Canica-Cawatose Map Area

by

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Introduction

The Canica-Cawatose area is from 47° 15' N to 47° 30' N latitude, and from 76° 55' W to 77° 20' W longitude, and is thus between the gold bearing district of the Abitibi and the Grenville subprovince as characteristically exposed near Mount Laurier. G.K. Lowther[1] has mapped Keewatin-type and Temiskaming-type rocks characteristic of the Abitibi zone in the Villebon-Denain area at a locality only twenty miles north of the northern boundry of the map area here described. Similarly, J.A. Retty[2] has shown Grenville-type paragneisses ten miles east of the eastern margin of the map accompanying this report. Differences in the characteristic of the typical rocks of the Abitibi and the Grenville sub-province are at once obvious to the observer, and what is economically more significant is the apparent differences in the mineral deposits of the two subprovinces. It is desirable that the presence of the mineral deposits either similar to, or different from those of Abitibi, should be established in this section of Quebec. Although it would be gratifying, indeed,

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(1) Lowther, G.K., Villebon-Denain Map Area, QBM 1935, C Map 345

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(2) Retty, J.P., Upper Gatineau Region, QBM 1933, C Map 301

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to find economic deposits in the area, the fact that a region has proven barren so far is also useful in guiding prospectors to sections of the province where their labours are likely to be rewarded.

Reconnaissance surveys and the fragmentary data available at the beginning of the work showed that it was improbable that the mapping of one sheet would enable definite answers to be made to questions that might be raised based on the preceding paragraph. The mapping of several sheets in this region may ultimately enable the questions to be answered. In the meantime, the conclusions presented herein must be regarded as tentative. The work completed shows that the present area is not favorable for deposits of metallic minerals, but additional information may change this conclusion, and it would certainly be hazardous to advise prospectors to avoid regions such as this because of information gathered in one season.

There was yet another reason for choosing this sheet for study. The Quebec Streams Commission is constructing a dam to raise the water level in part of the area here mapped. Many exposures will be covered and the information from them would never be available for examination. A map with this report shows an outline of the area to be flooded.

Acknowledgments

This thesis is based on work done for the Quebec Department of Mines during the summer of 1946. R.D.Hutchinson, H.B.Lyall and P.Duguay acted as field assistants, A.Turenne and A.Allen as canoemen, and Z.Brodeur as cook.

Dr. F.F. Osborne directed the fieldwork and the preparation of this thesis. Mr. Gagon and Mr. Cousineau of the Quebec Streams Commission furnished the data on the depth of lakes and the outline of the proposed flooding.

Access

The region is easy of access: the Mount Laurier-Senneterre highway (58) cuts diagonally across the extreme eastern part of the map sheet. Camp Dorval, which is 117 miles from Mount Laurier and 71 miles from Val-d'Or, is a convenient base for operation in this area. During the summer, two northbound and two southbound busses passed Camp Dorval daily. At Camp Dorval canoes may be placed in a lake draining into the Ottawa, and from there water routes make all parts of the area accessible. The elevation of the Ottawa River is 1105, and very few of the larger lakes are as much as thirty feet higher than this, so that rapids and falls are not numerous and few portages on the main streams are as long as a mile. Reference to the map accompanying this report will show the main routes together with alternate routes. The fire prevention signs, placed at portages, on the tips of islands, and on headlands, are helpful in marking the canoe routes on the lakes.

Only one route calls for comment because part of it is beyond the limits of the map. Camp Dorval is on Lake Soulier, also known as Lake Desmarais, and a route to Birch Lake is to proceed northwards on this lake to enter the Ottawa River near the section of fast water then go down stream beneath the highway bridge to the east end of Lake Dozois, then south and up the Camitogama River to Birch Lake. The distance from Camp Dorval to the middle of Birch Lake is approximately thirty miles. About seven miles of this distance may be saved by putting canoes in the Ottawa River at the highway bridge.

Climate

Inasmuch as the road from Mount Laurier to Senneterre has recently opened the Canica-Cawatose region, it is pertinent to give some data on the climate. Data from the two stations, one southeast and the other north-west of the area, have yeilded observations for about six years. The observations at Grand Lake Victoria are from August 1939 to October 1946 and those at Cabonga Reservoir are from August 1929 to October 1946. Inasmuch as the stations are equidistant from this region under consideration, the mean of the observations is thought to represent the climate of the Canica-Cawatose area.

The observations are reduced to a graphical form in Figure 1 and Figure 2, which shows the mean monthly temperatures together with the highest and lowest temperatures for the corresponding month. Only a few comments are called for: The highest temperature is 99° F. recorded at the Cabonga station in July. The lowest is -53°F. in February at Grand Lake Victoria station. The computed mean annual temperature is 36° F.

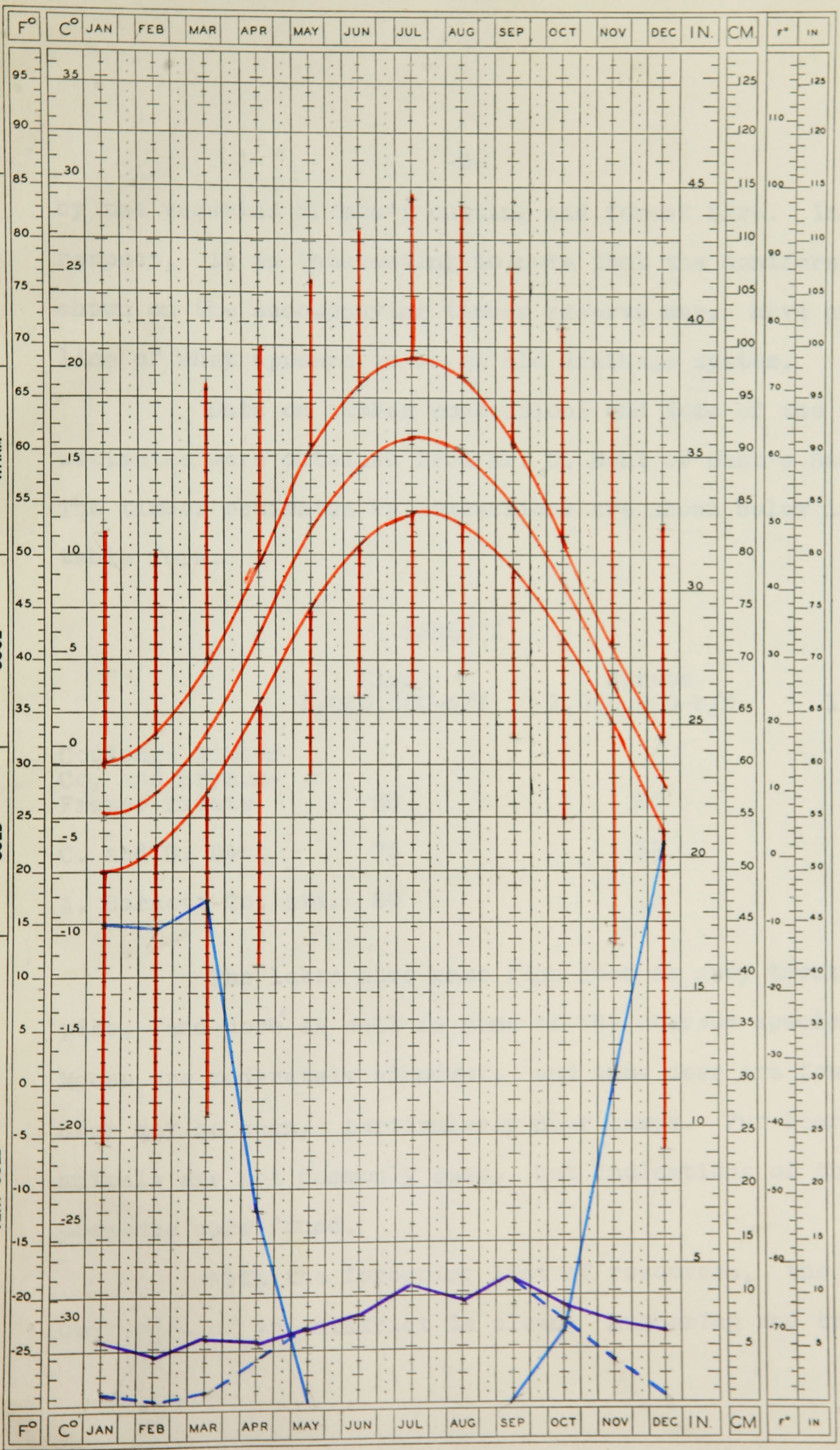
Graphs showing the precipitation are plotted on the temperature charts. On them the snow and the water equivalent of snow are plotted. The months of maximum snowfall are December, January, and February. The months of maximum rainfall are July, August, and September. Snow fluries have been recorded in May and September.

The climate is the type termed "continental" with a short growing season. Frost may occur in any month of the year. This killing frost restricts the potentialities of the region for agriculture, but does not prevent its utilization as a summer resort, for the summer temperature is appreciably lower than that of Montreal, Ottawa, and Toronto.

Resources

The potential resources of this district are far from developed. Parts of the area within reasonable distances of water were logged about half a century ago. Only white and red pine were removed. Little cutting has been done since, but in many places forest fires have exacted a greater toll than the lumber jacks. White, red, and jack pine, balsam, and black spruce are the principal conifers. Tamarac, commonly not large, are found here and there in the black spruce swamps. Cedar is prone to occur in swampy areas or along the margins of lakes. White and yellow birch, soft maple, and poplars are the common hardwoods. Alder and saskatoon berry commonly grow densely but not to large size. The distribution of trees is determined partly by their preference for soils, partly by the exposure to the sun, and in great measure

CLIMATIC—1 C



STATION

Cabonga, Quebec

Latitude 47° 18'

Longitude 76° 28'

Elevation 1225

Average annual rainfall 35.33"

Average annual temperature 36.3°

Source Dominion Dept. of Transport Meteorological Division

Remarks:

The scales in the outer right-hand column designed for extremes only.

HALL'S OUTLINE MAPS AND GRAPHS

PUBLISHED BY JOHN WILEY & SONS, Inc., NEW YORK

Figure 2

REMARKS:

Period of Record:

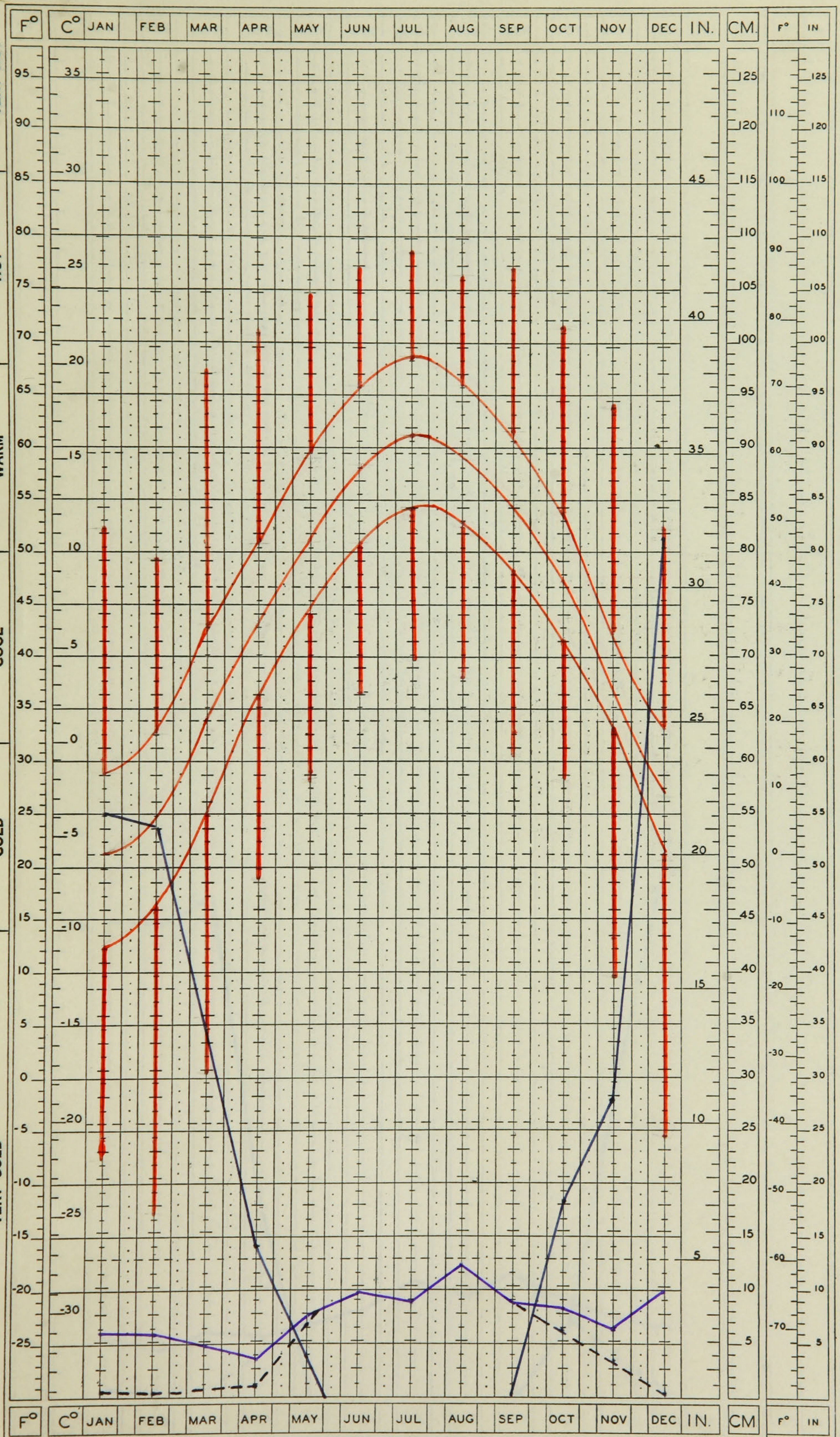
Cabonga, Quebec: August 1929 to October 1946.
Grand Lake Victoria: August 1939 to October 1946.

Mean daily maximum and minum, and average daily temperatures are plotted graphically as a solid red line.

Maximum and minimum recorded temperatures are plotted as vertical red lines.

Snowfall is plotted as a solid blue line.
Rainfall is plotted as a dashed blue line.
Total precipitation as a solid purple line.

CLIMATIC—1 C



STATION Grand Lake Victoria

Latitude 47° 51'

Longitude 77° 28'

Elevation 1075

Average annual rainfall 34.92"

Average annual temperature 35°

Source Dominion Dept. of Transport Meterological Division

Remarks:

The scales in the outer right-hand column designed for extremes only.

HALL'S OUTLINE MAPS AND GRAPHS

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Figure 1

by the vagaries of man's cutting and forest fire. In this respect, it is interesting to note that the conifers, shown on the accompanying timber reserve map, have an outline of what appears to be an old drainage system.

Data on timber concessions and some of the timber estimates were obtained from Mr. C. Dent of Dent's Sawmill. The timber estimates by concessions are shown below in table form.

TABLE I

	Pine 1,000,000-b/f	Spruce 1,000,000-b/f	Pulp 1,000 cord
Coulonge Timber Co, and Bryson-Frazer Estate	50	20	300
C. and G. Dent	75	10	100
A. Barnett Co. Ltd.	20	2	100

The lakes have game fish such as grey trout, pike, and doré as well as some of the coarser species. Moose are moderately abundant, and some deer are found. Bear may be seen, particularly near camps. Fur-bearing animals are not commonly seen, but indications of their presence were found.

With the foregoing list of resources, the economic role of the district is clear. Lumbering and trapping

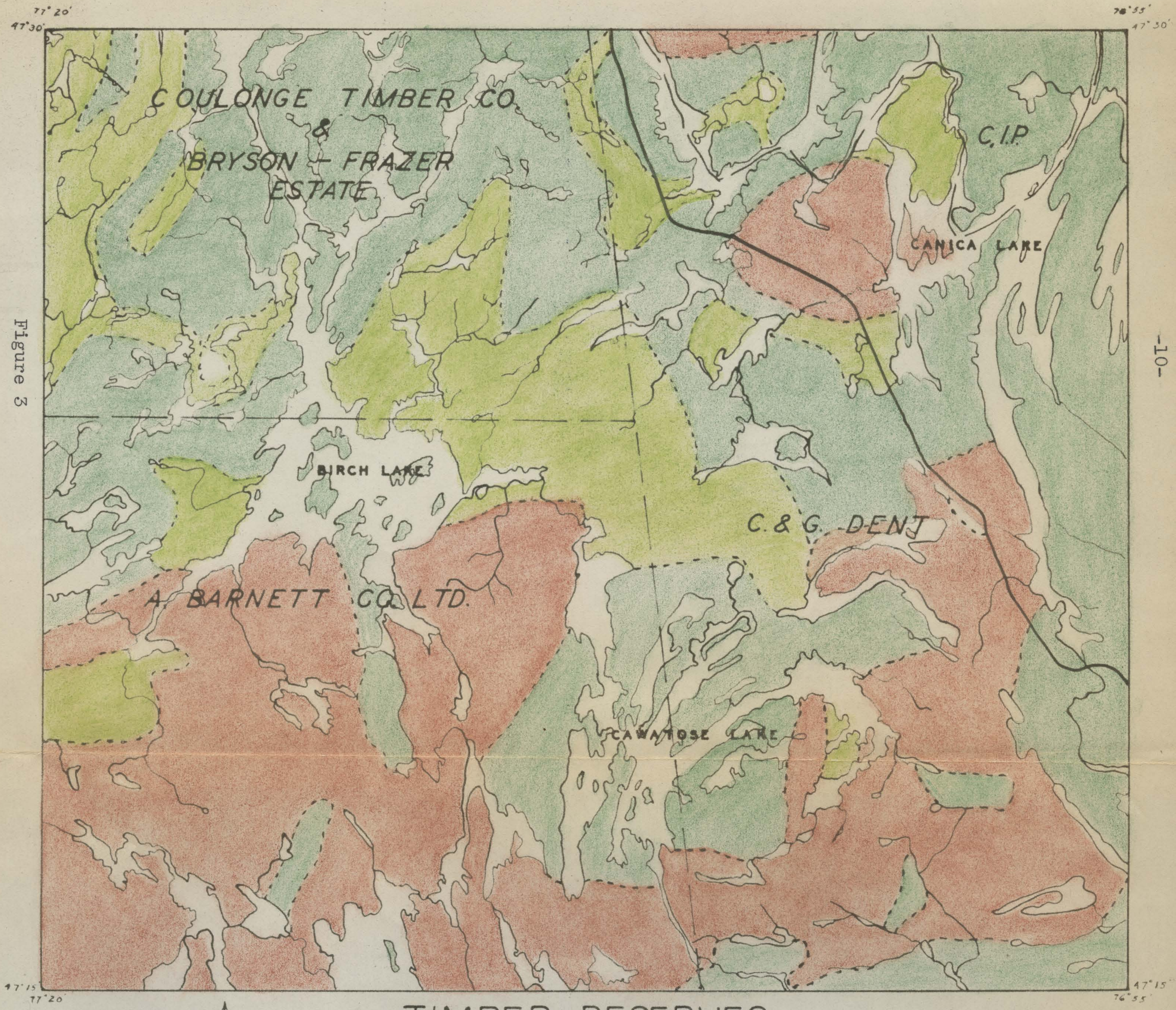

Figure 3

TIMBER RESERVES

CANICA CAWATOSE AREA

SCALE 1 INCH TO 2 MILES

CONIFERS
MIXED HARDWOODS
BURNED AREA

must provide a substantial part of the development, but the use of the area as a playground appears to be inevitable. The summer heat, as described above, is less than at Montreal, the lakes with fish, and the unspoiled character of the region makes it an attractive resort country. The Provincial Government anticipating this, established the Mount Laurier-Senneterre Fishing Reserve which extends 20 miles east and 10 miles west of Highway 58.

PHYSIOGRAPHY

Topography

The topography of the region is similar to many parts of the Canadian shield. Hills rise with smooth and commonly gentle slopes above the water plane. Most of the hills are not greater than 200 feet, only a few rise as much as 300 feet above the lakes. The hill summits tend to define a rather uniform surface that may be considered a somewhat-dissected peneplain. In the region to the south of the map area the summit surface is commonly at an elevation greater than 1300 feet, and inasmuch as the river and lake valleys are lower in elevation than the Birch Lake system, the relief in the region towards the St. Lawrence is much greater than that of the map area. This difference of relief is probably the most conspicuous difference between the topography of this area and that south of Mount Laurier, but no particular significance can be attached to this fact.

The hills to a considerable degree are a reflection of the bedrock structures, both schistosity and oblique structures such as joints and faults are shown by valleys and ridges. Conspicuously elongated ridges are not common. No general trends can be given, although there is a tendency for the topography to follow the "grain", ie, the several bedrock structures of the area. Inasmuch as lake basins and river channels follow the same controls, the ridges trend as do the lake shores. A glance at the pattern of the lakes (Figure 8) will show the confused "grain".

Lakes

About a quarter of the area of the sheet consists of lakes, and because of their use as means of access to most of the area, they perhaps tend to have a greater significance than is their right. The drainage pattern of the region was obviously disturbed by the Pleistocene glaciers and their deposits. The disturbance was so drastic that it is doubtful whether the position of the pre-glacial channels can be determined without very detailed work. The lakes occupy valleys similar to, if they actually were not, stream channels. This accounts for the elongated shape of most of the lakes. The channels were not deeply incised either by stream or by ice, for the lakes are shallow. Islands of rock promontories composed of angular blocks, and many submerged rocks in the lakes all show the shallowness. The water of the lakes is warm for this latitude and yellow in color, apparently from organic material. The shores of the lakes rise only gently from the water line although exposures of bedrock are present. A part of the shore-line is sand and gravel from the eroded edges of terraces, less of it is rock, and elsewhere low peaty ground comes to the water edge.

Deposits of arkosic sand are found at bay-heads and as spits (Figure 4), and in some places as tombolas (Figure 5). The sand, which grades laterally into deposits of pebbles or cobbles or both, is composed of angular particles of which 60% are quartz and most of the remainder are fresh feldspar. Grains of hornblende are not common and biotite grains are rare, although biotite is commonly present as concentrations which may give part of a beach a golden appearance when wet. A somewhat unusual feature is "pink beaches". Many of the gneisses have up to 20% garnet and detrital garnet may coat a beach so that it appears pink. Deposits of black sand are present, but are not very common. Magnetite is the dominant constituent of the black sands.

Streams

The character of the streams is in keeping with that of the lakes. The valleys occupied by rivers are wide and most of the streams are sluggish. The rapids or

[illegible] 4 Scale-4"=1 mile

[illegible] east shore of Birch [illegible] to the south.

Figure 4 Scale-4"=1 mile

Arkosic sand beaches and spit on the east shore of Birch Lake and the coalescing of two eskers to the south.

Figure 5 Scale-4"= 1 mile

Tombola east side of Lac Carrière

falls are the result of either an accumulation of boulders or of rock ridges encountered by downcutting streams. In some places newly-built beaver dams have resulted in the formation of wide flooded areas.

PLEISTOCENE

The Pleistocene ice sheets undoubtedly passed across this area on their southward march. Their destructive affects, however, are much less apparent in this than in other regions of the Canadian Shield. Their role appears to have been to smooth the hills, and little plucking is evident on the south ends of ridges trending in the direction of movement. Scratches on the summits of ridges with chatter marks and crescentric gouges are the best evidence of the direction of movement, which was from S 10° E to S 10° W. It is perhaps noteworthy that both directions of movement were observed on the same exposure, and that the direction of motion at most localities approaches either S 10° E or S 10° W. Although such observations are normally untrustworthy, the directions of striae taken near the water plane are in accord with those at the summits. Neither fluting nor gouging is noteworthy.

The constructive effects of the ice sheets are more conspicuous than the destructive. Hill slopes are mantled by angular blocks, pebbles, and sand. Moranic ridges extend north or south from the shores of lakes, and ridges of blocks mark their position in lakes.

Till, that is boulder clay, is not abundant in the area. This does not mean that it does not occur in some force: vegetation is prone to grow densely on till because of the water retaining properties of the clay and cause till to be overlooked. Erratics are numerous and many are large, but practically all of them are locally derived. Rocks characteristic of the Abitibi zone are rare, although pebbles of greenstone may be found.

Because of the heavy forest cover, outwash and stream deposits can be identified even under the best of circumstances only with difficulty, but well-developed eskers, kame terraces, and stream deposits were observed. Eskers were seen in all parts of the map area, and these may attest the relatively stagnant condition of the last ice sheet. The eskers seldom exceed 400 feet in width and were seen to follow a sinuous course trending southwards for as much as eight miles. These eskers exhibit several features worthy of comment. For example, east of Birch Lake two eskers, one from the north-east and the other from the north-west, coalesce to the south (Figure 4). This feature was observed in the esker south of Cawatose Lake (Figure 8). Parasitic deposits of sand and gravel were seen on the east side of the esker between Lake

Carrière and Lake Canimina (Figure 6). The origin of these parasitic features is not clear, but they may be immature outwash aprons.

South of Birch Lake numerous small boulder trains were found in north-south trending valleys. These boulder trains are not traceable for great distances and commonly terminate on the south in small outwash fans. These valleys may have served as outlets for Birch Lake when its surface was higher and when its present outlet to the north was blocked by ice. Terraces now sixty feet above Birch Lake may have been formed at the same time as the boulder train and can possibly be correlated with two terraces found twenty feet above the lake level on the north shore of Lake Carrière. These terraces are approximately the same elevation as those on Birch Lake and consist of gravel and fine arkosic sands. The position of a spillway that would determine a lake with a surface at approximately 1160 is not known, but parts of the region to the south remain to be mapped.

Highway 58 crosses the map area near the crest of what might be considered a broad ridge of sand and gravel. The limits of the ridge are indicated approximately by the stippling on Map Number II. The way in

Figure 6

Scale [illegible] mile

Esker between [illegible]

Figure 6 Scale 4"=1 mile

Esker between Lac Carrière and Lake Canimina which the sand and gravel are shown on the map may tend to give a false impression of the continuity of the formation. The highway climbs steep hills and descends into broad valleys, some of which have swampy lakes, in crossing the map area, but along the highway sand and gravel are more abundant and exposures of bedrock sparser than elsewhere in the map area. The origin of this feature is important despite the fact that its origin is not at once clear.

On its south end the sand and gravel ridge merges with the broad area of sand and gravel that is beyond the south limit of the map area. On the north the ridge extends to the Ottawa and appears to be replaced by a relatively thin but persistent cover of sand and gravel. The sand plains at both the north and south end of the ridge stand at a lower elevation than the ridge summit. On both east and west side, the ridge merges with drift deposits of normal type at an elevation not much above the water plane. It may be significant that the ridge forms much of the divide between the Soulier-Canica Lake system on the east and the Birch system on the west.

The sands and gravel are well shown in the gravel pits along the road and along Rivière Trompeuse. Cross-bedding is ubiquitous, but there is apparently no consistent direction in which the cross-bedding faces. Furthermore there are two places at which eskers appear to merge with the ridge. One such esker was partly destroyed for gravel and is west of Dorval Lodge, and the other is a mile north of Dent's sawmill on the west side of Lake Canica. The presence of forms such as eskers suggests that the edges of the ridge are not the result of erosion and that the ridge itself is not a relic of a more extensive plain. The material of the ridge is much less coarse than that in the eskers and the width of the feature, viz. two miles, make the use of the term esker inappropriate.

A suggestion for the origin of the feature is that at a late stage in the glaciation lobes of ice extended down the site of Lake Soulier on the east and Birch Lake on the west. The sands and gravel were deposited between these lobes at the same time as eskers were forming. There is in the area no obvious topographic feature that would explain the formation of two ice lobes at this place, and the explanation herein advanced is weak to that extent, but no other explanation appears to fit the observations.

There remains for consideration a series of small irregular terraces fronting the Birch Lake Basin at a greater elevation than the lake terraces previously mentioned. These terraces do not appear to be directly related to the broad band of sands and gravel east of Birch Lake, but are in general, similar in texture, composition, and structure. These can conceivably be kame terraces, marking the position of irregular re-entrants in the ice front.

GENERAL GEOLOGY

The table of formations for this region may be given in a very simple form if inferences are avoided, or it may be complex if an attempt is made to correlate the formations with those elsewhere. The geology of the region may be described in the most general terms as follows: orthogneisses and paragneisses of uncertain but complex origin and of Precambrian age are the dominant formations of the area. The gneisses are cut by syenite, dykes, and stringers of pegmatite, and basic dykes.

A table of formations is shown as Table II.

TABLE II

Recent	Sands and gravel
Pleistocene	Till, morainic deposits, outwash sands and gravels

Precambrian	Basic dykes
	Quartz syenite
	Pink granite gneiss
	Grey granite gneiss
	  Hornblende granite gneiss
	  Biotite granite gneiss
	Paragneisses
	  Hornblende gneiss
	  Biotite gneiss
	  Biotite-garnet gneiss

This table would be very similar to that given in early reports of the Geological Survey of Canada, if "Fundamental Gneiss" were substituted for ortho- and para-gneisses. M.E. Wilson[1] did not separate the varieties of gneisses on the map of the Birch Lake basin, but described all the gneisses as "Pre-Huronian Batholitic Intrusives"- largely biotite gneisses. The gneisses underlie approximately nine-tenths of the area mapped. They are grey to pink and most of them are well-banded with rapid gradation in texture and composition from band to band. Three paragneisses were identified: these are biotite-garnet gneiss, biotite gneiss, and hornblende gneiss. Two orthogneisses, a hornblende granite and a biotite granite, are shown as separate units on the map.

Limestone and quartzite of Grenville aspect were seen at one locality (indicated by an arrow on the map). Their relationship to the dominant paragneisses is not clear.

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(1) Wilson, M.E., Temiskaming County, Quebec, Memoir 103 Canadian Geological Survey

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STRUCTURE

Inasmuch as distinct formations, such as the Keewatin and Temiskaming of the region to the north of the map area, are not found, the structure of this region must be ascertained from the elements found in the rocks themselves. If the quartz syenite massif and the dykes of basic rocks be excluded from consideration, all of the rocks may be considered gneisses. As a group, the gneisses are characterized by well-defined foliation and schistosity, and a granularity and composition similar to that of a granite or of a diorite. It is possible to divide the gneisses into three groups, viz, those of igneous origin, those of composite origin, and those derived from sedimentary rocks. The original rock or rocks were folded and rendered schistose, solutions, partly magmatic and partly pneumatolytic, invaded them, and sills of granitic material then injected the complex. Throughout the period of formation of the gneisses, stress was active, and the structures of the complex shows the effect of movement in the universality of schistosity. In the absence of distinct small lithologic units, the distribution of rocks need not be considered, and only three elements, <u>viz</u>, foliation, schistosity, and lineation may be used in a structural analysis of the gneisses.

Foliation is banding or layering which may or may not be the result of original inhomogeinity from bed to bed, the result of injection of material into a pre-existing schistose rock in a <u>lit</u>-<u>par</u>-<u>lit</u> fashion, or simple parallelism of the constituents of a rock of igneous origin that was deformed during consolidation. The foliation is the most conspicuous structure of the gneisses, and in places an alternation of one inch thick light and dark bands gives a conspicuous "layer-cake" arrangement. Elsewhere the banding is less conspicuous for the layers are more similar in composition than in the layer cake gneisses, but foliation is visible in every exposure.

Schistosity is a descriptive term applied to a parallel arrangement of inequidimensional minerals, so that the two greater dimensions are in a common plane, the plane of schistosity. It is less easily observed than the layering in granitic rocks, because in the field only rocks with abundant dark minerals show it plainly. In rocks without dark minerals, schistosity, although present, is not easily seen. Furthermore, because of the crystal habit of hornblende, richly hornblendic rocks may show it only obscurely. The difficulty of determining schistosity is of no particular concern in the map area, for the foliation is parallel to the schistosity.

Lineation is less evident than either schistosity or foliation, but it is nevertheless present. If a schistosity plane is examined, certain linear elements, although lying in the plane of schistosity, tend to be parallel. These linear elements may be the axes of minor crenulation, "flutes" in quartz veins, or the long dimensions of crystals of metamorphic minerals.

The presence of a linear element in the foliation of metamorphic rocks and in igneous rocks was long unrecognized. Martin[1] has mapped linear elements in the Adirondacks, but it has remained for Sanders of Innsbruck to discuss the significance of the linear elements in metamorphic rocks and for Hans Cloos to describe and discuss the linear elements in intrusive rocks. According to the interpretation presented by Sanders[2], the linear elements

(1) Martin, J.C., Precambrian Rock Canton Quadrangle, New York State Museum Bulletin, Number 158, 1916.

(2) Sander, Zur Petrographisch-tektonischen Analyse III, Jahrb, geol. Bundesanst Wien, 76, 323, 1926

in a rock are the result of the combined effect of the shearing and independent intergranular (rotational) movement, in such a manner that, although "B", the intermediate axis of the strain ellipsoid, is only a minor axis of elongation, it is the most effective one. He also postulates formation of linear elements parallel to "A", but the assumption of grain rotation in this direction does not permit continuous elongation, because at certain times these elements lie in the plane of maximum stress. Sanders suggests that elongation parallel to "A" may develop where deformation is relatively rapid and intense, and elongation along "B" may be the result of slower, less intense deformation. The former type, as exemplified by slickensides, occurs in local zones, and the later type of elongation is found regionally. In igneous rocks, according to Cloos and his student Balk[1], the linear elements were formed when solid bodies were suspended in a moving liquid, and the long axis of these elements would lie parallel to the movement.

The map bears two sets of symbols; one for the schistosity or foliation, and the other for lineation.

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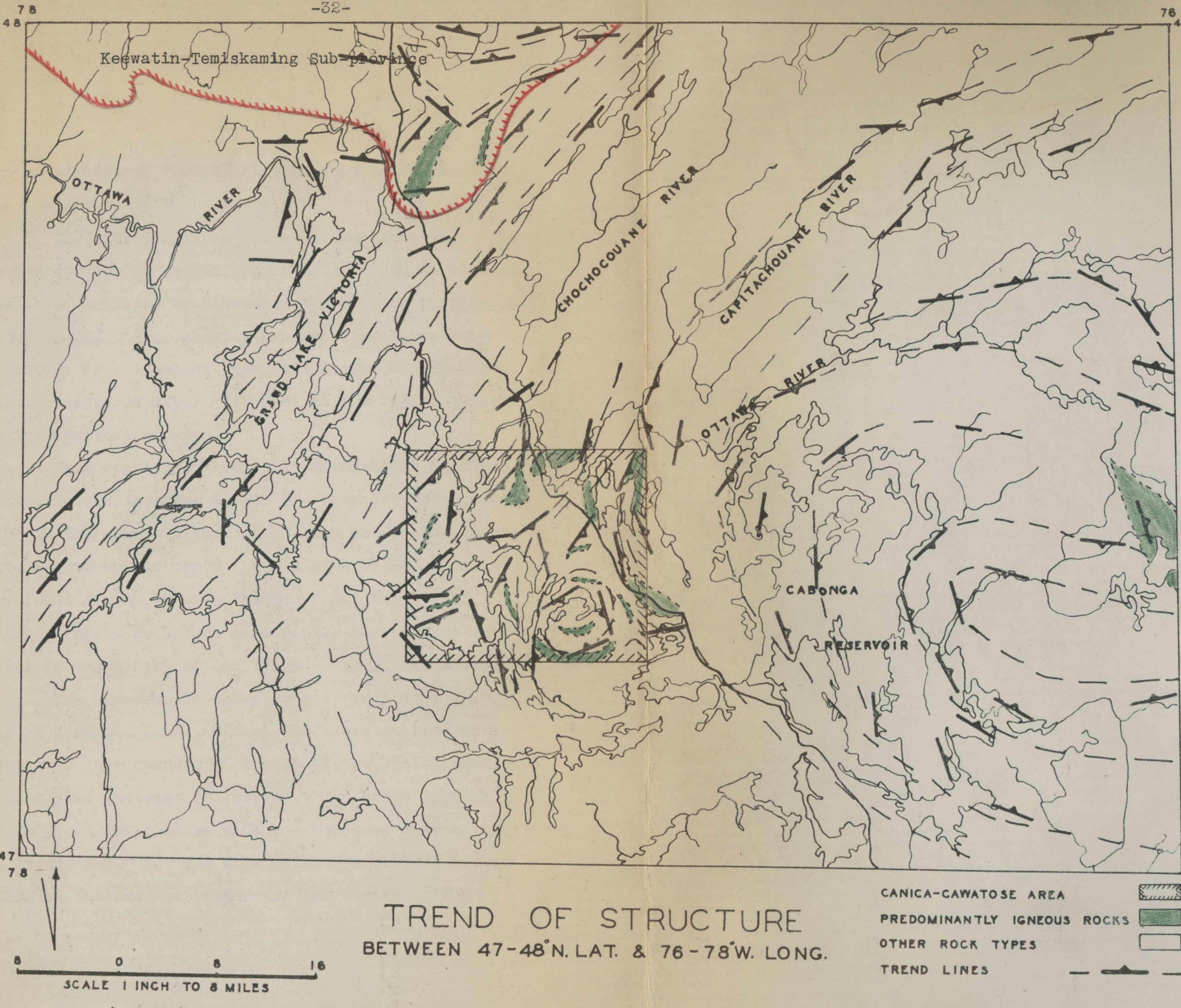
(1) Balk, R., Structural Behavior of Igneous Rocks, Mem. 5, Geological Society of America

It is from these two, in conjunction with the distribution of rock types, that structure may be worked out. Within the map area the general structure of the paragneisses is relatively simple and consists of north-south folds with foliation dipping east at low angles. Such a structure is obviously part of a larger structure and has a bearing on the determination of the age of the paragneisses. Some information is therefore to be found in the section on correlation.

The mapping of structure in the district surrounding the map sheet is necessarily incomplete except in part of the Keewatin-Temiskaming sub-province, but an attempt was made to compile a map showing trends of foliation for an area of 6,000 square miles around the Canica-Cawatose sheet (Figure 7).

Retty's map of the region to the east shows an open fold with an outcrop axis trending S 70° E with its western apex in the Canica-Cawatose sheet. Northward from and also crossing the Canica-Cawatose sheet, a belt which has been considered predominately granite shows foliation striking N 45° E and dipping generally southeast. Still farther north and within the definite Keewatin-Temiskaming sub-province the foliation trends east and dips north. A



TREND OF STRUCTURE
BETWEEN 47-48°N. LAT. & 76-78°W. LONG.

Apparent trends as published with interpretations

Figure 7

region of structural irregularity is seen in Villebon and Denain townships.

The Canica-Cawatose area is therefore in a zone where two structural trends appear to join and in addition to the irregularities mentioned in the ensuing paragraphs, as interrupting the apparently general structure there are probably complications that will become apparent only as further detailed mapping is done in the region adjacent to Canica-Cawatose map area.

This regular structure is interrupted by three structural units trending N. 60° E. They are the Cawatose "basin" in the southern part of the map area, the quartz syenite massif on the north, and a zone of cross schistosity found midway between the basin and the massif. It is interesting to note that some of the basic dykes are parallel to the strike of the trend of the cross zones.

The Cawatose basin is roughly indicated by the shores of Cawatose Lake, whose elliptical outline is a reflection of the changes in strike of the schistosity of the underlying gneisses (Figure 8). The basin is nine miles long and seven miles wide and the long axis of the basin trends N 60° E. The form of this structure was determined by the arcuate pattern of the strike of the

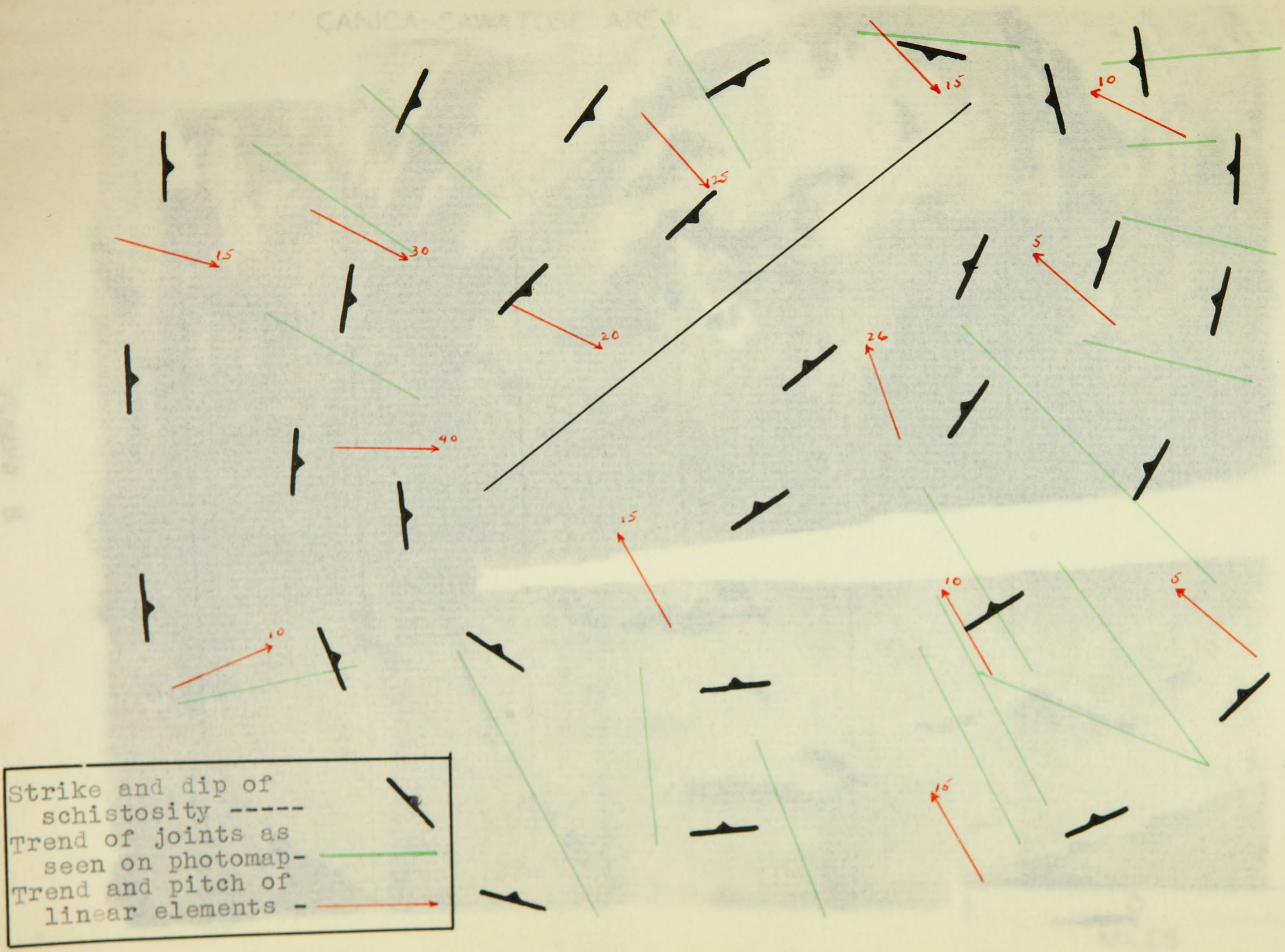

15
10
25
30
15
5
5
20
26
40
15
10
5
10
15
Strike and dip of schistosity -----
Trend of joints as seen on photomap-
Trend and pitch of linear elements -

Figure 8

gneisses, by the concentric trends of foliation, and by the inward dips of the schistosity or foliation. The linear elements in the schistosity show a tendency to converge inwards. A projection of the lineations in the outermost part of the basin tends to form a line three miles long, trending N. 60° E, and at an approximate depth of 6,000 feet. The regular outline of the orthogneisses and the consistency of dip attest the symmetry of the basin.

Other basin structures have been described from Loon Lake, Ontario[1], the Adirondack, New York[2], and Stoco Lake, Ontario[3]. As to the origin of these structures in the Adirondacks, Balk[4] states:

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(1) Cloos, E., Loon Lake Pluton, Bancroft Area, Ontario, Canada, Journal Geology, Vol. 42, 1934

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(2) Buddington, A.F., Granite phacoliths and their contact zones in the northwest Adirondacks, N.Y. State Mus., Bull. 281, 1929

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(3) Wilson, M.E., The Grenville pre-Cambrian Subprovince, Jour. Geol., Vol. 33, 1925

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(4) Balk, R., Structural behavior of Igneous rocks, Geol. Society America, Memoir 5, 1937

"that these masses seem to be a part of larger gneissic intrusives, which have caused plastic movement of their surroundings, so that outlying satellites were squeezed into local syncline or structural 'gaps' between the margins or larger masses of folded wall rock."

Although basin structures similar to that at Cawatose Lake have been described, the origin of the Cawatose basin is far from clear. The in-dipping schistosity of the rock and the linear elements that may be projected towards a line of focus, described above, appear to have no simple explanation. Cone sheets have been described from Skye and Mull[1] and Ardnamurchen[2] and are considered to be the result of the advance of a Tertiary magma towards the surface. Inverted cones have been occupied by magmas in such a fashion as to indicate a magma chute and source of magma about three miles below the present surface.

Basin structures with domical structures are found in some regions where domes and basins alternate, particularly where metamorphism was intense.

Explanations for these occurences are in no way

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(1) Anderson, E.M., The Geological Survey of Scotland

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(2) Thomas, H.H., Ardnomurchan Memoir, Geological Survey of Scotland, 1930

complete. Hans Cloos has developed the theory of structures of igneous rocks and has related the linear feature to the direction of jointing and to the direction of stress in a region. The lineation is, according to his contention, simply the direction of greatest ease of movement. If the Cawatose basin were considered an igneous structure an interpretation based on the work of Cloos would not be difficult. A line or locus from which rocks flowed or towards which rocks flowed, would explain the arrangement of foliation or lineation. The basin would be a "sink hole" or a source.

The rocks of the Cawatose basin, however, are not igneous. In fact, only a small part of the structure is composed of igneous rocks, and it is necessary to consider the possibility that the basin was formed during a stage when the normal behavior of metamorphic rocks was the rule. Sander and Schmidt have discussed the relationship of metamorphic rocks in detail. Although all their contentions have not been substantiated by fieldwork, nevertheless, at least for rocks deformed under conditions that were less severe than those obtained in the Canica-Cawatose area, their interpretations have proved acceptable.

Sander and Schmidt asseverate that the direction of instantaneous elongation of a rock mass during deformation is not the same as that of gross elongation of crystals or aggregates. This interpretation is at variance with that of Lieth and Mead[1] and is in accord with an interpretation presented by G.F. Becker[2].

If the contention that lineation is at right angles to the greatest elongation be accepted for the Cawatose basin, the interpretation becomes difficult for the stress then must be considered as represented by concentric circles. The interpretation of Cloos, that this basin in which there was a relief of stress and the "movement picture" with its lineation points towards a focus, is possible.

Either the Sander-Schmidt reconstruction does not apply to rocks altered to a grade such as is shown in the Canica-Cawatose or the whole group of rocks behaved as fluid igneous rocks, and therefore, the structures accord with the interpretation of Cloos.

The quartz syenite massif which interrupts the

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(1) Lieth and Meade: Structural Geology, 1923.

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(2) Becker, G.F., Finite homogeneous strain, flow and rupture of rocks, Geol. Soc. America, Bull. 4, 1893

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normal fold structure of the region will be discussed in a later section on igneous rocks.

The zone of cross schistosity mentioned previously is approximately a mile wide, striking N 60° E with dips from 70° N to 70° S. The exact significance of zones of cross schistosity is not clear, but they are not incompatable with the stress which produced the folds. Osborne has determined and described one such zone near Shawinigan Falls[1] and another near St. Jerome[2].

In addition to the structures involving rock flowage, joints or faults have played a part in determining the outlines of lakes and particularly the direction of stream channels. In the sheet southwest of Birch Lake a trellis drainage pattern is particularly marked, furthermore the continuity of one feature for 20 miles suggests that the streams follow one joint or fault rather than run in the direction of one set. Within the area mapped "lineaments" may be seen, Figure 8 and Figure 9, but the foliation of gneisses appears to be dominant in the pattern.

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(1) Osborne, F.F. and Lowther, G.K., Petrotectonics at Shawinigan Falls, Quebec, Geol. Soc. America, Bull., Vol. 47, N 9, Sept. 30, 1936.

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(2) Osborne, F.F., Lachute map-area: Quebec. Bur. Mines An. Rept., Pt. C, 1936.

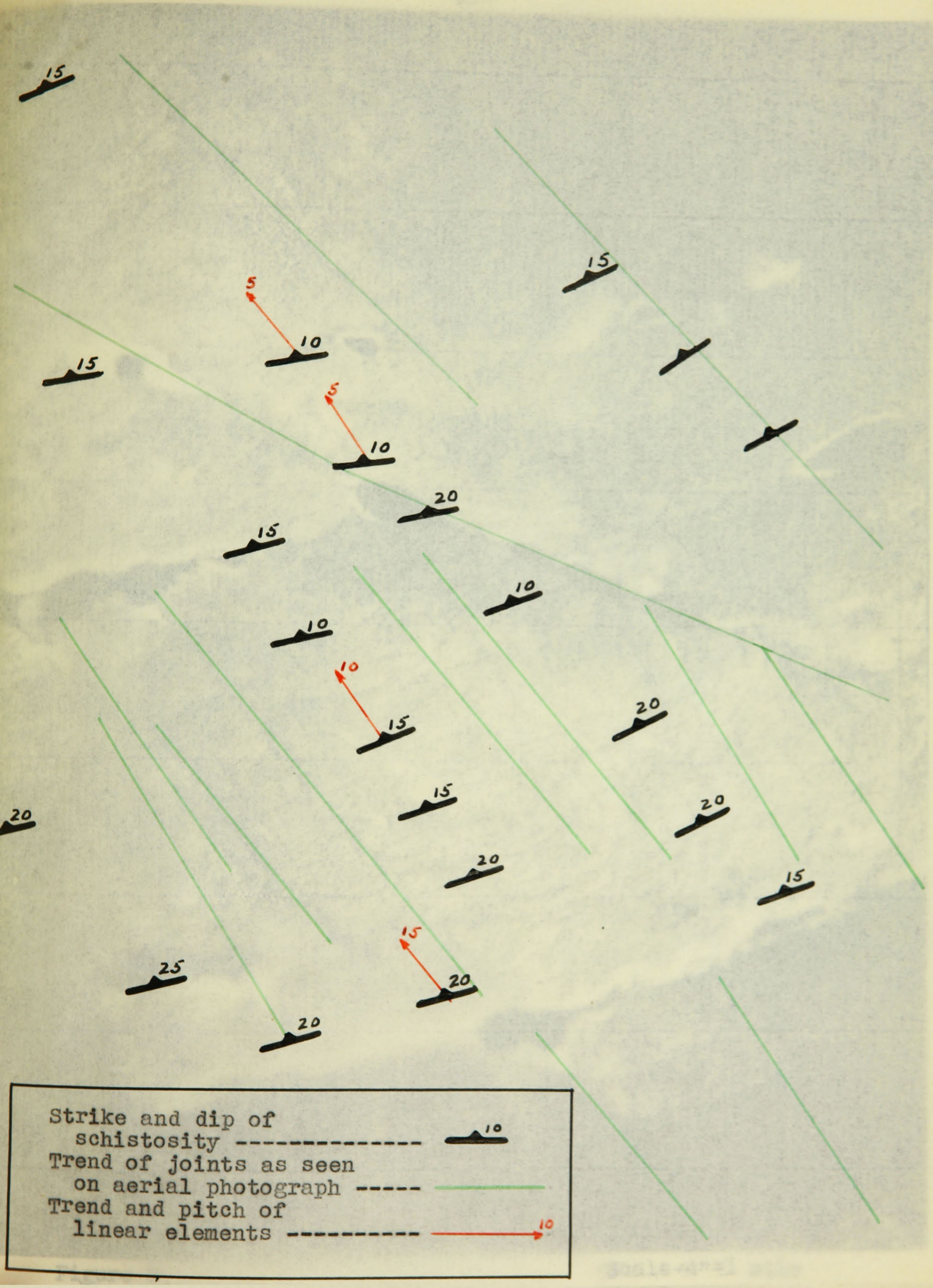
Strike and dip of schistosity --------------- 10
Trend of joints as seen on aerial photograph -----
Trend and pitch of linear elements ---------- 10

Figure 9 Scale-4"=1 mile

Conspicuous jointing of the paragneiss and the control of lakes and streams by foliation and jointing (south-east of

PETROLOGY

Paragneisses

Paragneisses, viz, gneisses formed principally from sedimentary rocks, underlie most of the area mapped. The correlation of the sedimentary rocks involved is one of the important problems of this area. Exposures along the Mont Laurier-Senneterre highway show that paragneisses are present to diverse extent at localities from the Abitibi district to Mont Laurier. The composition of the gneisses are such that they may have been graywacke, shales, or in a few places flows or tuffs. However, the metamorphism has destroyed the original textures and most of the structures of the original rocks. For purposes of mapping and description, the paragneisses are divided into three groups; biotite, biotite-garnet, and hornblende paragneiss, but it must be emphasized that gradations from one variety to another are common and that small lenticles of one variety may be enclosed by another.

Biotite Paragneiss

The biotite paragneiss is the dominant gneiss in the area. The composition, texture, and colour, are far from uniform even in a small area, and no single specimen is a type, however handspecimens from two localities will serve to give an idea of the megascopic features of this rock type. In a road-cut a half mile east of Camp Dorval and near the bridge over Beaver Creek a yellow-brown weathering gneiss is dark grey and medium-grained. It has biotite, quartz, and feldspar, in approximately equal amounts. The schistosity is not pronounced, but the foliation is accentuated by lit-par-lit injections of a grey pegmatite. The second specimen is from the southwest shore of Birch Lake, and is grey-black, medium-grained, and gneissic. Biotite is the predominant mineral with some quartz, feldspar, and hornblende. On a weathered surface the rock is rusty brown and extremely friable. The schistosity is marked and the foliation is shown in the alternation of biotite rich layers and those with abundant quartz and feldspar.

Lit-par-lit injections of pink or grey pegmatite as shown in Figure 10 and Figure 11 serve to make the foliation more apparent. Some gneisses consist of alternation of light and dark layers about two inches thick, which gives what is commonly described as "layer-cake" gneiss.

The thin sections show that the biotite paragneisses are characterized by a high content of biotite and a low tenor of hornblende and potassic feldspars. The rock

Figure 10 Lit-par-lit injection of grey pegmatite in the biotite paragneiss, west shore of Birch Lake.

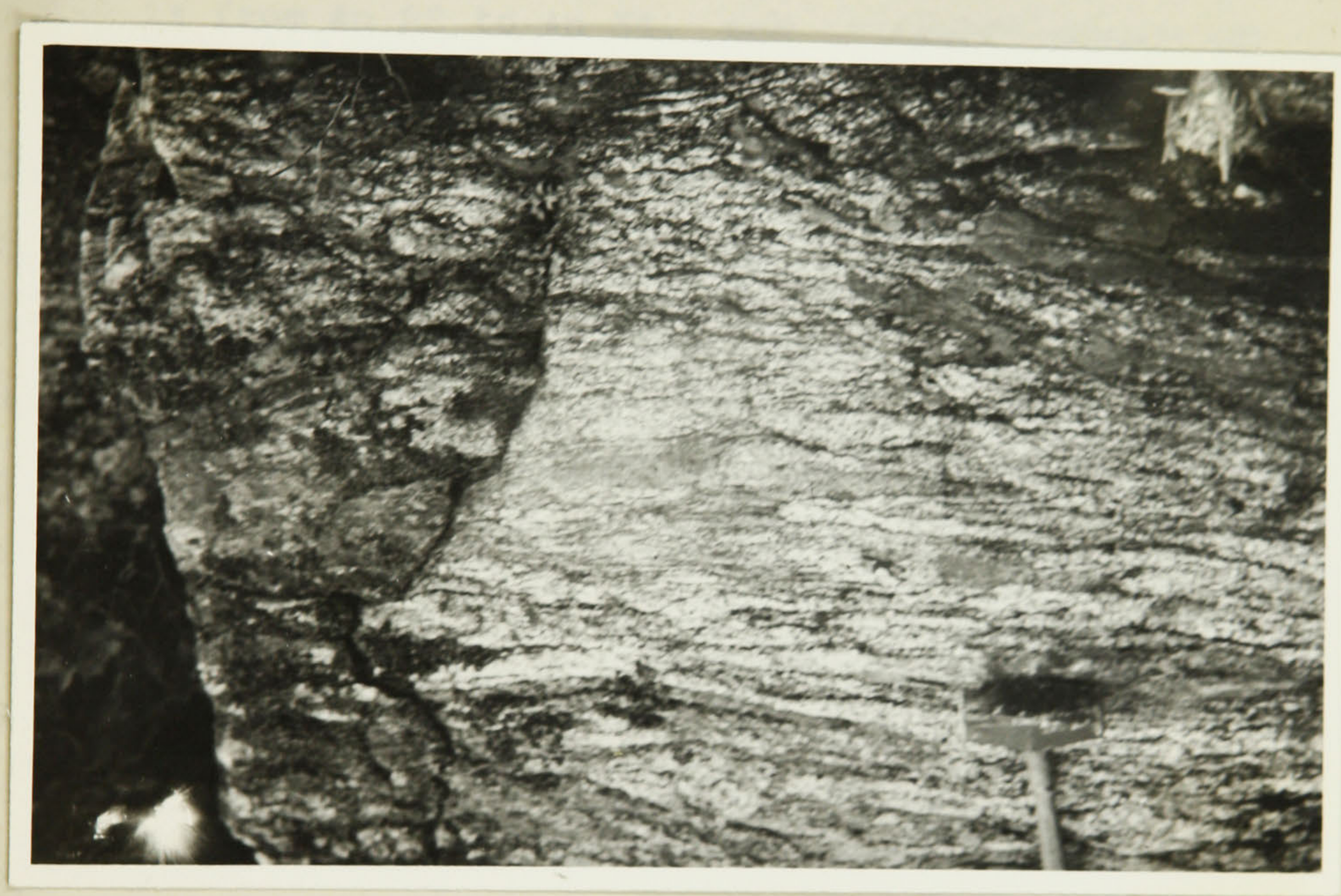

Figure 11 <u>Lit</u>-<u>par</u>-<u>lit</u> of pink pegmatite in the biotite paragneiss, south shore of Birch Lake.

has a granoblastic texture with grains up to 4 millimeters long orientated with the longer axes parallel to the schistosity or foliation. In the slides examined, the plagioclase is from An 22 to An 54, and saussuritization of this mineral is universal. Quartz is strained and Bohm's lamellae are common. The quartz aggregates form elongated ovals or tongues with rounded terminations. Biotite, which may comprise 36% of a rock, is pleochroic in brown and straw-yellow. Chlorite is found as thin rims on the biotite. Diopside is rare but is found with green hornblende. Other minerals occurring in minor amounts are; apatite, zircon, magnetite, and pyrite. Alteration to scapolite, epidote, and zoisite is not prevalent although these minerals may occur in force in some specimens. Microcline was found only in the rocks which have been injected by pink pegmatite. Albitization of plagioclase feldspars and the formation of vermiform myrmikites are common in the injection gneisses.

The results of a "Rosiwal", determination[1] of biotite gneisses, without conspicuous lit-par-lit injections, in volume percent are listed on the following page:

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(1) Made with a Dollar intergrating micrometer in volume percent

TABLE III

Specimen	3	15	27	64	H-3	H-9
Plagioclase	68%	26%	44%	54%	45%	64%
Quartz	18	8	31	19	19	27
Biotite	11	49	18	26	36	9
Hornblende	--	11	6	1	--	--
Scapolite	--	5	--	--	--	--
Microcline	2	--	--	--	--	--
Plagioclase Composition An %	22	54	25	32	28	33

Biotite-garnet Paragneiss

The biotite-garnet paragneiss has similar texture, colour, and composition, excepting garnet, to the biotite paragneiss, and is found as small lenticules or as long narrow bands within the gneiss. The contact between these two gneisses is not sharp but is gradational. A specimen considered as typical of the paragneiss, was obtained from a road cut two miles east of Camp Dorval. The rock is brown-weathering with an uneven surface caused by the differential weathering of the garnets and the ground mass. Lit-par-lit injections of grey pegmatite accentuate the uneveness of the surface. This rock is holocrystalline, dark-grey, medium-grained, and slightly schistose. Red garnets four millimeters in diameter are contained in a ground mass of quartz, biotite, and feldspar. In some exposures of this gneiss, the garnets attain a diameter of half an inch and are pink to red.

In thin sections the rock is seen to be characterized by garnets contained in a ground mass similar to that of the biotite paragneiss. Fractured, pink, isotropic garnets, commonly form porphyroblasts which enclose quartz and biotite poeciloblastically. The plagioclase of the paragneiss is from An 14 to An 36, and little sericitation was observed. Microcline and albitic plagioclase are found only in association with the pink pegmatite injected lit-par-lit. Biotite is pleochroic in brown and straw and is found as curved crystals with little alteration to chlorite. The amphibole, associated with the pink pegmatite, was identified as hastingsite. It is pleochroic in blue-green and green with low birefringence and a small optic axis angle. Other minerals identified are quartz, apatite, epidote, zircon, and magnetite. In a specimen from the east shore of Cawatose Lake, sillmanite was found to be approximately 30% of the rock, but in general this rock shows no mineral of the Al_2SiO_5 group.

The results of a "Rosiwal" analysis of four slides are listed below:

TABLE IV

Specimen	40	48	54	75
Plagioclase	32%	47%	41%	48%
Microcline	32	3	--	--
Hornblende	5	--	--	--
Quartz	22	30	17	32
Biotite	1	8	31	12
Opague	--	--	2	1
Garnet	9	12	4	5
Plagioclase Composition An %	14	28	32	33

The high tenor of garnet in the biotite garnet paragneiss suggests that the rock may be derived from aluminous rock[1].

Hornblende Paragneiss

In some localities the tenor of amphibole is greater than that of the ordinary biotite or biotite-garnet paragneiss, and this rock might be appropriately termed

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(1) Adams, F.D., Laurentian area in the north-west corner of the sheet, Can. Geol. Survey, An. Report, Vol. 7, 1894, Pt. J, p. 101.

hornblende paragneiss. Few exposures of such rocks are to be seen except in the eastern part of the map area, where they form a veneer on the flanks of ridges. It is logical to suppose that the intervening valleys are underlain by this paragneiss as they are more easily eroded than the massive granite gneiss which forms the ridges.

This rock is dark-green, medium-grained, and gneissic, with a typical salt and pepper appearance. Hornblende is the predominant mineral in a ground-mass of biotite, quartz, and feldspar. In some exposures, with a low tenor of quartz, this rock approaches an amphibolite in composition.

From a study of thin sections, it was found that the hornblende paragneiss is characterized by a high content of amphibole and a low tenor of biotite. This rock is a medium-grained (4 mm), granoblastic paragneiss, consisting of amphibole, feldspar, quartz, biotite, and several accessory and secondary minerals. The amphibole, which commonly forms more than 50% of the rock, is either common hornblende which is pleochroic in green and yellow, large 2V, and $z \wedge c$ of 25-30°; or actinolite which is pleochroic in blue-green and green, large 2V, and $z \wedge c$ of 15°. The plagioclase is from An 25 to An 31, and commonly alters to sericite. Biotite is pleochroic in brown and straw-yellow, but in one slide it is leached and slightly altered to chlorite so that it is pleochroic in blue and green. Pink garnets are in poeciloblastic grains enclosing quartz. The accessory minerals are apatite, magnetite, epidote, and sphene.

The results of a "Rosiwal" analysis are listed below:

TABLE V

Specimen	7	8	33	H-8
Plagioclase	19%	33%	14%	22%
Hornblende	55	49	58	54
Quartz	9	15	14	15
Biotite	2	2	3	3
Opague	4	2	6	8
Garnet	3	T[1]	5	T
Calcite	8	--	--	--
Plagioclase Composition An %	30	25	26	31

These determinations do not clearly indicate the origin of this paragneiss, but the compositions are such as may be derived from a basaltic or andesitic flow, tuff, graywacke, or a delomitic limestone.

(1) Trace

Amphibole Rocks

Irregularly-shaped bodies of mafic-rich rocks are found parallel to the schistosity and foliation of the biotite and hornblende paragneiss. These mafic-rich rocks may take the form of narrow stratiform masses, aligned blocks or lenticles, or as isolated ellipsoids. Hornblende is commonly the dominant mineral, but in certain exposures a monoclinic and orthorombic pyroxene are found in amounts approximately equal to the hornblende.

The hornblende rich masses are found in all parts of the map but are more abundant within the gneisses on the east shore of Lake Canica. These bodies assume no consistant shape or size and are in general conformable to the schistosity of the enclosing gneiss although transgression of the schistosity was observed. The schistosity of the containing gneiss curves or bends around large ellipsoidal masses, Figure 12, and no schistosity and foliation were observed within the amphibolites. The rock is dark green to black, coarse-grained (6-8 mm) and massive, and weathers to a light green. In addition to hornblende, which may comprise 80% of the rock, feldspar, biotite, and an occasional grain of quartz may be seen in a handspecimen.

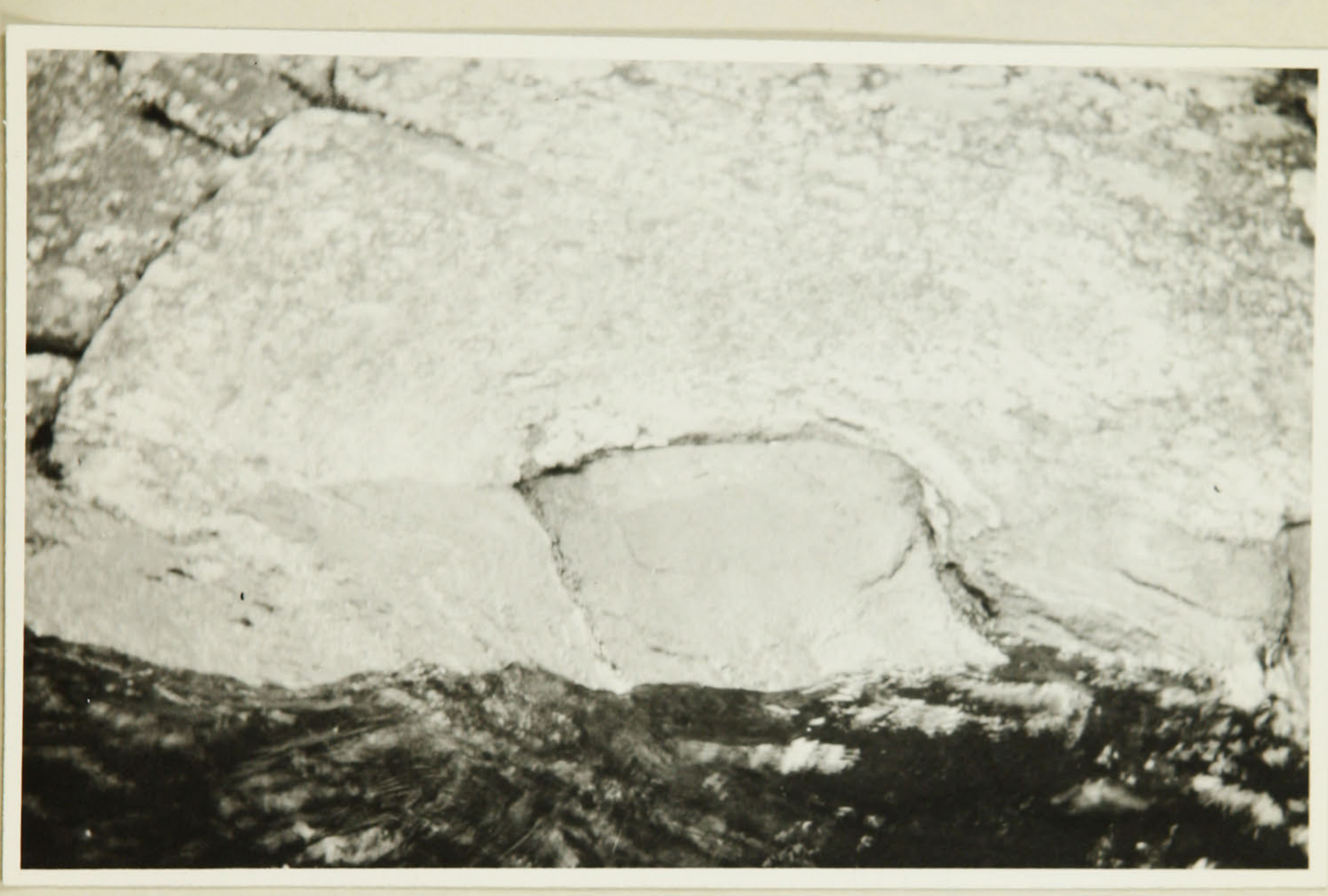

Figure 12 The foliation of biotite paragneiss is molded around the irregular-shaped mafic rich rock, south shore of Birch Lake.

As seen under a microscope, the rock is characterized by a preponderance of hornblende which is pleochroic in green and yellow-green, $Z \wedge c\ 22^{o}$, and a large 2V. Biotite is pleochroic in brown and straw, and augite is present in small amounts. The light-colored minerals are plagioclase, An 18, and quartz.

The origin of these rocks is not clear. Adams and Barlow in the Haliburton sheet described numerous amphibole-rich rocks similar to these. The occurrance of these amphibolite rocks in considerable force in the eastern part of the map area with a limestone, suggests that they may have been derived from an impure dolomite, but other possible sources, viz, basaltic flows or tuffs, basic intrusives, or even concentration of constituents by metasomatism cannot be eliminated.

A pyroxene rich rock was found as a stratiform mass 15 feet wide and 200 feet long parallel to the schistosity of the enclosing biotite paragneiss on an island in south-central Birch Lake, Figure 13. This rock is dark-green to black, medium-grained, and massive. In a handspecimen the mafic minerals are an amphibole, pyroxene, and biotite. Quartz and feldspar are the other identifiable minerals accentuated on the surface by a mottled grey and brown weathering.

Figure 13 A pyroxene rich rock 15 feet thick and 200 feet long parallel to the schistosity of the enclosing biotite paragneiss, on an island in south-central Birch Lake.

In several thin sections studied, the rock is granoblastic, medium-grained (4mm), and has a rude orientation of the minerals. Two pyroxenes were identified; a monoclinic pyroxene (augite) is a fresh greenish mineral, non-pleochroic, with $z \wedge c$ of 43-45^{o}, a birefringence of 0.025 and a large 2V, and an orthorombic pyroxene (hypersthene) which is pleochroic in pink and green, parallel extinction, a birefringence of 0.012, a large 2V, and a negative sign. The amphibole is hornblende; pleochroic in blue and yellow-green, z c of 20^{o}, and a large 2V. Biotite is pleochroic in brown and straw. The plagioclase is from An 31 to An 43 and alteration to sericite is common. Quartz is found in small strained crystals. Apatite, magnetite, and sphene are the aceessary minerals.

Microbreccia

A rock worthy of comment, found on the west side of Canica Lake 2 miles north of the locality for "Grenville and on an island a half mile south of where the Ottawa leaves Canica Lake, may be considered a microbreccia or mylonite. The rock is in half inch thick layers parallel to the schistosity of the pink granite gneiss or biotite paragneiss. Nowhere was the material observed to cut the foliation. Fragments of quartz and feldspar set in a very finely comminuted green matrix suggest that the material is a microbreccia or mylonite, but other effects or movement on the surrounding gneisses cannot be seen.

Orthogneiss

Orthogneisses may be divided into two categories based on their origins, viz, those formed from igneous rocks that were emplaced before deformation, and those that were injected during a period when stresses were still active. The orthogneisses in the Canica-Cawatose area may have originated in either manner, but the latter appears to be the predominent mode of origin. Igneous material was injected as lenticular or stratiform masses parallel to the schistosity of the paragneiss during the last period of deformation.

In some localities these orthogneiss were seen to transgress slightly the older formations, but most of the injections are parallel to the foliation. Schlieren of paragneiss in the orthogneiss are common. Contacts between ortho- and para- gneiss are commonly marked by a transitional zone, the thickness of which is roughly proportional to the sizes of the bodies of gneisses involved. Three orthogneisses are shown as formations on the map accompanying this report, viz, biotite granite, hornblende granite, and pink granite gneiss, and these are described below.

Biotite Granite Gneiss

The biotite granite gneiss which is the predominant orthogneiss, is found as stratiform masses as much as eight miles long and a half mile wide (west of Lake Cawatose) or as lenticular bodies seven miles long and two miles wide (west of Lac Soulier). It is grey-white, medium-grained, and leucocratic. Feldspar, quartz, and biotite were identified in the handspecimens.

Under the microscope this orthogneiss is characterized by a low tenor of biotite and an absence of hornblende. It is holocrystalline, medium-grained (4 mm), and slightly gneissic. Plagioclase is from An 22 to An 31 and is commonly twinned. Microcline is gridded and can readily be distinguished from the twinned feldspar by its negative relief. Muscovite and biotite occur in minor amounts, but they are present in sufficient quantities to emphasize the schistosity. Quartz is strained and Böhm's lamallae are common. The accessory minerals are apatite, magnetite, sphene, and zircon, commonly in well-developed crystals. Alteration of feldspar to sericite and biotite to chlorite is present but not prevalent.

A "Rosiwal" analysis of this rock is as follows:

TABLE VI

Specimen	44	72	80	82
Plagioclase	59%	71%	63%	53%
Microcline	T	1	7	3
Quartz	23	22	24	39
Biotite	17	6	3	5
Muscovite	1	--	2	--
Plagioclase Composition An %	31	22	23	24

Most specimens of this rock can be called appropriately oligoclase-biotite granite, but specimen 44 could be termed a quartz diorite.

Hornblende Granite Gneiss

Granite gneisses in which hornblende is dominant over biotite are found intruding the paragneiss in all parts of the map area, but the only outcrop of this gneiss large enough to form a mappable unit is in the east-central part of the area. This gneiss is a coarse-grained, dark-green, pepper-and-salt rock. Dark green amphiboles are often found in feather-like crystals an inch long in a groundmass of feldspar, quartz and biotite.

It is a holocrystalline, coarse-grained, granitic rock. The plagioclase is from An 24 to An 30. Most of the thin sections of this rock have hornblende but some have actinolite. The amphibole, which is in crystals three quarters of an inch long, encloses quartz and diopside. The actinolite is pleochroic in blue-green and yellow-green, $z \wedge c$ of 14°, and a large 2V. Hornblende is pleochroic in dark-green and yellow-green, $z \wedge c$ of 25°, and a large 2V. Biotite is pleochroic in brown and straw. The quartz is strained and Bohm's lamellae are common. Microcline occurs in considerable force only when conspicuous lit-par-lit injection of pink pegmatite is found. In these rocks albitization of the plagioclase and the formation of myrmekite are common.

The results of a "Rosiwal" determination are listed below:

TABLE VII

Specimen	29	80-A	81	83
Plagioclase	54%	53%	34%	51%
Microcline	--	5	28	--
Hornblende	21	12	17	29
Quartz	19	21	15	18
Biotite	6	9	7	2
Plagioclase Composition An %	30	26	24	25

Pink Granite Gneiss

The name, pink granite gneiss, is used for rocks of two textures but with a similar pink or rose colour. One variety assigned to this formation is found as sills intruding the paragneisses in all parts of the region. These rocks are medium to coarse grained and have a distinctive white, rough-weathered surface. Pink feldspars and quartz with minor amounts of biotite and muscovite are the principal rock forming minerals.

In thin sections this orthogneiss is characterized by a relatively high tenor of microcline, a low content of biotite, and the absense of hornblende. It is holocrystalline, medium to coarse grained (4-7 mm) and faintly gneissic. The plagioclase is from An 12 to An 15 with little alteration to sericite observed. A red stain, possibly hematite, is found on the feldspar cleavage. Quartz is unstrained and clear, and biotite is pleochroic in brown and straw-yellow.

The other rock type assigned to this formation is found as irregular masses of medium-grained composite gneisses. In the rocks of this type all degrees of absorption of and intercalation with other gneisses may be seen, so that the composition, texture, and colour are variable.

In general, the injection gneiss is pink to rose, medium grained, and gneissic. The foliation is apparent and is accentuated either by lit-par-lit injection of pink granite in less assimilated varieties of paragneiss or by pelitic seams within the granite. In a completely assimilated portion of the zone, pink feldspars, quartz, and biotite are the minerals identified, but in less absorbed rocks the remnants of the original minerals influence the composition.

A composite gneiss in which extensive metasomatism is evident is chosen for description inasmuch as it represents the end stage of the reaction which many of these rocks have undergone. Under the microscope, it is medium-grained (3 mm), holocrystalline, and gneissic. This gneiss is similar in composition to pink granite gneiss in that there is a relatively high tenor of microcline and a low content of biotite. It is perhaps worthy of comment that only in the composite gneiss are zoned feldspars, perthites, and myrmekites common. The tenor of biotite and the "An" composition of the plagioclase is greater than in the variety described in a preceding paragraph.

The results of a "Rosiwal" determination of three pink granite gneisses and one composite gneiss, specimen 28, are given in table VIII.

TABLE VIII

Specimen	19	28	36	37
Plagioclase	42%	53%	39%	30%
Microcline	18	14	32	38
Quartz	28	27	24	28
Biotite	2	6	4	4
Opague	--	--	1	--
Muscovite	1	--	--	--
Plagioclase Composition An %	15	23	12	15

Quartz Syenite

The quartz syenite crops out in the north-central part of the map area and is exposed in road cuts and along the shores of Lac Soulier. Most of the area believed to be underlain by quartz syenite is so covered by glacial and related deposits that the limits of the mass could not be accurately found, despite the fact that repeated attempts were made to do so. In all exposures the quartz syenite is fresh appearing and is without the conspicuous gneissic structure, which is common in granite gneisses which have been involved in the folding within the area.

Along the highway and along the shore of Lac Soulier linear elements, such as elongated clots of minerals and the long axis of prismatic minerals, trend north-east and pitch easterly; flow layers, although not readily apparent in the field, strike north-east and dip steeply south. On the bases of a few observations the size and shape of this massif was deduced, and it is considered a stock, ie, it is a cylindrical body with a long axis pitching northeast.

The quartz syenite is pink to grey-green and is coarse-grained with phenocrysts of feldspar and clots of mafic minerals. In a handspecimen, plagioclase, microcline, and quartz were identified with minor amounts of hornblende and a pyroxene. In some exposures, with an increase in quartz, this rock approaches an alkaline granite in composition.

Under the petrographic microscope, this quartz syenite is a holocrystalline, medium-grained, granitic rock, characterized by a low tenor of quartz and the presence of aegerine-augite. The plagioclase is from An 14 to An 16 and is commonly twinned. Microcline is gridded and an intergrowth of the two feldspars is common. Quartz is in small irregular grains. The aegerine-augite is pleochroic in pale-green and brown, with an absorption of X>Y>Z, $x \wedge c$ of 26°, and a large 2V. The amphibole is common hornblende and is pleochroic in brown-green and yellow-green, with an absorption of Z>Y>X, $z \wedge c$ of 24°, and a large 2V. Biotite is pleochroic in brown and straw. Apatite, magnetite, and sphene are accessory minerals.

The results of a "Rosiwal" determination are listed below:

TABLE IX

Specimen	9	62
Plagioclase	38%	20%
Microcline	44	59
Aegerine-augite	3	9
Quartz	6	7
Hornblende	8	4
Biotite	--	1
Plagioclase Composition An %	14	16

The possible age of this formation is discussed under the correlation.

Basic Dykes

Unaltered basic igneous rocks were found as dyke-like intrusives in three parts of the map area; on an island in south-west Birch Lake, at the east end of Lake Cawatose, and on the north-east shore of Lac Soulier.

These igneous masses are found as tabular intrusives fifty feet wide and over two hundred feet long, inclined to the schistosity of the containing gneiss. The rock is dark-brown to black, coarse-grained, and massive. The mafic minerals identified are an amphibole, a pyroxene, biotite, and garnet. Quartz and feldspar are the salic minerals. The plagioclase crystals are in long laths which impart an ophitic texture to the rock. This texture is emphasized on the exposed surface by a mottled chalk-white and brown weathering.

In thin sections this rock is characterized by a low tenor of quartz and a high content of augite and hornblende, and is considered to be a quartz gabbro. It is a holocrystalline, medium-grained, ophitic-textured, igneous rock. The plagioclase is zoned and is near An 34 in composition. Alteration to sericite is not common, but minute dark rods are included in the feldspar and are arranged parallel to (001) and (010). The pyroxene is a clear greenish augite, non-pleochroic, with an extinction $z \wedge c$ of 42°, and a large 2V. The hornblende is pleochroic in dark-green and yellow-green, $z \wedge c$ is 18°, and 2V is large. Biotite is pleochroic in red-brown and straw. A pink garnet is found as small irregular grains around the mafic minerals. The origin of these "reaction rims"[1] is not clear, but several associations were noted in these rocks and they are listed in table X:

TABLE X

Magnetite Biotite Hornblende Augite and Quartz Garnet	Magnetite Biotite Hornblende Garnet	Biotite Hornblende Garnet	Magnetite Garnet	Augite Garnet

Limestone and quartzite "Grenville type"

An exposure of "Grenville type" limestone and quartzite was found within the pink orthogneiss on the east shore of Lake Canica at a locality marked by an arrow on the map. The exposure is approximately 20 feet wide and 30 feet long and is bounded on the north by the water of a small bay of Lake Canica and on the south by glacial drift. To the east and to the west the rocks are in intrusive contact with pink granite gneiss, and the attitude of the foliation, bedding, and schistosity of

(1) Gillian, J.L., Calahan, W.H., and Millar, W.B.; Adirondack Studies:. The Age of Certain of the Adirondack Gabbros, and the Origin of the Reaction Rims and Peculiar Border Phases Found in Them, Jour. Geol., Vol. 36, 1928

the meta-sedimentary rocks is similar to that of the containing orthogneiss. A table of formation for this exposure is given below:

TABLE XI

	Thickness
Pink granite gneiss	
Intrusive contact	
Iron formation	3 feet
Limestone	3 feet
Garnetiferous schist	3 feet
Quartzite	6 feet
Intrusive contact	
Pink granite gneiss	

The contact between the pink granite gneiss and the quartzite is irregular and marked by a "mixed" zone six inches thick.

The quartzite layer is approximately six feet thick and is light grey, coarse-grained, and massive. The dominant mineral is quartz with some small grains of garnet, some feldspar, and biotite. The thin section examined consists almost entirely of large (7-8 mm) quartz anhedra, which are strained and show Böhm's lamellae. It is interesting to note, that all the quartz anhedra have the <u>c</u> axis in a common direction. The orientation of a few flakes of biotite and muscovite is sufficient to mark the schistosity. This quartzite passes abruptly upwards through a zone less than an inch wide of fine-grained quartz, biotite, and garnet, into a garnetiferous biotite gneiss.

The garnetiferous schist is three feet thick and is red-brown, coarse-grained, and slightly schistose. Garnets are the principal mineral, forming 75% of the rock, and are so fractured as to impart a sugary texture to the rock. Biotite is as small flakes molded around the garnet. This rock is overlain conformably by a thin layer of limestone.

The limestone is about three feet thick and is coarse-grained, chalk-white, and is dark-grey to black on the weathered surface. In a fresh handspecimen the calcite is found as large, white, interlocking crystals, three-quarters of an inch long. Under the microscope this rock is characterized by large irregular grains of calcite most of which show gliding lamellae. The limestone is in sharp contact with the magnetite-garnet gneiss which occurs on the east side of the limestone.

The magnetite-garnet gneiss is a three foot layer of massive, rusty-brown, weathering paragneiss. The rock consists of alternating bands, up to a half inch thick, of clear, glassy quartz, and fine-grained, red-brown layers of magnetite and garnet. In a thin section small pink garnets, and irregular grains of magnetite and quartz, are found in approximately equal amounts. This rock may be a metamorphosed iron formation or a contact metamorphic product of the pink granite gneiss and an impure quartzose sedimentary rock.

Pegmatites

Pegmatites of diverse composition are found in all parts of the area as thin lit-par-lit injections, as dyklets, as lenticles, or as stratiform or dyke-like masses as much as two hundred feet long. The pegmatites may be divided into three groups based on their composition and colour, *viz*, a grey pegmatite, a pink pegmatite, and a low quartz alkaline pegmatite.

Grey Pegmatite

The grey pegmatite is found almost exclusively as lit-par-lit injections, but dykes and lenses as much as five feet wide and twenty feet long were seen. In the lit-par-lit injections this pegmatite is dark-grey and fine-grained (5 mm) consisting of quartz, feldspar, and biotite. The occurrance of dark-red garnets within the pegmatite suggests that there was some absorption of the host rock by the pegmatite. A lenticular body of coarse-grained grey pegmatite was found on the south-east shore of Lac Dozois. This pegmatite is ten feet long and three feet wide with several "books" of muscovite two to three inches thick and approximately two inches in diameter. In thin section, microcline was found to be the dominant mineral. It is either as unaltered gridded microcline or as a microcline perthite. Plagioclase An 21, was found in amounts equal to that of the quartz, and the intergrowth of these two minerals is common. Flakes of muscovite and biotite, which is pleochroic in brown and straw, were identified.

Pink Pegmatite

The pink pegmatite is found as dykes several hundred feet long and fifty feet wide or more commonly as thin lit-par-lit injections. It is pink to rose, and the crystals in the larger masses are of diverse size from less than an inch to nearly a foot long. The minerals found in this pegmatite are quartz, pink feldspars, biotite and muscovite, and in a few exposures hornblende and garnet. "Books" of biotite an inch thick and nine inches in diameter were found in a pegmatite on the south shore of Birch Lake, Figure 14. A muscovite-bearing

Figure 14 A biotite-bearing, pink pegmatite with "books" of mica up to nine inches in diameter, south shore of Birch Lake.

pegmatite was found a half mile from the head of the bay on the north-east arm of Birch Lake. Under the microscope microcline was found to be the dominant mineral with quartz and plagioclase (An 17) in equal amounts. Additional information concerning these pegmatites will be given in the section on economic geology.

Alkaline Pegmatite

The low quartz alkaline pegmatite was found only in the vicinity of the massif of quartz syenite. Pink to dark-rose feldspars and dark-green amphiboles and pyroxenes were identified in the handspecimen. In a thin section microcline and microcline-perthite are found to make up 75% of the slide. Plagioclase, An 14, is zoned and myrmekite is present but not common. The amphibole is hornblende, which is pleochroic in dark-green and yellow-green with an absorption of $Z>Y>X$, and has an extinction of $z \wedge c$ 30° and a $2V$ of approximately 60°. The pyroxene is aegerine-augite which is pleochroic in pale-green and brown with an absorption of $X>Y>Z$, and has an extinction of $x \wedge c$ of 23° and a large $2V$. Biotite and muscovite were found as small flakes as were some grains of rutile, magnetite, apatite, and zircon.

Amphibole Pegmatite

There remains for discussion an amphibole-bearing pegmatite found in a road cut three miles north-west of the bridge over the Trompeuse River. The pegmatite is irregular and strikes parallel to the strike of the enclosing paragneisses. It is a grey-white medium-grained (25 mm) pegmatite composed of feldspar, quartz, biotite, and an amphibole. The amphibole occurs not only as separate crystals two inches long in a ground mass of feldspar and quartz, but also as aggregates some of which are as much as three feet long. The amphibole in the aggregates tend to be coarser than those that are disseminated in the pegmatite. In the handspecimen examined, this amphibole is long-bladed, dark-brown crystals nine inches long. Under the microscope this mineral is colourless, with z parallel to c, a birefringence of .023, a 2V of approximately 85°, and biaxial positive. The refraction indices determined by the oil immersion method are $\alpha = 1.655$, $\beta = 1.665$, and $\gamma = 1.670$. This amphibole is considered to be anthophyllite. The possibility that this amphibole is metasomatic must be considered. Indeed it is possible that some of the anthophyllite has replaced the paragneiss.

CORRELATION

Observations in the field and the examination of thin sections of important rocks from the area show that considerably more than half of the gneisses were derived from sedimentary rocks; that is they are paragneisses. Igneous rocks, commonly gneissic, form moderate-sized bodies generally conformable to the paragneisses in structure. Sills occur. Some of the paragneisses appear to have been "granitized". Although it is very difficult to prove or disprove that addition of material took place in the formation of some gneisses, nevertheless, the observation that microcline is abundant in paragneisses near lit-par-lit injections must be considered. The introduction of thin layers of granitic material appears to have contributed to microcline formation. It is not clear whether much or all the components of microcline were brought in. In any case, although quartz and feldspar form in rocks of this composition as a result of regional alteration it is probable that some quartz and feldspar were introduced.

The presence of fine-grained aggregates of quartz and feldspar as lit-par-lit injection is easily seen in cuts near the highway crossing the Ottawa River. Although some authors have contended that such injections may be generated in place in rocks of this composition, it is possible that actual addition of material took place.

Amphibolites or medium-mafic hornblende gneisses such as might appropriately be derived from andesite or basalt at the grade of metamorphism found in the Canica-Cawatose area do not occur in force. It is exceedingly improbable that as robust a member of a series as a basalt flow could be completely destroyed by injection or metamorphism. It is logical to conclude that none or at the most an insignificant amount of basalts or equivalent was present with the sediments that gave rise to the paragneisses. Furthermore a rock of greywacke composition can give a hornblende gneiss on metamorphism. Still other facts serve to support the contention that the gneisses were derived from sedimentary rocks: the geological map of Quebec shows that the band of basic volcanics that extends eastwards through Dubuisson, Bourlamaque, and Louvicourt townships are flanked on the south by sedimentary or meta-sedimentary rocks, Figure 15. These rocks are impure quartzites or argillaceous quartzitic rocks

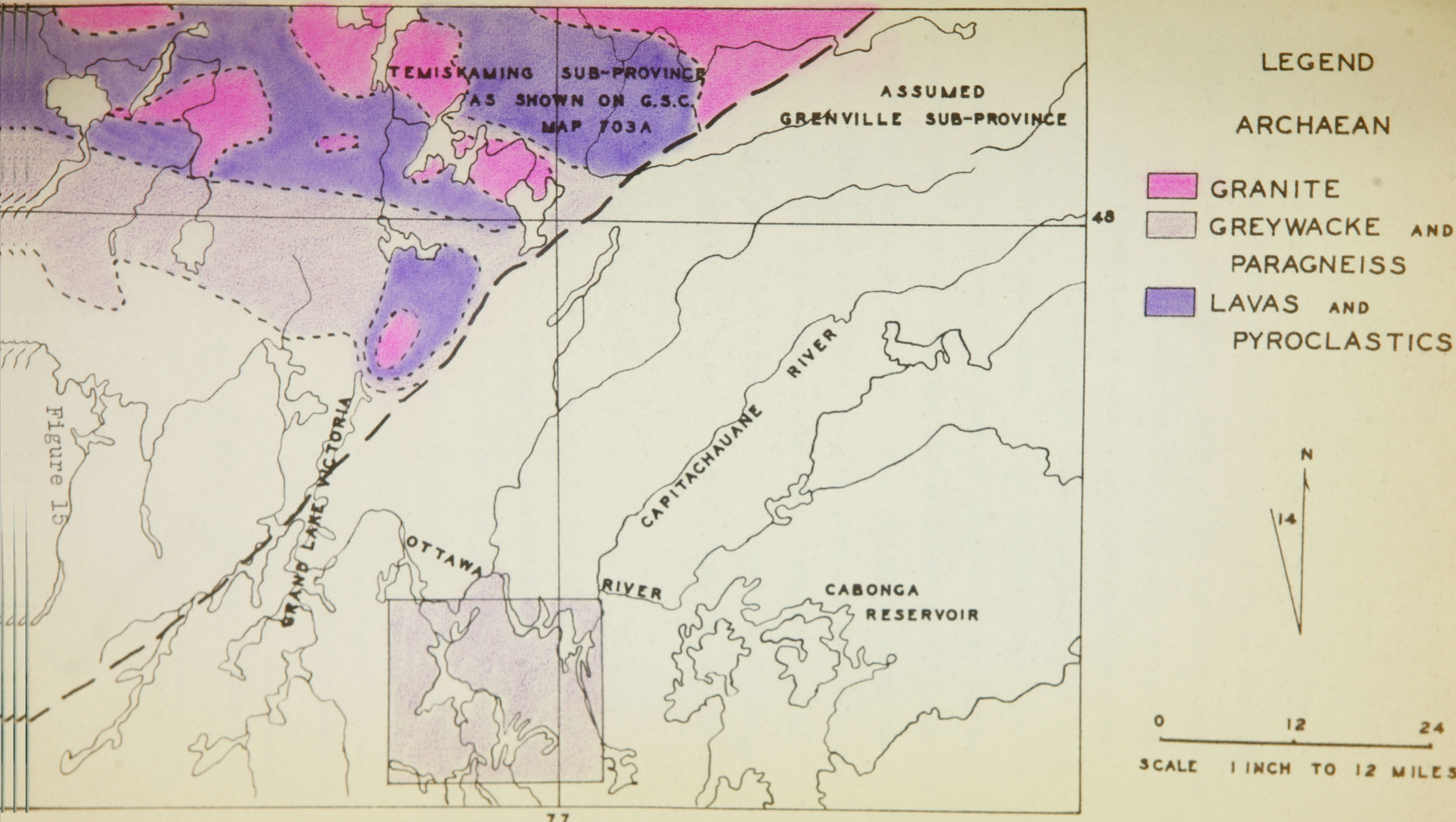

Figure 15

REGIONAL GEOLOGY

that have been metamorphised to diverse extents and show few intercalated volcanics. Some of the beds have yielded biotite gneisses on metamorphism and in some localities biotite garnet gneisses [1]. These paragneisses are similar, except for a lower grade of metamorphism, to those of the Canica-Cawatose area. It is believed that further mapping in the region will show an actual continuity between the paragneisses of the Canica-Cawatose area and the sedimentary rocks on the south side of the Keewatin volcanics. The reconnaissance mapping that has been done is not adequate to prove this contention, and the use of "biotite-gneiss", for example, in a report by Wilson[2], for rocks of diverse origins has not helped to clarify relationships.

Thus two lines of evidence suggest that the two series may be identical, the one is the similarity in the composition of the original sedimentary materials on the south side of the volcanics to the paragneisses of the Canica-Cawatose are, the other is the as yet unconfirmed probability that the rocks may be traced from one

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(1) Lowther, G.K., Villebon-Denain Area, Quebec Bureau of mines, Annual Report, 1935, Part C.

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(2) Wilson, M.E., Temiskaming County Quebec, Canadian Geological Survey, Memoir 103, 1918.

district to the other.

Canica-Cawatose map area is only 20 miles from the volcanics and metasediment rocks in the Villebon township, but within that distance the structure changes. In the area described here the metasedimentary rocks are complexly folded but trend generally north and south with a gentle dip east with a structural pitch east, whereas the volcanics in the zone passing through Villebon are in a band trending east and west with steep dips. The structural map, Figure 7, in this report shows the apparent trends as shown in published reports. North of the Ottawa River the strikes of the formations swing northeast and for a distance become parallel to the line marking the southeast limit of the Keewatin-Temiskaming subprovince. Norman has suggested that the Keewatin-Temiskaming is separated from the province to the southeast by a fault. Near Lake Mistassini, he[1] has mapped a relatively clean-cut fault but other possibilities that might yield the same effect must be envisaged. The adjustment

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(1) Norman, G.W.H., Thrust faulting of Grenville gneiss northwestward against the Mistassini series of Mistassini Lake, Quebec, Journal of Geology, Vol. 48, No. 5, July-August, 1940.

may have been distributed over a wide zone with many planes along which movement took place. Still another possibility is that the line of junction was the locus for magmatic invasion and a series of orthogneisses came up along the zone. The apparent transition of the paragneiss of the two districts may perhaps be adduced as an argument opposing this view. However the apparently abrupt increase in grade southeast of the Keewatin-Temiskaming sub-province may indicate a zone of faulting or of intrusion.

The relationship of the paragneisses of the Canica-Cawatose area to the paragneisses of the Grenville sub-province is not clear. Too great an unmapped area intervenes between the two districts. It is 60 miles from the Canica-Cawatose area to the Sicotte area mapped by Aubert de la Rüe[1]. A reconnaissance survey[2] has been made of the geology along the road but, inasmuch, as the work was limited to two days, great reliance should not be placed on

(1) Aubert de la Rüe, E., Sicotte Area, Labelle and Gatineau Counties, Quebec Bureau Mines, Preliminary Report, 160, 1941.

(2) Aubert de la Rüe, E., Notes on the geology along the new Mont Laurier-Senneterre highway, Quebec Bureau Mines, Preliminary Report, 163, 1941.

it. Grenville paragneisses with associated limestones and quartzites occur on the south end of the road to the Abitibi and apparently extend as far north as Lac la Fourche. North of that locality the characteristic paragneisses tend to assume the aspect that they have in the Canica-Cawatose area. The writer made some observations along the highway from a car, but these are not to be considered equivalent to detail mapping. However, a difference in the paragneisses of the Grenville is at once apparent. Those of the north are less aluminous than the typical Grenville garnet sillimanite gneisses. Adams[1] has discussed the criteria for the origin of the gneisses, and Wilson[2] has given data on the gneisses. It has been shown that many of the Grenville gneisses are rich in sillimanite with garnet. The garnet is commonly very abundant and with the sillimanite indicates that the rocks were very aluminous, indeed some of the gneiss have a composition near that of the average shale. At a grade

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(1) Adams, F.D., Geology of a portion of the Laurentian area lying to the north of the island of Montreal, Geology Survey Canada, Annual Report, 1895, J.

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(2) Wilson, M.E., The banded gneisses of the Laurentian highlands of Canada, American Journal Science, (4), 36, 1913.

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of metamorphism lower than that of the typical Grenville rocks cyanite proxies for sillimanite but garnet is present. The gneiss except for one exposure of Canica-Cawatose area contain neither sillimanite nor cyanite, and garnet is less abundant than in typical Grenville paragneiss. The sediments were presumably less aluminous than the average shale. Their present composition would indicate that they were clastic rocks such as impure sandstone. Somewhat argillaceous sandstones or greywacke sandstones could yield a paragneiss of the type observed.

The exposure of six feet of quartzite and three feet of a crystalline limestone on the east side of Lake Canica might suggest that Grenville rocks are present. However, the very insignificant amount of such rocks raises an important problem. If the layering of the paragneiss represents bedding, and the series is not overturned, the limestone and quartzite are stratigraphically above the bulk of the paragneiss. Retty[1] explored the region to the east of Lake Canica and found very little limestone or quartzite. Most of the area shown as Grenville-type rocks is apparently medium-mafic paragneisses.

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(1) Retty, J.P., Upper Gatineau Region, Q.B.M., 1933,C, Map 301

The information gained by mapping is adequate to indicate that quartzite and limestones that may be considered characteristic of the Grenville do not occur in or near the map area. Heavier beds of limestones and quartzite are found near the Mount Laurier end of the road.

In some measure the disparity of composition of typically Grenville rocks and the paragneiss of the Canica-Cawatose suggest that the series are not the same. However the differences are not so great that they could not be the result of a facies change in the sedimentation accompanied by a change in degree of metamorphism. The paragneiss of the Canica-Cawatose area might well be the near-shore facies of the sediments with the Grenville as the off-shore facies. The small amount of limestone in the Canica-Cawatose region may be as the structure suggests in the upper part of the series and therefore be in the upper part of the clastic series. There is no obvious way in which the question can be solved except by relatively detailed mapping of the region between the typical Grenville and the paragneiss of the Canica-Cawatose area.

If the paragneisses of the province and Grenville are continuations and the paragneiss are traceable into the band of sedimentary rock on the south side of the Keewatin volcanics the relationship of volcanics and sedimentary rocks must be discussed.

Keewatin-type[1] volcanics were first described in the Lake of the Woods Area in western Ontario. They were considered a series of metamorphosed volcanic and sedimentary rocks steeply-folded and intruded by granite. The Keewatin was believed to be the base of the Archean. Later a relatively thick series of meta-sedimentary rocks, named Couchiching, was mapped in this area, but the mapping is in error as some of the sedimentary rocks may be younger than the volcanics and some are pyroclastics associated with the volcanics. Even with the removal of the Couchiching, a considerable thickness of intercalated meta-sedimentary rocks remains in the series called "Keewatin".

In western Ontario a series of clastic sedimentary rocks termed "Temiskaming"[2] were found to overlie volcanics that are thought to be of Keewatin age. The classification of the Archean into Keewatin and Temiskaming is not applicable in all parts of the Canadian Shield, and

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(1) Lawson, A.C., On the Geology of the Lake of the Woods Region, Geol. Survey Canada, Annual Report, Vol. 1, Pt. C-C, 1885

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(2) Miller, W.G., Notes on the Cobalt Area, Eng. and Mining Jour., Vol. 92, 1911

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the tendency has arisen to call Archean rocks in which volcanics are dominant "Keewatin-Type" and similarly those in which sedimentary beds predominate "Temiskaming-Type. Ambrose and Gunning[1] have discussed the problem, and although no general solution has been arrived at and generally accepted, it is believed that Temiskaming and Keewatin rocks are approximately the same age. Volcanic and sedimentary rocks appear to interdigitate and replace one another. Such an association is common elsewhere. For example, flows and pyroclastics have intercalated sedimentary rocks of Jurassic and Triassic age in British Columbia[2]. Lake sediments are intercalated in the basaltic rocks of Tertiary age in the Interior Plateaus of British Columbia[3]. Lava flows associated with the Newark series in the Triassic troughs in the Appalachian region may be cited in this connection.

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(1) Gunning, H.C. and Ambrose, J.W., Malartic Area, Quebec, Geol. Surgey Canada, Memoir 222, 1940

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(2) Cairnes, C.E., Geology of Bridge River Mining Camp, British Columbia, Geol. Survey Canada, Memoir 213, 1937

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(3) Lay, Douglas, Fraser River Tertiary Drainage History, British Columbia, Dept.of Mines, Bull. 11, 1941

The interdigitation of sedimentary and volcanic rocks may be seen to be common not only in the Archean but also in many other geological periods. Ambrose, Gunning <u>et al</u> have asseverated that the Temiskaming and Keewatin may be the same age. No definite evidence has been offered to prove that all Temiskaming-type sedimentary rocks are younger than the Keewatin, and it seems plausible that during the Archean there was volcanic activity with some periods during which local deposition of sedimentary rocks occurred. The absence of considerable thickness of volcanics in the southern part of the Temiskaming sub-province may have resulted from either a cessation of volcanic activity during the deposition in the later part of the series, or this area may have been removed from the locus of volcanic activity.

Bain[1] has discussed this problem, and he considers that the Temiskaming, Keewatin, and the Grenville are correlatives. His contention is that the gradation of grain size, thickening of formations, and the inclination of fold axis, indicate that the source of

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(1) Bain, G.W., Correlatives of the Grenville Series, Bull., Geol. Survey of America, Volume 49, 1938

material is northwest of the Temiskaming sub-province. This interpretation of Bain's is, in essence, similar to that postulated in the preceding paragraphs, that is, the Keewatin-Temiskaming-type rocks are correlatives of the Grenville, with the volcanics and clastic sedimentary rocks as near-or on-shore deposits and the limestones and associated sediments as the off-shore deposits.

The present evidence supports the contention outlined in the preceding paragraph, but several pertinent questions remain to be answered such as : is the transition from the Abitibi to the Canica-Cawatose area to the Grenville marked by a zone of adjustment, an abrupt increase in grade of metamorphism, or by an increase in igneous activity? The answer to these and many other problems must be deferred until relatively detailed mapping of several sheets to the north and south of the Canica-Cawatose map area has been completed.

Correlation of intrusive rocks offer a separate problem inasmuch as the intrusives may be correlated only on the basis of similarity of composition, intrusive relationships, and similarity of metamorphism. The age of the intrusives that are intimately associated with the deformed rocks and appear to have shared in the deformation is unknown. The character of undeformed intrusives that might be related to them in age is obscure.

A correlation of the unmetamorphosed, post-kinematic, quartz-syenite can be suggested, but this correlation is uncertain. If the contention regarding the age of the paragneisses as outlined in the preceding paragraphs is correct, the quartz-syenite is probably post-Temiskaming in age and perhaps should be correlated with the syenite or syenite porphyry of Beauchastel or Dasserat townships of western Quebec. Cooke[1] states that the syenites are late pre-Huronian, that is, they are post-Temiskaming and pre-Cobalt. Gunning[2] determined the age of the syenite porphyry as post- "Older Gabbro" and pre- "Later Gabbro", which is in accord with Cooke's interpretation.

Although the quartz syenite is similar to the Beauchastel stock, this correlation should not be accepted

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(1) Cooke, H.C., Opasatika Map-Area, Temiskaming County, Quebec, Canadian Geol. Survey, Summary Report, 1922 Part D.

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(2) Gunning, H.C., Syenite porphyry of Boischatel Township, Quebec, Canadian Dept. Mines, Bulletin 46, July 21, 1927

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as absolute. As previously mentioned, the igneous rocks mapped as granite orthogneisses could be termed quartz monzonite or diorites; the igneous rock of the Canica-Cawatose area are similar in composition to some of the acidic intrusives of the Abitibi, but there appears to be a difference in the intrusive habit of the igneous rock of the Canica-Cawatose and Abitibi regions. The intrusives of the Abitibi are lenticular or stock-like, that is the stocks are post-kinematic, whereas those of the Canica-Cawatose map area are predominately syn-kinematic. It is necessary to again suggest that the ultimate solution of the correlation problem can be achieved only by detailed mapping.

ECONOMIC GEOLOGY

Metallic Minerals

This area is so close to the Temiskaming sub-province from which much mineral wealth is won, that it must be considered worthy of prospecting, despite the fact that lavas and greywackes, identifiable as such, do not occur in the Canica-Cawatose area. Some of the intrusives, which under some systems of nomenclature might be termed granodiorite and quartz monzonite, associated with the paragneisses could quite possibly stem from a larger massif which may have been a source for ore minerals, but no significant mineral deposits have been found. A quartz vein exposed on the east side of a roadcut a mile southeast of Camp Dorval was sampled because it has pyrite, some of which is as cubes a half inch on the edge. Assays of this material made in the laboratories of the Quebec Department of Mines show neither gold or silver, but this result should not be taken to indicate that all quartz veins in this region are devoid of precious metals.

Within the quartz-syenite, some of the dykes of pegmatite show considerable magnetite. Although the amount of magnetite is too small for deposits to be workable, nevertheless the prevalence of the minerals suggests the possibility that at some locality a deposit of magnetite may be found within the area. Some difficulty was experienced in running traverses across the west end of the quartz syenite massif, so that the possibility of the presence of a concealed body of magnetite must be considered.

Non-Metallic and Industrial Minerals

Mica-bearing pegmatites are exposed in several parts of the region. A pink pegmatite, which is found in a small bay on the south side of the north-east arm of Birch Lake a mile and a quarter from the head of the bay, contains potassic feldspars and quartz with "books" of muscovite as much as three inches in diameter. The dyke is 75 feet wide and is exposed for 200 feet in a west-south-west direction. The micas are broken by parting and it is exceedingly difficult to obtain large plates of muscovite.

A small biotite-bearing pegmatite dyke is found on the south shore of Birch Lake one mile to the west of the entrance into the south bay. This dyke is five feet wide and twenty feet long with "books" of biotite as much as nine inches in diameter.

The raising of the water surface in the Ottawa River will cause these dykes to be covered by water, but they are significant in showing that some of the dykes of the district may yield muscovite and biotite as well as feldspar, quartz, and possibly other industrial minerals.

Feldspars, both sodic and potassic, commonly attain a length of more than a foot and are in well-developed crystals without intergrowths of other minerals apparent in the handspecimen. The feldspars are suitable for use in ceramics or as abrasives. The quartz, associated with the feldspars in pegmatite dykes might be used for abrasives or as fused silica in laboratory equipment. The remoteness and inaccessibility of this region prevents the exploitation of these minerals at the present time.

Although this district is remote, the quartz syenite might serve as a stone for buildings or monuments. The tenor of quartz is so low that the rift is not good[1]. The colour and "mixture" of this stone is, however, at

(1) Osborne, F.F., Rift, grain, and hardway in some pre-Cambrian granites, Quebec, Econ. Geology, Vol.30, No. 5, Aug. 1935.

some localities pleasing.

Sand and gravel deposits are found in considerable quantities especially along Highway 58, where numerous borrow-pits attest the suitability of this material for road construction.

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CANICA CAWATOSE AREA
PONTIAC COUNTY
SCALE 2 INCHES TO 1 MILE
CARMAN LAKE
LAC NOLLET
HOPE LAKE
YOUNGS LAKE
MOSQUITO LAKE
LAC DAVIER
SERVICE LAKE
BIRCH LAKE
LAC CARRIERE
CAMITOGAMA LAKE
SUTHERLAND LAKE
STEWART LAKE
WHISKEY LAKE
CAWATOSE LAKE
HARRIS LAKE
CANICA LAKE
NOTTAWAY LAKE
OTTAWA RIVER
BEAVER CREEK
LAC SOULIER
CULLEN CREEK
LEGEND
STRIKE & DIP OF EITHER FOLIATION OR SCHISTOSITY
A - INCLINED B - VERTICAL
STRIKE & DIP OF JOINTS
A - INCLINED B - VERTICAL
TREND & PITCH OF LINEAR ELEMENTS IN FOLIATION OR SCHISTOSITY
GLACIAL STRIAE
GEOLOGICAL BOUNDARY
A - APPROXIMATE B - ASSUMED
EXPOSURE OR STRIKE & DIP SYMBOLS
ESKERS
PORTAGE
RAPIDS
TELEPHONE LINE
ROAD & TELEPHONE LINE
PLEISTOCENE
GLACIAL DEPOSITS
ESKERS
PRECAMBRIAN
DYKES
QUARTZ SYENITE & PEGMATITE
PINK GRANITE & PEGMATITE
GRAY GRANITE GNEISS & PEGMATITE
HORNBLENDE GRANITE GNEISS
BIOTITE GRANITE GNEISS
PARAGNEISS
HORNBLENDE GNEISS
BIOTITE GNEISS
BIOTITE GARNET GNEISS
DECLINATION

CANICA–CAWATOSE AREA

PONTIAC COUNTY

SCALE 1 INCH TO 1 MILE

1/2 0 1 2 3

LEGEND

- CANOE ROUTES
- PORTAGE
- RAPIDS
- TELEPHONE LINE
- ROAD & TELEPHONE LINE
- BUILDINGS
- AREA TO BE FLOODED ELEVATION 1135'
- GLACIAL DEPOSITS
  - SANDS & GRAVEL
  - ESKERS