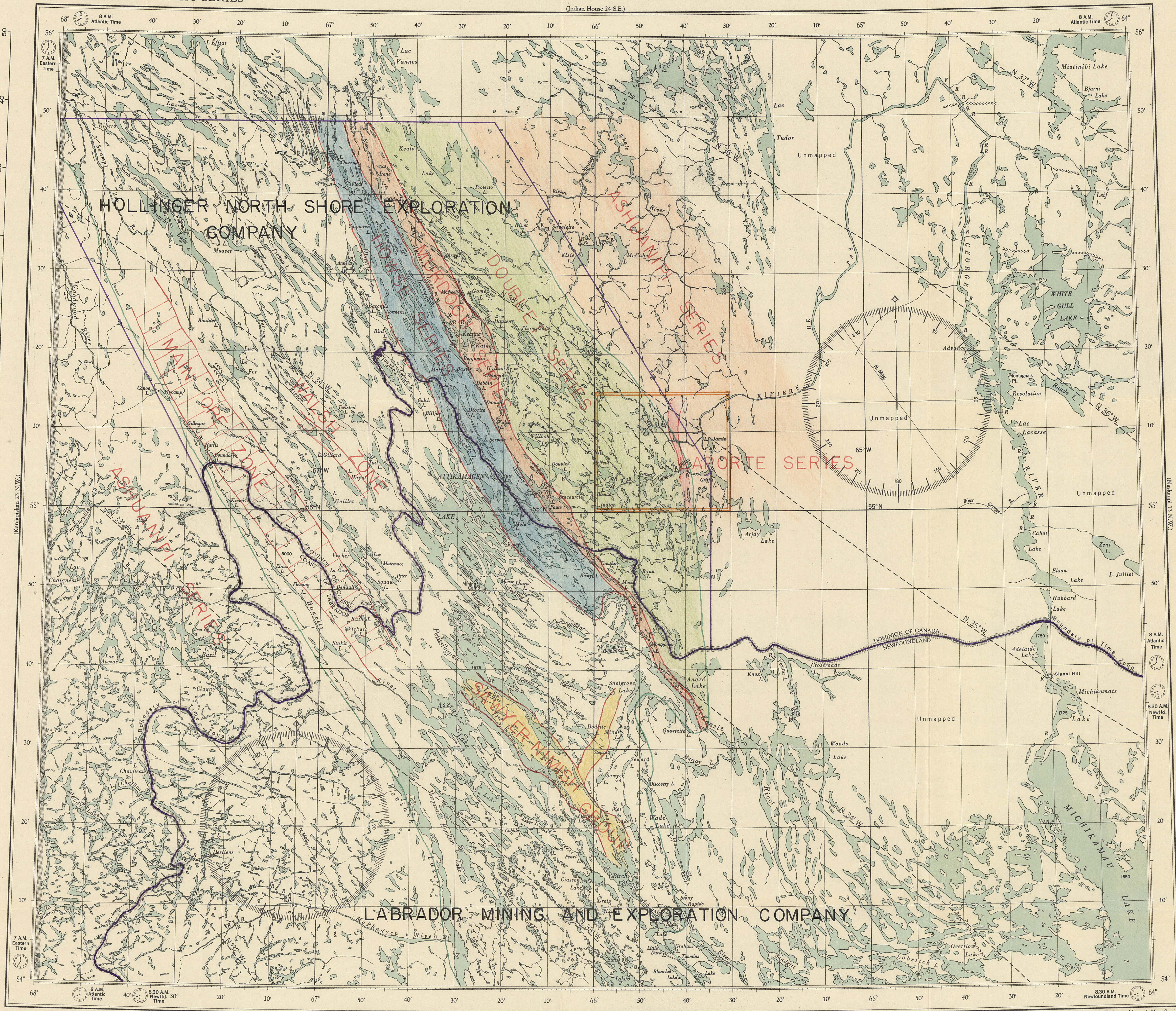
Department of Mines and Resources

SURVEYS AND ENGINEERING BRANCH

HYDROGRAPHIC AND MAP SERVICE

DYKE LAKE | DYKE LAKE
NATIONAL TOPOGRAPHIC SERIES | SHEET 23 N.E.

(Indian House 24 S.E.)



LEGEND

BOUNDARY OF ROCK SERIES

BOUNDARY OF CONCESSION

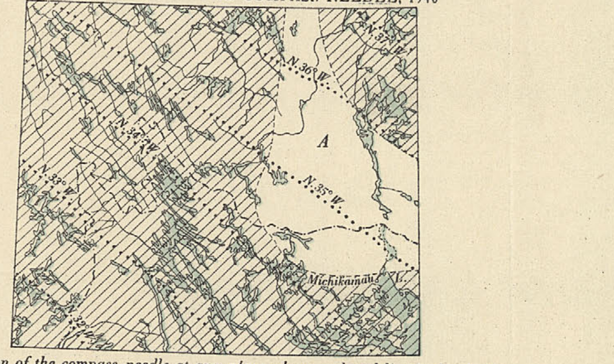
BOUNDARY OF LABRADOR TROUGH

OUTLINE OF ORE ZONE

GRIFFIS LAKE MAP AREA

DYKE LAKE | DYKE LAKE

THE DECLINATION OF THE COMPASS NEEDLE, 1940



The declination of the compass needle at any place along a dotted line is the declination given on that dotted line. At other places the declination is between those given on the neighbouring dotted lines; thus at the place marked A, the declination is between N. 35° W. and N. 36° W.

The declination of the compass needle is decreasing 5 minutes annually.

Where the magnetic declination is westerly it is added to the true course to obtain the magnetic course; easterly declinations are subtracted.

Aerial photography

Transverse Mercator Projection; on each map scale errors are negligible, and great circles may be taken as straight lines.

REFERENCE

Boundary: international (approximate)	
Rapids and falls	
Height in feet (approximate)	1725
Lines of equal magnetic declination	(1940) N. 35° W.
Esker	< < < < <

(Ashuanipi 23 S.E.)

AERONAUTICAL EDITION

DYKE LAKE

QUEBEC-COAST OF LABRADOR

(PRELIMINARY EDITION)

Scale 8 miles to 1 inch or 1:506,880

Miles 8 6 4 2 0 8 16 24 32 Miles

Datum is mean sea level

Reliable information concerning additions or corrections to this map is invited by the Hydrographic and Map Service, Labelle Building, Ottawa.

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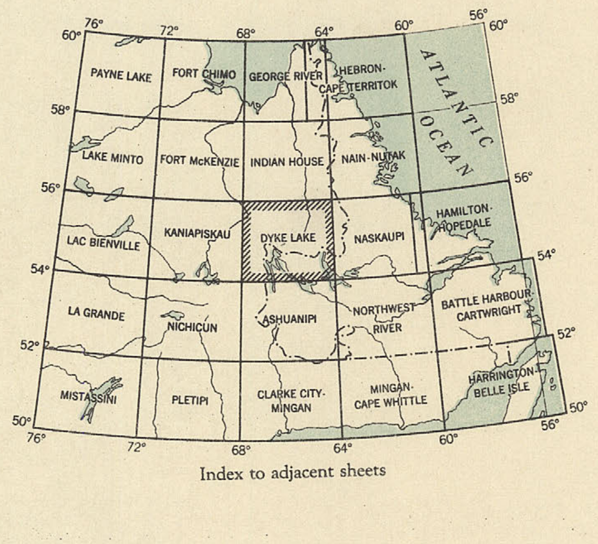

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SHEET 23 N.E.

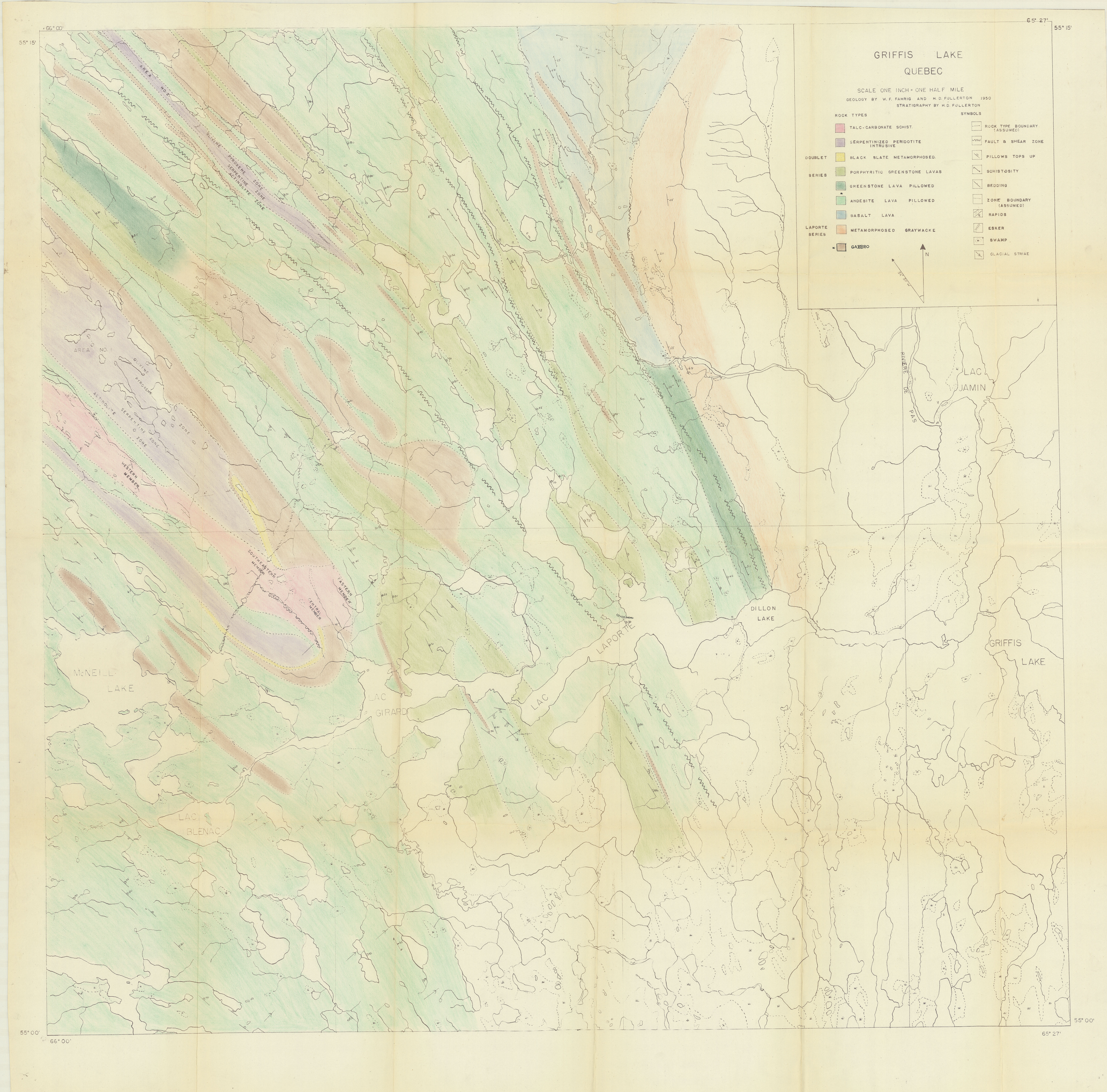
GRIFFIS LAKE
QUEBEC
SCALE ONE INCH = ONE HALF MILE
GEOLOGY BY W. F. FAHRIG AND H. D. FULLERTON 1950
STRATIGRAPHY BY H. D. FULLERTON
ROCK TYPES
TALC-CARBONATE SCHIST.
SERPENTINIZED PERIDOTITE INTRUSIVE
DOUBLET SERIES
BLACK SLATE METAMORPHOSED.
PORPHYRITIC GREENSTONE LAVAS
GREENSTONE LAVA PILLOWED
ANDESITE LAVA PILLOWED
BASALT LAVA
LAPORTE SERIES
METAMORPHOSED GRAYWACKE
GABBRO
SYMBOLS
ROCK TYPE BOUNDARY (ASSUMED)
FAULT & SHEAR ZONE
PILLOWS TOPS UP
SCHISTOSITY
BEDDING
ZONE BOUNDARY (ASSUMED)
RAPIDS
ESKER
SWAMP
GLACIAL STRIAE
N
66° 00'
65° 27'
55° 15'
55° 00'
LAC JAMIN
RIVIERE DE PAS
DILLON LAKE
GRIFFIS LAKE
LAC LAPORTE
LAC GIRARD
McNEILL LAKE
LAC BLENAC
AREA NO. 1
AREA NO. 2

TABLE OF FORMATIONS*

DYKE LAKE SHEET

Rock Types underlined are believed to be the predominant members

UNCONSOLIDATED MATERIAL

Glacial till, gravel, sands, minor clay, eskers and drumlins, terraces. Gossans, bog iron and manganese ore.

CAMBRIAN ?

SANDGIRT SERIES

- **SIMS QUARTZITE** — Quartzite, grit and conglomerate (Flat lying?) Sandstone

MONTAGNAIS INTRUSIVES (KEWEENAWAN?)

- Diorite, gabbro, pyroxenite and related types – Diabase, diorite porphyry, syenite dikes.
- Diorite, gabbro, pyroxenite and related types – Sulphide mineralization – "feldspathic" diorite
- Diorite, gabbro and related types. Serpentinite – Sulphide mineralization.

KANIAPISKAU (HURONIAN)

POINT SERIES (UPPER HURONIAN, POSSIBLY KEWEENAWAN)

- **MENIHEK SLATES** — Grey and black slates, shale, conglomerate, minor narrow arenaceous and calcareous beds, dolomite
- **SAWYER-NIMISH GROUP** — Jasper conglomerate, banded jasper iron formation, grey quartzite, shale and greywacke with Nimish Volcanics

HOWSE SERIES — Slate, carbonaceous shale, greywacke, quartzite, conglomerate, iron formation, volcanics.

DOUBLET SERIES — Pillowed and massive lavas. Greenstones, tuffs, greywacke, quartzite and slate

RELATIVE AGE OF HOWSE AND DOUBLET SERIES IS UNKNOWN. BOTH MAY BE NACHIKOPI (BELOW)

UNCONFORMITY?

FERRIMAN SERIES (MIDDLE HURONIAN?)

- **SOKOMAN IRON FORMATION**
  - IRON ORE-MANGANESE ORE
  - SOKOMAN Chert
  - Hematite quartzite
  - Slaty iron formation
  - Conglomeratic iron formation
  - Banded Jasper and chert iron formation
  - Cherty iron carbonate
  - Magnetite greywacke
  - Greenalite greywacke
- **NIMISH VOLCANICS**
- **RUTH SLATE** — Ferruginous slate, slaty iron formation, black and brown slate, carbonaceous slate, shale. Locally enriched to ore.
- **WISHART QUARTZITE** — Chert, quartzite, sandstone, greywacke, calcareous grit, conglomerate.
- **FLEMING CHERT BRECCIA** — Chert breccia with minor lenses of chert, shale and slate.

UNCONFORMITY?

HAMILTON RIVER SERIES (LOWER HURONIAN?)

- **DENAULT DOLOMITE** — Dolomite, limestone and cherty facies, fragmental dolomite, N.B. -Locally interbedded with Attikamagen shales near contact and in part probably contemporaneous
- **NIMISH VOLCANICS**
- **ATTIKAMAGEN SHALES** — Green, grey, red and black shales, slates, graphitic slates, phyllites, argillite. Some relatively narrow arenaceous and calcareous beds
- **SEWARD GRITS** — Grits, arkose, conglomerate, white or pink quartzite, greywacke

WALSH INTRUSIVES (ALGOMAN?)

- Syenite, granite, diorite, felsite porphyry – intrusives show foliation
- Intrusives not observed cutting these rocks

NACHIKOPI (KEEWATIN?)

KANIAPISKAU-NACHIKOPI CONTACT NOT OBSERVED

MURDOCH SERIES — Chloritized pyroclastics and clastics, lavas.

LAPORTE SERIES — Biotite rich and chloritized sediments.

ASHUANIPI SERIES (GRENVILLE TYPE)

ANCIENT BASEMENT COMPLEX

Ortho and paragneiss intruded by a wide range of acidic and basic rocks of unknown age. granite, pegmatite, syenite, diorite, gabbro, anorthosite, pyroxenite