STRUCTURE AND STRATIGRAPHY OF THE SHERBROOKE SERIES IN THE MEMPHREMAGOG AREA

by

B. M. Veilleux

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McGill University,
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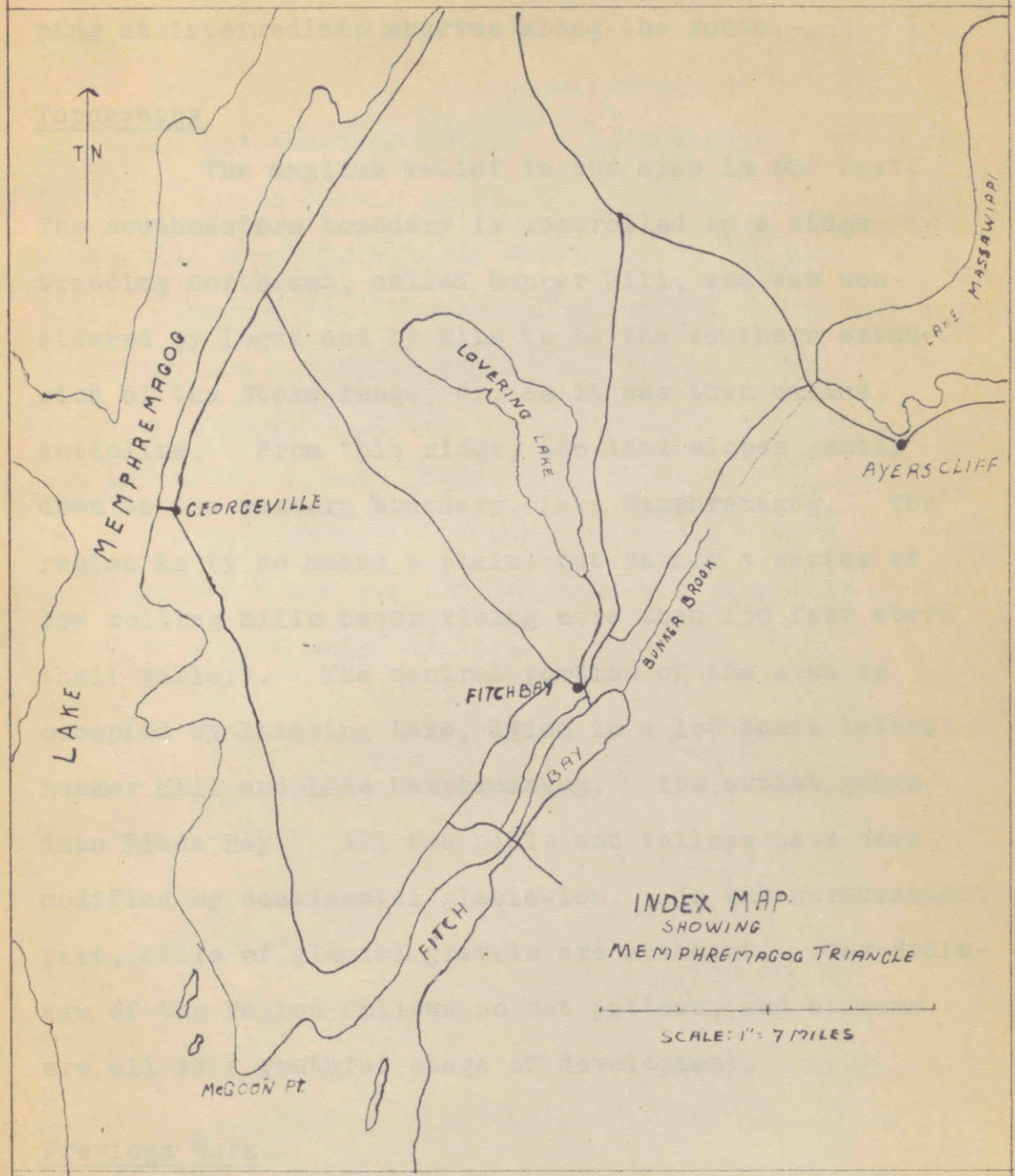
INTRODUCTION

Location and Access to the Area

The Sherbrooke series was examined in detail in the vicinity of Lake Memphremagog in the Eastern townships of Quebec. More specifically, the area lies within the eastern half of the Memphremagog map-area (Canada Sheet 31 $\frac{H}{I}$). This map derives its name from the most priminent topographic feature, namely, Lake Memphremagog, which, running north and south, divides the sheet roughly into east and west halves. The Sherbrooke series occupies a triangular area, with its apex at McGoon Point, bounded on the west by Lake Memphremagog and then on the southeast by a line running from McGoon Point along Fitch Bay, Bunker Hill into Lake Massawippi, and on the north by the northwest shore of the latter lake to the eastern edge of the map sheet. In the following pages this area will be designated the Memphremagog triangle.(See Index Map).

The area is easily accesible in any direction, and by practically any means of transportation. The Canadian Pacific railway passes through the town of Magog just a few miles north of the northern extremity of the map sheet. First class highways cross cut the region in both north-south and east-west directions. During the



INDEX MAP
SHOWING
MEMPHREMAGOG TRIANGLE

SCALE: 1" = 7 MILES

summer months, a steamer service operates on the lake between the towns of Magog and Newport, Vermont, stopping at intermediate wharves along the route.

Topography

The maximum relief in the area is 600 feet. The southeastern boundary is controlled by a ridge trending northeast, called Bunker Hill, and was considered by Logan and by Ells to be the southern extension of the Stoke range, or, as it was then called, anticline. From this ridge, the land slopes gently down to the western boundary, Lake Memphremagog. The region is by no means a plain, but rather a series of low rolling hills never rising more than 150 feet above their valleys. The central portion of the area is occupied by Lovering Lake, lying in a low basin between Bunker Hill and Lake Memphremagog. Its outlet pours into Fitch Bay. All the hills and valleys have been modified by continental glaciation. In the northeastern part, hills of glacial gravels are abundant. The drainage of the region follows no set pattern, and streams are all in a youthful stage of development.

Previous Work

Sir William Logan traversed the southern part

of this area in 1849 and 1850 in connection with his work on the Eastern Townships. The next investigation was undertaken by Ells in 1896. F. A. Kerr surveyed the area for the Geological Survey of Canada in 1923, but published no report. Burton (1932), Dresser (1902-1910) and Harvie (1911-1914) covered the area in connection with its mineral possibilities. Clark (1934) examined the lake shore on the western boundary while mapping a section across the Appalachians of southern Quebec. Ambrose (1943) published a preliminary map of Stanstead, Brome and Hatly counties, but failed to publish an accompanying report. Thus, though many had traversed the area, no one had published a detailed report prior to 1948.

During the field season of 1948 Dr. H. C. Cooke mapped the Memphremagog area for the Geological Survey of Canada, and I acted as his assistant. The discovery of a previously unidentified sedimentary series, here designated the Sherbrooke series, attracted my interest, as its areal distribution and structural relationships to the other rock formations in the Memphremagog triangle presented me with the problem of attempting to untangle it. The solution of this problem, as far as I can untangle it, is the subject matter of the following pages.

Method of Mapping

The region is covered by an excellent topographic map on a scale of 1 inch to a mile prepared by the Department of National Defence (Memphremagog Sheet), and this was used as a base map. The area is divided into an irregular grid by roads, and all traverses were worked from one road to another by pace and compass method. The topographic features are represented in sufficient detail to allow checking of one's position with fair accuracy at all times. In the western part of the region, outcrops are scarce, as the surface is wooded and covered with glacial drift. In the eastern part, outcrops are numerous and good exposures are available. The geology was plotted directly on the base map, and notes were kept on all observed structures and stratigraphic relationships.

GENERAL GEOLOGY

Generalized Statement

The lake-bounded triangle which occupies the northeastern half of the Memphremagog quadrangle presents a great variety of rock types and ages. The petrographic natures range from basic intrusives, such as granites and altered peridotites, to lavas in the igneous group, and from conglomerates to limestones in the sedimentary series. The age range in the area is from Cambrian (?) to Devonian in the sedimentary series and from post-Cambrian to post-Devonian in the igneous group.

The oldest rocks of the area are the Caldwell series, a succession of more or less pure quartzites, slates, and both basic and rhyolitic lavas. These have been traced continuously from the Thetford area by Cooke (Personal Communication). The Caldwell series lies with angular unconformity beneath a series of black slates in which fossils of middle Ordovician age have been found. They have therefore, been tentatively placed in the Cambrian.

Unconformably above the Caldwell is a series of black slates, starting with a basal conglomerate. This

has been correlated with the Beauceville series, named by MacKay in the Beauceville map-area, and have been traced more or less continuously thence by Cooke. This series has elsewhere been called the Farnham series by Dresser (1910, p.211) and the Magog slates by Clark (1934, p.11).

The Bolton lavas followed the Bauceville in the geological succession of events in so far as extrusives are concerned. They were named and described by Clark and Fairbairn (1936, pp.13-18). They consist of metabasalts which lie unconformably above the Beauceville. Fragments of the basalts are found in the basal beds of the Silurian and so their formation must have followed closely upon the Taconic orogenic period.

The next development in the geological succession is the "Sherbrooke Series". This is a new formation and was first found in the Sherbrooke Sheet (Stanstead Range VIII lot 17) by H. C. Cooke in the summer of 1947 while mapping the area for the Geological Survey of Canada, and it has been traced fairly continuously into the present area. It lies unconformably upon the Beauceville and appears to be later than the Bolton

lavas. The Devonian basal conglomerate was found to overlie the Sherbrooke unconformably in the Sherbrooke sheet (Orford Range II lot 4). This places its age somewhere between the Middle Ordovician and the Devonian, probably in the Silurian.

Devonian shales and limestones outcrop all along the eastern shore of Lake Memphremagog. No direct age relationship between the Devonian and the older formations was observed, but a fault contact was indicated at several points.

The oldest intrusive in the area is a metamorphosed gabbro which intrudes the Caldwell lava on the northern side of Bunker Hill but does not intrude the Beauceville. It is therefore assumed to be Middle Ordovician in age.

Peridotite occupies two hills in the northeastern part of the area west of Lake Massawippi. This intrudes the Caldwell series but was not found in contact with any other formation. Clark (1934, pp.1-20) found fragments of peridotite in the basal conglomerates of the Silurian. Cooke (1937, p.71) places the intrusion of peridotites at the end of the Ordovician folding. Thus, it would appear that the peridotites are pre-Silurian

and post-Taconic.

The granite body in the area of McGoon Point intrudes the Sherbrooke series and is doubtless related to the large granite masses to the south and east in the Stanstead area, which have tentatively been placed as post-middle Devonian.

TABLE OF FORMATIONS

QUATERNARY		Post-glacial gravel	
	Unconformity		
POST MIDDLE DEVONIAN			Granite
	Unconformity Acadian Orogeny		
SILURIAN-DEVONIAN		Limestones Slates	
	Unconformity		
	Sherbrooke Series	Slates Conglomerates Grits	
SILURIAN(?)			
	Bolton Lavas	Metabasalts	Peridotite
	Unconformity Taconic Orogeny		
	St.Francis Series	Limestones Slates	
ORDOVICIAN			
	Beauceville Series	Slates Conglomerates	
	Unconformity		
			Gabbro
CAMBRIAN(?)	Caldwell Series	Slates Schists Lavas Quartzites	

CALDWELL SERIES

A series of quartzites, grey to black slates, and lavas, are correlated with the Caldwell series of the Beauceville area, (MacKay 1921, p.20) because of lithological and structural similarities between the rocks of the two areas. Dr. H. C. Cooke traced these formations southwestward from the Beauceville area into this region while mapping the intervening areas during the years 1944-48.

Quartzites

The Caldwell quartzites in the Memphremagog area consist mostly of quartz with argillaceous impurities, and the latter have been metamorphosed into sericite and chlorite. In the more impure quartzites the tendency has been to produce a quartz-sericite schist. This schist, where fully developed, was called by Knox (1918, p.21) the "Bennett Schist", and can be seen all along the west shore of Lake Massawippi where it forms a prominent ridge rising about 500 feet above the lake. This schist is highly impregnated with quartz veins which have developed parallel to the foliation, and numerous small drag folds can be seen all along the strike of the

foliation.

The pure quartzites can be seen in several localities, the most prominent of which is in a road cutting on the main highway from Ayers Cliff to Magog at location Hatley, Range X, lot 5. Here the quartzite is quite massive and only slightly affected by the intense folding of the area. As is usual, this quartzite ranges in color from light to dark grey, and the quartz is mostly fine grained.

Grey Slates

Associated with the massive quartzite there are many bands of grey slate 6"-8" wide, which have been metamorphosed to a sericite schist.

Grey slate of the Caldwell series can be found in many localities in the area. The most typical section occurs on the shore of Lake Memphremagog, just west of the northern tip of Long Island. Here the slate has been converted into a silvery sericitic schist with a very finely developed cleavage. Bedding in this slate has been obliterated by folding and cleavage. This slate in many places grades into an impure quartzite which is not so highly metamorphosed by the folding and retains its more massive nautre. Many of the impurities in this

quartzite have been converted into a white mica, but the development has nowhere gone so far as in the quartz schist seen on the west shore of Lake Massawippi. A good section of the grey slate and impure quartzite can be seen in the bed of the brook down-stream from the road in Stanstead, Range I, lot 17.

Rhyolite

The most important igneous rock of the Caldwell series in the area is the rhyolite. The rhyolite usually stands out as a white mass and when not too badly sheared flow structures can be identified. Usually, however, it is highly sheared and only from structural and areal relationships can it be identified as Caldwell. On the east-west road in Stanstead, Range II, lot 15, Caldwell rhyolite was found interbedded with the Caldwell quartzites. Farther west along this road outcrops of rhyolite occur, but never in contact with any other formation. The criteria used for placing these in the Caldwell were first that the rock was more highly sheared than the contiguous rocks in this limited area, and second lithologically and in degree of deformation these beds resembled the rhyolite found in contact with the Caldwell quartzites.

Andesite

A basic lava of possibly andesitic composition was found in one locality in the area. This was placed in the Caldwell, because of its degree of deformation and alteration. The basic lavas of the Bolton igneous groups can easily be distinguished from the Caldwell lava by using this criterion of deformation. The Caldwell basic lavas are usually altered to a chocolate colored mass of carbonates, and only occasionally can flow structures be recognized. The intensity of shearing has obliterated most of the original extrusive features. The locality where this basic lava is found is on Bunker Hill, Hatley, Range X, lot 4, a quarter of a mile south of the east-west road.

Structure and Age of the Caldwell Series

The average strike of the Caldwell in the area wherever bedding is found is about 35°, and the dip ranges from vertical to 60°. Nowhere in the area can the Caldwell be found in a horizontal position. This is to be expected when it is considered that the Caldwell has been affected by the two main periods of deformation, the Taconic and Acadian. Clark (1937, p.36) found that the Caldwell had been moderately folded prior to the deposition of the Beauceville.

These successive periods of deformation have made it practically impossible to untangle the structure of the Caldwell in the Memphremagog triangle. One generalization proved to be very useful. Wherever the basal conglomerate of the Beauceville was found, as a general rule the Caldwell was not far distant.

The age of the Caldwell has by no means been accurately determined and about all that can be stated is that is is pre-Beauceville. In the area of Castle Brook on the northwest side of Lake Memphremagog, the Caldwell lies stratigraphically below black slates whose age has been determined by the evidence from fossils to be of Middle Ordovician (Ruedemann, R. 1947, p.69).

These black slates have been correlated with the Beauceville in this area by Dr. H. C. Cooke in 1947. The Caldwell underwent a period of erosion prior to the deposition of the Beauceville, and quartzite and slate pebbles lithologically similar to the Caldwell are found in the basal conglomerate of the Beauceville. Clark found this to be so in his work in Thetford-Disraeli district (1937, p.34). The Beauceville series has been determined to be middle Ordovician, and considering the

marked unconformity between it and the Caldwell a Cambrian age is suggested.

BEAUCEVILLE SERIES

MacKay (1921, p.24) proposed the name Beauceville for a series of black slates and conglomerates that he found in the Beauceville map-area of Quebec. Dr. H. C. Cooke traced these slates and conglomerates from the Beauceville area to the Memphremagog area while mapping the intervening region between the years 1944-48.

In the Memphremagog triangle the Beauceville forms a band running approximately north and south about a mile east of the lake shore. This band is about 10 miles long and ranges from one to two miles wide. In other parts of the region the Beauceville appears as irregular masses without any distinct orientation.

The Beauceville of this area is made up of two main rock types -- a basal conglomerate, and a black slate interbedded with thin beds of a brown silty material.

Basal Conglomerate

The basal conglomerate is composed of quartzite pebbles and grey slate fragments in a matrix of black slate. The quartzite pebbles are in some instances rare

or even absent, but in the majority of cases make up from 10 to 30% of the mass. These hard quartzite pebbles are everywhere strung out with their long axes parallel to the direction of rock cleavage. Instances of this can be seen in a band of the basal conglomerate that cuts across the north south road in Stanstead, Range V, lot 24. The pebbles range in size from 1/8" to 3" along their long axes and from 1/8" to 1" along their short axes. In color the pebbles range from dark grey to buff.

The slate fragments in the basal conglomerate usually make up not more than 10% of the mass. The fragments range in size from 1/8" to 1' and can be distinguished from the matrix either by their color or by a difference in strike of the cleavage in the pebbles and matrix. In fresh rock surfaces the brown color of the slate pebbles contrasts strongly with the fresh black matrix.

In this area no contact between the Beauceville basal conglomerate and the underlying Caldwell beds was found, but several patches of Beauceville conglomerate were found to be completely surrounded by the Caldwell, and are, therefore, erosional remnants of the Beauceville on the Caldwell. An example of this can be found in

Stanstead, Range III, lot 16. Here a patch of Beauceville conglomerate forms a small mound completely surrounded by the Caldwell quartzite. A band of this basal conglomerate runs southwest from a trail in Stanstead, Range II, log 14, for about 2 miles, and appears on the shore at McGoon Point. Southeast of this band, and parallel to it, is a band of the Caldwell slates and impure quartzites. This is a good instance where the Beauceville conglomerate indicates the presence nearby of the Caldwell. Northwest of the conglomerate is the Sherbrooke series.

Slates

The Beauceville slates are, on the whole, black in color, possibly due to the presence of carbonaceous material. Interbedded with these beds of black slates are beds of brown silty material which are not as highly cleaved as the black slates. These silty beds range from 1" to 1' in width. The widths of the intervening black slate bands range from 3" to several feet. An excellent typical exposure of these slates can be seen east of Georgeville in a stream bed which crosses the north-south road in Stanstead, Range XI, lot 24. These slates constitute the main band of Beauceville running north from the creek in Stanstead

Range I, lot 20, to the northern limit of the map area, and ranging in width from half a mile to two miles.

This band of Beauceville slates is bounded on the west throughout its entire length by the Silurian-Devonian shales and limestones. No contact between the Beauceville and Devonian was found, but the intensity of the shearing in the Beauceville close to the Silurian-Devonian contact indicates a fault contact. Finally, along the approximate contact there is a faint depression. This may be seen just west of Georgeville. On the east these slates are bounded by the Sherbrooke series.

Structure of the Beauceville

The general strike of the Beauceville is 33° and the dips range from vertical to 60°. The slates were closely folded in the Taconic disturbance. This is evidenced by the persistent steep dips found throughout the Beauceville. Because of the tendency to form isoclinal folds, no large regional structures could be determined.

Age of the Beauceville

The age of the Beauceville has been determined

on the basis of its contained fossils. A series of black slates in the bed of Castle Brook contains grapolites which were determined by Ruedemann (1947, p.69) to be younger than Normanskill, and he considered them to be middle Trenton. These slates in Castle Brook were found during the preceding season's field work by Dr. H. C. Cooke to belong to the Beauceville series. Thus, the Beauceville belongs to the middle Ordovician.

BOLTON LAVAS

The Bolton lavas were named and described by Clark and Fairbairn (1936, pp.13-18) from the western half of the Memphremagog Sheet, in the townships of Bolton and Potton. In the Memphremagog triangle under consideration, the Bolton lavas occupy only a narrow belt extending from McGoon Point northeastwards to a mile beyond the village of Fitch Bay. Remnants of the Bolton lavas can also be found on the northeastern end of Bunker Hill. Between the area of McGoon Point and the village of Fitch Bay, these lavas occupy the high ground just west of Fitch Bay, and, in places, outcrop along the shore of the bay itself. Loon Island is a mound of the lavas protruding up above the surface of the water.

Fairbairn (1936, pp.553-558) described the Bolton lavas as metabasalts and divided them into two lithological units, an ankerite rock and a uralite rock. The latter he found to be the predominant type. The uralite rock he described as

> "Typically grey-green massive and fine textured. Under the microscope the essential minerals are seen to be albite-oligoclase, actinolitic amphibole, epidote-clinozoisite, chlorite and leucoixinized titanite."

The ankerite rock he described as

> "usually buff colored, massive and of fine texture. It is most easily recognized in the field by its rusty, weathered surface, due to decomposition of the carbonate and formation of hydrous ferric oxides."

No thin sections of the Bolton lavas from the eastern half of the Memphremagog area were studied, but from megascopical examination, the vast manority of the exposures can be placed in the uralite type described by Fairbairn. A few patches of the ankerite type were found, but are of negligible importance.

Structure of the Bolton Lavas

Pillow and flow structures are abundant, but rarely give any clues as to the dip and strike of the basalts, because of numerous changes in attitude within a few feet. It would appear that the lavas had been poured out on an extremely uneven surface, as this would account for the extreme diversity in the attitudes of the pillows and flow structures.

Ambrose's preliminary map of the Brome and Stanstead Counties (1943) shows the Bolton lavas to be interbedded with Ordovician slates. Clark (1936, p.17) shows that they lie unconformably above these slates. In the summer of 1947, when I was working for the

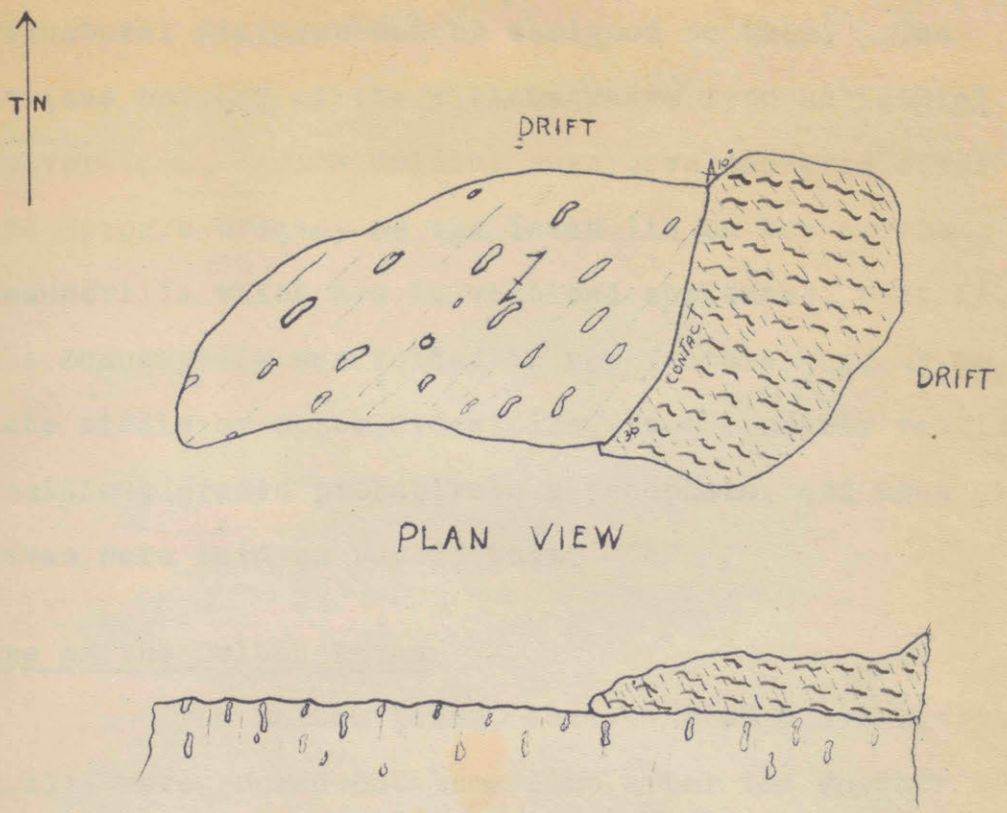
Geological Survey of Canada, under Dr. H. C. Cooke, in the Brome County area, we too found the Bolton lavas of Hog Back Mountain, to lie unconformably upon the Magog slates, which are the equivalent of the Beauceville slates in the eastern section of the map. The slates had vertical dips and the lavas rested upon them in a horizontal position. Thus, it is evident, that instead of the lavas being interbedded with the slates, they are unconformably above the slates.

In the Memphremagog triangle, Hatley, Range IX, lot 2, the Bolton lavas were found to lie on top of the Beauceville conglomerate, in an outcrop in which the approximately vertical cleavage of the Beauceville conglomerate strikes 40. (Plate No. 1).

In his preliminary map Ambrose shows the lavas interbedded and folded with the Cambrian slates in the area of McGoon Point (Stanstead, Range II, lot 12). However, here too I found the lavas to be resting unconformably on the slates and not interbedded with them.

The Bolton lavas in Memphremagog triangle show that they have been fairly well folded, but no large

PLATE-No 1



UNCONFORMITY BETWEEN BOLTON LAVAS
AND
BEAUCEVILLE CONGLOMERATE
LOT 2 RANGE IX HATLEY

structural features can be assigned to them. The strikes and dip of the pillows range from horizontal to vertical. This folding must have occurred after the Taconic orogeny as the lavas lie on top of the Beauceville, which are in vertical attitudes, that is, the Beauceville was folded in the Taconic orogeny in late middle or upper Ordovician, into a nearly vertical position, eroded probably to a peneplain, and then the lavas were laid on top of them.

Age of the Bolton Lavas

The Bolton lavas, according to Clark (1936, p.17), were poured out some time after the Taconic orogeny, and so are at least post-Taconic (i.e. post-Ordovician). They lie unconformably upon the vertical beds of the Beauceville conglomerate and slates. Clark (1936, p.17) found pieces of the basalt in the basal breccia of the Silurian. This would date the Bolton lavas somewhere between the end of the Taconic orogeny and the middle Silurian.

In the Memphremagog triangle the Bolton lavas were found to lie unconformably above the Beauceville, but further evidence to limit their age between the Beauceville and the Silurian is lacking.

The Sherbrooke series was found to have a similar relationship to the Beauceville, and in many places both the lava and the Sherbrooke can be seen within a few chains of each other, lying upon the Beauceville, but they were never found to exist side by side where some distinct structural relationship between them could be studied. However, I am inclined to consider the Bolton lavas to be older than the Sherbrooke series, but for this there is no factual evidence.

SHERBROOKE SERIES

Introduction

This new series, composed of conglomerates, grits, and slates, lying unconformably above the Beauceville and similarly situated below the Devonian, was first noticed in the summer season of 1947, when I was working as an assistant to Dr. H. C. Cooke of the Geological Survey of Canada, in the Orford Sheet of the Eastern Townships of Quebec. The discovery was made in the latter part of the season, and time did not permit us to make a detailed examination.

On Dr. Cooke's suggestion, and with the agreement of Dr. T. H. Clark of the Department of Geological Sciences of McGill University, I decided to make a study of this series the following summer and to submit it as thesis material for the M.Sc. degree.

Prior to their discovery, the rocks of the Sherbrooke series had been included with the Beauceville group, not because of any lithological similarities, but because their structural relationships had never suggested their separation, and their institution as a new series. However, a suspicion of the existence of the

latter had long been harboured by Dr. Cooke, but it was not till he came to be working in the Orford Sheet at Orford, Range VII, lot 18, that the decisive data were found.

Kerr, working in the Memphremagog area in 1923, described rock types which are similar lithologically to the Sherbrooke series, and though he did not recognize that they belonged to neither Ordovician nor Silurian-Devonian series, his pin-pointing of the outcrops was extremely valuable in locating the rock types described in his notes.

Distribution

The Sherbrooke series is not confined solely to the Memphremagog triangle. It was traced by Dr. Cooke and the writer through the Orford and Sherbrooke sheets up to the area around Dudswell and Marbleton.

In the Memphremagog triangle the Sherbrooke series is distributed areally in two bands running about north-northeast. The first band, composed of slates, extends from just south of Lovering Lake to the northern limit of the area, and ranges in width from one to two miles. It is bounded on the west by the Beauceville series, and on the east by the Sherbrooke grits and

conglomerates. The second band is not as regular in shape, and extends from McGoon Point along Bunker Hill to a mile west of the southern extremity of Lake Massawippi, and then turns northwest up to the top of the sheet. It is bounded on the east by the Bunker Brook fault, and on the northern limb by the Caldwell schists.

The Sherbrooke series consists of two main lithological groups, a grit and conglomerate group, and a slate group. In the grit and conglomerate group, the grit predominates, and the conglomerate appears only as local lenses in the grits. However, in some areas, the conglomeratic phases of the grit have basal relationships, and in other parts, the grit acts as the basal phase of the series. The slate group consists of thin grit beds interbedded with a dark bluish slate member which is predominant.

Conglomerate

In the conglomeratic phases of the grit, the pebble assemblage consists of quartz, quartzites, black and grey slate, and feldspars. The ground mass is usually a fine grit that under the microscope appears to be composed of fine-grained quartz, feldspars, sericite,

calcite and slate material. On the average the quartz pebbles predominate, and make up from 20% to 40% of the pebbles. In size these pebbles range from 1/8" to 1/2" in diameter, and usually display a well rounded outline, except in cases where they have been subjected to crushing by folding, and even under such circumstances the outline is still recognizable. The quartz pebbles are of two kinds, the glassy and the milky varieties of which the former is the more numerous (Plate 2A).

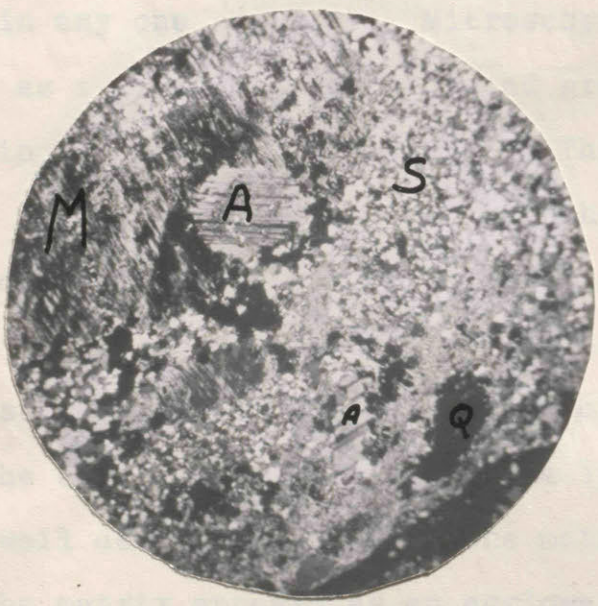
The quartzite pebbles never make up more than 20% of the total, and range in size up to 1/4". They are usually a white to light buff fine-grained variety.

The feldspar pebbles should more properly be termed fragments, as they exhibit very little rounding. Never do they exceed 1/8" in length, and rarely make up more than 5% of the mass. They are always of plagioclase, and in thin section were found to range from albite to andesine in composition. In some specimens the variety myrmekite predominated. However, on the whole, the feldspars have been much altered to sericite and their determination in thin section proved difficult (Plate 2B).

The next most important group of pebbles is

PLATE No.2

Microphotograph of Sherbrooke conglomerate.
(QT) quartzite pebble; (F) andesine feldspar;
(Q) quartz; (S) fine quartz and slaty matrix.
(crossed nicols, x65)



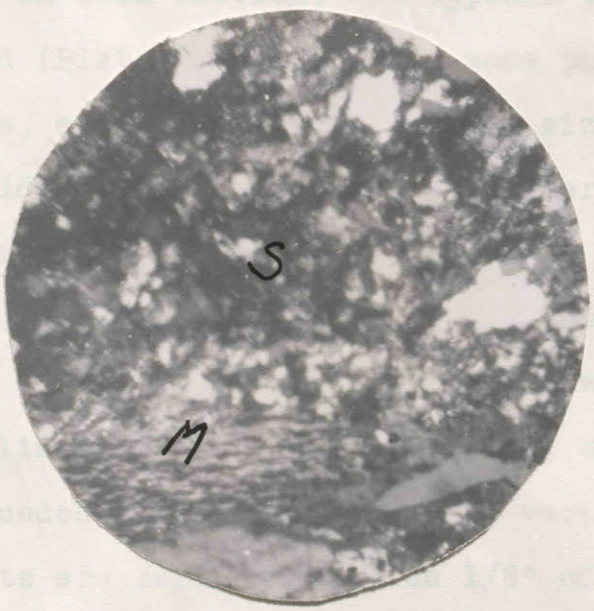
Microphotograph of Sherbrooke conglomerate.
(M) myrmekite;(A) andesine feldspar;(Q) quartz;
(S) fine-grained matrix. (crossed nicols, x65)

composed of slate. These range in color from dark grey to black. In shape the slate pebbles are usually flat and elongated in the direction of the imperfect cleavage of the conglomerates. They appear to have been stretched by the dynamic stresses imposed on the rock during folding. They do not make up an important total of the mass in the conglomerate, and in most hand specimens not more than three or four slate fragments will be noticed (Plate 3A).

The matrix of the conglomerate varies from a coarse grit to a slaty material. Usually both varieties will be found in any one specimen. Microscopically, the matrix appears as a mass of fine white and grey angular fragments set in a slaty mass (Plate 3B). This matrix often displays a slaty sheen, depending on the amount of sericite developed in it. It ranges in color from a light brown to a dark grey. The light brown color is due to the presence of fine disseminated limonite, resulting from the oxidation of pyrite. The latter is often seen in well developed cubes in the matrix. In thin section the matrix appears as an agglomeration of very fine quartz and sericite, together with some feldspar fragments. Crystals of calcite were seen in some specimens, but more as the exception than the rule. Some

PLATE No.3

Microphotograph of Sherbrooke conglomerate.
(S) slate pebbles; (Q) quartz; (I) limonite;
(G) sericite; feldspar; quartz; fine-grained;
(crossed nicols, x65)



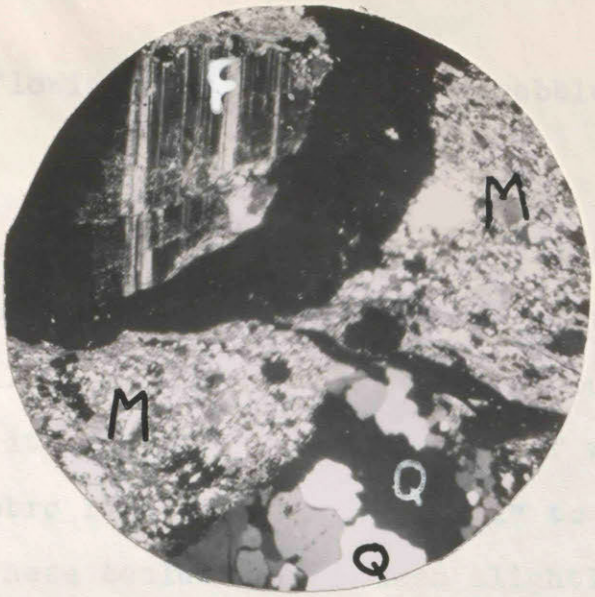
Microphotograph of the Sherbrooke conglomerate.
(S) fine-grained matrix of sericite, limonite, quartz and feldspar; (M) myrmekite.
(crossed nicols, x65)

of the matrix is so fine-grained that with ordinary microscopic methods its constituents were undeterminable.

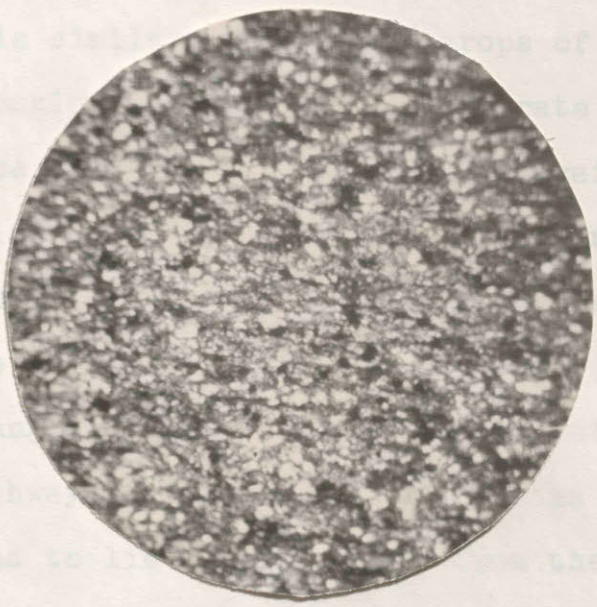
Grits

The grit ranges from an impure quartzite to a greywacke. In some areas the grit is very quartzose, and in others the amount of feldspar increases till it would qualify petrographically as greywacke, that is a rock containing quartz, a lot of feldspars together with a fine gritty material, which is usually undeterminable in thin section, but appears to have been a fine mud (Plate 4A and B). In some phases, it is quite coarse, and the quartz ranges in size up to 1/4". The feldspars are always much smaller, possibly because they are less resistant to erosion. Fragments of black slate are found in the grit, but these are usually rare. The fragments in the grit always show an angular outline, except the fine quartz, which is always well rounded and is of the glassy variety. The quartz fragments are seldom more than 1/8" of an inch in diameter. The color of the grit is always a dark grey in outcrop. It also looks to be massive and unaffected by folding, but in fresh specimens sericite can be seen permeating the whole mass and giving to it a poorly developed cleavage. In thin section, the sericite

PLATE No.4



Microphotograph of Sherbrooke grit.
(F) andesine feldspar; (Q) quartz pebble;
(M) gritty matrix. (crossed nicols, x65)

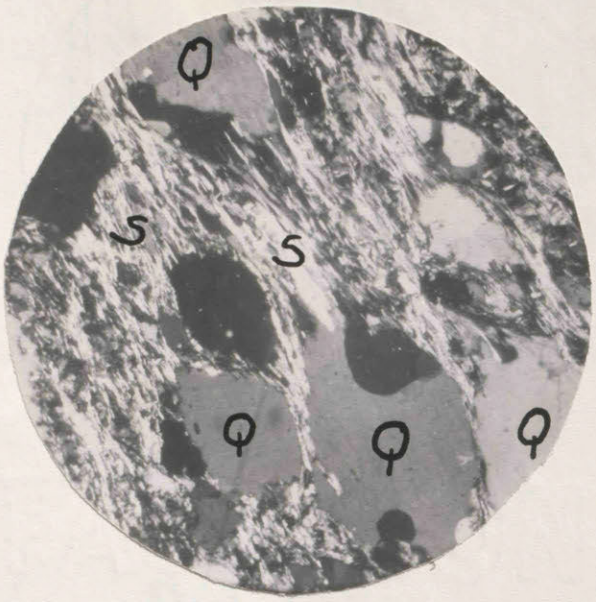


Microphotograph of fine grit of the Sherbrooke formation.

can be seen flowing around the quartz pebbles (Plate 5).

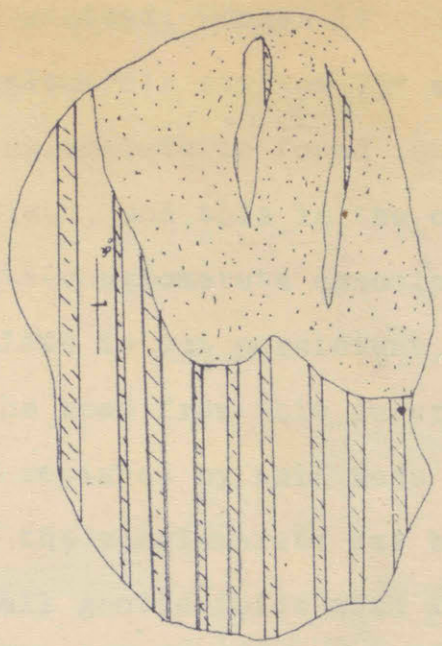
The grit and conglomerate group was first found in Orford, Range VII, lot 18. Here the conglomerate has all the usual characteristics, but in this region alone it displays large boulders of what may have been gabbro ranging in size from 2" to 13" in diameter. These boulders have been slightly carbonated, and are now composed, in addition to carbonates of unknown components, of kaolin, epidote, chlorite and altered pyroxenes. Apart from this unusual feature, it is similar to other outcrops of the Sherbrooke conglomerate. The conglomerate grades through coarse into fine grit, and back again. In this locality grain gradation is of little use in determining tops of beds, and was relied upon only as corroborative evidence. The grit was traced to the road corner in Orford, Range VII , lot 18, and a hundred yards east along the highway on the right-hand side an outcrop of grit was found to lie unconformably upon the Beauceville slate. The slate bedding has a vertical dip, and strikes about 30°, and the grit lies in a nearly horizontal position on top of the slate (Plate 6). This is one locality where the grit is basal to the Sherbrooke.

PLATE No.5

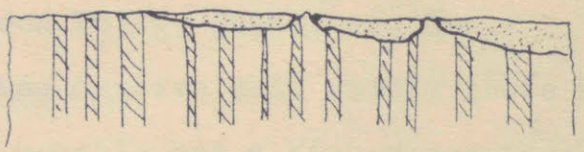


Microphotograph of Sherbrooke grit, showing development of sericite around quartz pebbles.
(crossed nicols, x65)

PLATE-No 6



PLAN VIEW



VERTICAL SECTION

SHERBROOKE GRIT

BEAUCEVILLE SLATES

SCALE 5" = 1"

UNCONFORMITY BETWEEN SHERBROOKE GRIT AND BEAUCEVILLE SLATE

LOT 18 RANGE VII, ORFORD

In Stanstead, Ranges IV and V, lot 27, the Sherbrooke conglomerate strikes 75° and dips 20° northwest. The conglomerate is found interbedded with thin beds of slate, and this is the only locality where this slate-conglomerate association is found. However, the slate is not persistent, for about 30 yards across the road from this outcrop the slate is missing and is replaced by thin beds of grit. In this locality, the conglomerate has been thrown into a series of small gentle folds with a plunge of 5° to the south.

The Sherbrooke grit is well displayed in the area of McGoon Point, Stanstead, Range I, lots 11 and 12. Here the massive grit rarely shows any trace of bedding and usually has a high percentage of quartz grains. Several isolated lenses of conglomerate can be found interbedded with it, but these latter never show any continuity along the strike, and seem to die out within a few chains. In this same locality the Sherbrooke conglomerate runs in a short band from the road in Stanstead, Range XI, lot 15, southwest towards McGoon Point. For the most of its length it is bounded on the south by the basal conglomerate of the Beauceville series. In the northeastern part of the band, the Beauceville

conglomerate is replaced as a bounding formation by the Caldwell slates and quartzite. The Sherbrooke conglomerate grades into a grit towards northwest. This conglomerate may well be a basal phase of the Sherbrooke, but no actual contact between it and the Beauceville could be found, but its areal distribution would indicate such a relationship.

Northwest of the McGoon Point area along Bunker Hill, the Sherbrooke grit is well exposed. The strike on the average is about 37° and the dips are generally 60-80° to the west with the folds overturned to the southeast. In this region the grit is quite massive, but a close inspection reveals a fairly well developed cleavage.

In Stanstead, Range VI, lot 24, about 9 chains north along the power line from the road, the Sherbrooke grit lies on top of the Beauceville slate. At the contact, which strikes 45°, both the grit and the slate are intensely sheared. This is uncommon for the grit, and even a few chains to the north of this outcrop it is fairly massive. The Beauceville slate is also more sheared than usual. This would indicate a possible fault contact. It may be the result of the Fitch Bay-Bunker Brook fault (Ambrose Preliminary Map 1943) which

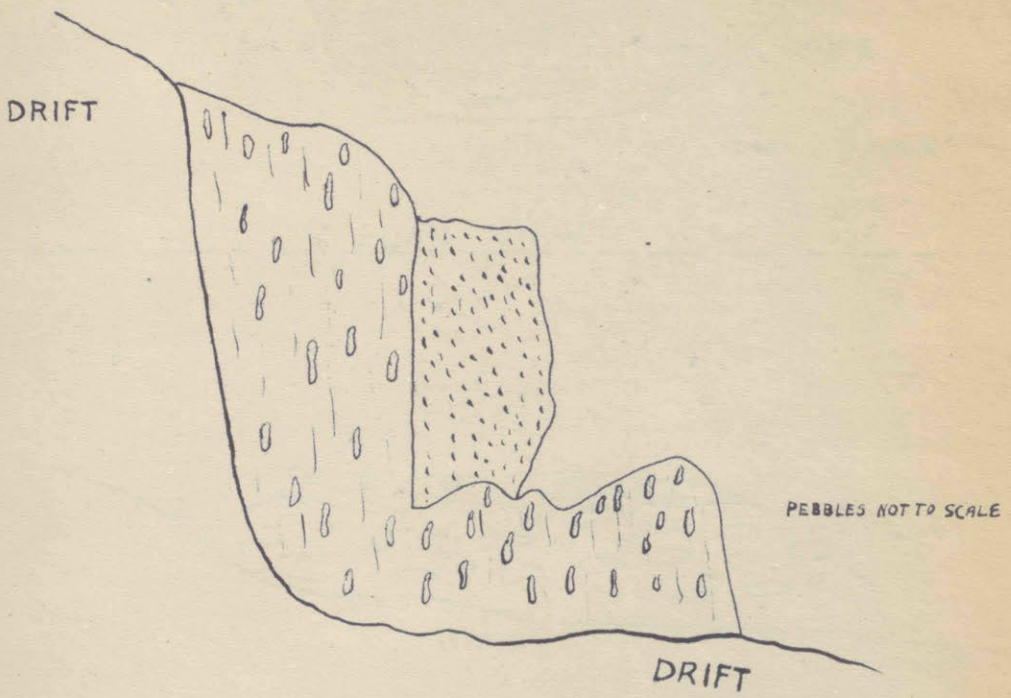
is about 20 chains to the south and strikes 48°.

On the northeastern end of Bunker Hill, Hatley, Range IX, lot 2, the Sherbrooke grit was found lying unconformably upon the Beauceville conglomerate (Plate No. 7). The grit had been deposited on an erosional surface developed on the Beauceville conglomerate. The grit does not show any evidence of having been folded into the conglomerate, but appears to have been laid down in that position.

Opposite the junction of the northwest road running along the north side of Bunker Hill and the main road from Magog to Ayers Cliff in Hatley, Range IX, lot 5, the Sherbrooke conglomerate can be seen lying unconformably upon the Beauceville conglomerate. The latter is well cleaved, and its pebbles elongated, while the Sherbrooke beds resting on top are relatively undisturbed (Plate No. 8).

In Stanstead, Range IV, lot 25, on a side road striking northwest from the main raod between Oliver Corner and Fitch Bay, the Sherbrooke grit lies in a horizontal attitude on the Caldwell slate and quartzite. The first outcrop on the eastern end of the road shows the grit lying horizontally on the Caldwell slates which

PLATE-No 7



VERTICAL SECTION

SHERBROOKE GRIT

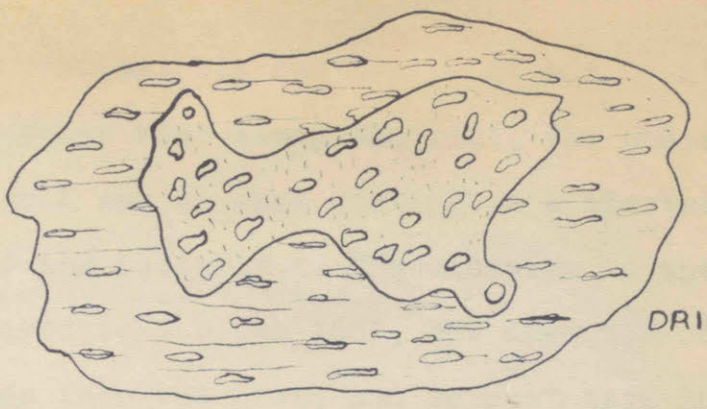
BEAUCEVILLE CONGLOMERATE

SCALE 2' to 1"

UNCONFORMITY BETWEEN SHERBROOKE GRIT AND BEAUCEVILLE CONGLOMERATE

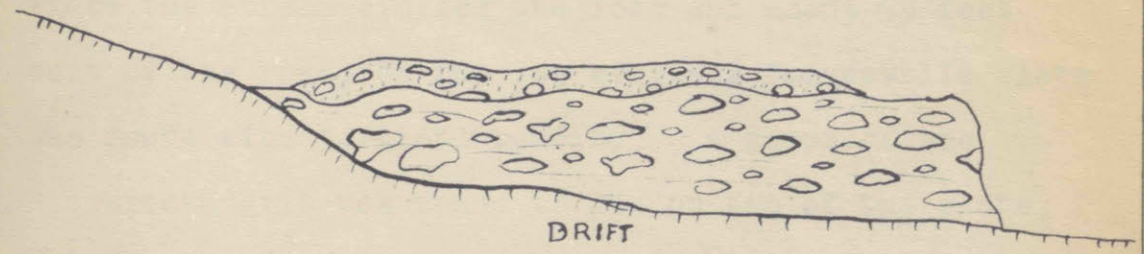
LOT 2- RANGE IX- HATLEY

PLATE No 8



PEBBLES NOT TO SCALE

PLAN VIEW



VERTICAL SECTION

SHERBROOKE CONGLOMERATE

BEAUCEVILLE CONGLOMERATE

1" = 5'

UNCONFORMITY BETWEEN SHERBROOKE CONGLOMERATE AND BEAUCEVILLE CONGLOMERATE

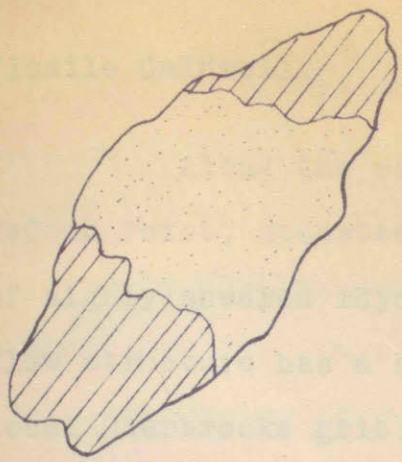
LOT 5 — RANGE IX — HATLEY

here have a vertical dip and strike at 40°. About 20 chains further west along the road, the undisturbed Sherbrooke grit can be seen resting on a cleaved quartzite of the Caldwell. The cleavage in the Caldwell quartzite strikes 160°, but does not continue on upwards into the grit, and so must have been produced in the quartzite prior to the deposition of the grit (Plate No. 9A and B).

In Hatley, Range X, lot 5, 500' southeast of where the stream crosses the road and about 75 feet east of the road, an outcrop of black Beauceville slate was found with vertical bedding. A patch of the Sherbrooke grit was found to lie on top of the slate. In this same outcrop, the grit was found to strike across the strike of the slate.

In the northeastern section of the map-area, the grit is never found in contact with the Caldwell (Bennett) schist, though the latter usually surrounds it, and the lithological differences are quite apparent. That the grit is a later development than the Caldwell is evident from the fact that grit is never deformed to the same extent as is the Caldwell, and it usually displays only a very poor cleavage in contrast to the highly

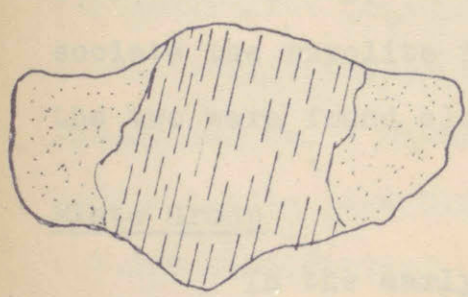
PLATE-No9



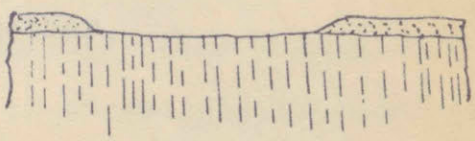
PLAN

HYPOTHETICAL VERTICAL SECTION

"A"



PLAN



HYPOTHETICAL VERTICAL SECTION

"B"

SHERBROOKE GRIT

CALDWELL SLATE

" QTzITE

UNCONFORMITY BETWEEN CALDWELL AND SHERBROOKE GRITS

LOT 24 RANGE IV STANSTEAD

fissile Caldwell.

Along the east-west road in the area of McGoon Point, Stanstead, Range XI, lot 15, two bands of highly sheared rhyolite cross the road, and their flow structure has a similar strike to that of the local Sherbrooke grit. It was therefore contemplated placing the rhyolite within the Sherbrooke series, but on close examination, it was found that it was too highly sheared and metamorphosed to accompany the Sherbrooke group, and this criterion was used to dissociate the rhyolite from the Sherbrooke series wherever the two were found close together.

Slate Group

In the early examination of the Sherbrooke series, there was no indication that it contained a slate member. However, in the Lovering Lake area there is a series of slates interbedded with the Sherbrooke grit. Prior to this discovery, the rocks now called the Sherbrooke slates had been placed in the Beauceville group. This caused a perplexing distribution of the latter in the area, and only when the demonstration that the Sherbrooke series had a slate member was complete did the problem unravel itself.

In the field, it is often a very difficult problem to distinguish one series of slates from another. This is the case in the separation of the Sherbrooke and Beauceville slates, and only when the slates were associated with grits could they be definitely designated as Sherbrooke.

The Sherbrooke slates consist of a series of thin beds, alternating in color from dark grey and bluish to buff. The dark grey and bluish slates are extremely fine grained, and the buff beds consist of coarse grained silty beds, high in feldspar content and low in quartz. These latter often show barely megoscopic needle-like crystals of staurolite or andalusite, and cubes of pyrite. The dark grey and bluish beds are often filled with siderite crystals, which in the weathered zone has altered to limonite, causing rusty patches in the slate. The width of the beds range from 1/4" to 2", and unlike the Beauceville slates they were never found to be any wider.

Near the conformable contact between the Sherbrooke slate group and the grit group on Lovering Lake in Magog, Range XIII, lot 1, the slate contains small lenses of a felspathic grit with a very irregular distribution. This characteristic was not persistent in

the slate 5 feet from the grit slate contact. In this same area, the slate was found to lie conformably upon the grit and the tops of both formations were found to lie to the west. The determination of tops was made by the bedding-cleavage relationship, and was confirmed by grain gradation in the grit near the contact.

Slates were also found on the northwest road in Magog, Range IX, lots 12, 13 and 14. Here the problem of differentiating them from the Beauceville was solved by the recognition of felspathic grit beds interbedded with them. Another factor which aided their determination was that they were on strike with the Sherbrooke slates of Lovering Lake.

East of the above Sherbrooke slate in Hatley, Range IX, lot 13, another small area of Sherbrooke slate is visible. It is bounded on each side by the Sherbrooke grit, and is possibly a small syncline, but only westward dips were found.

The thickness of the Sherbrooke slates, calculated from the outcrops on the shore of Lovering Lake, is 1300'. This figure is only approximate as it was calculated on the assumption of a constant dip of 20° on one

limb of a fold.

Structure of the Sherbrooke Series

The structure of the Sherbrooke series proved difficult to understand, partly due to the lack of a sufficient number of strike readings, and partly to the discontinuity of particular beds from one area to another.

The average strike of the Sherbrooke series is about 38° and a variation of 10° either way was common throughout the area. A few abnormalities in the strike were found, but when studied with reference to the overall structural picture, were found to be explainable on the basis of their position near the axes of the folds.

Structurally, the Sherbrooke group consists of a series of isoclinal folds which on the southeast side of Bunker Hill become overturned towards the southeast. Near the eastern boundary the folds are more open, especially in the grit beds, while the incompetent slate members in the same region have been compressed into tight isoclinal flexures.

In order to explain the structural relationship of the Sherbrooke series to the Beauceville, Caldwell

and St. Francis series, an assumption must be made for which there are no facts as evidence, but which seems to explain logically their relationships as observed in the field.

The St. Francis limestones and slates that exist southeast of the Bunker brook fault will be considered as slightly younger than the Beauceville in age. Dr. H. C. Cooke has traced this formation from the Thetford area to the present location, and Clark (1937, p.42) considered the St. Francis series to be either contemporaneous with the Beauceville, or a little older.

Here it will be assumed that the St. Francis Series was laid down on top of the Beauceville with no unconformity in a basin and that its greatest thickness was to the southeast and that subsequent erosion prior to the deposition of the Sherbrooke removed sufficient of the St. Francis in the northwestern section of the syncline to lay bare the Beauceville. This is not an unreasonable assumption, considering that such conditions are often observed in sediments deposited in synclinal basins.

Before discussing the sequence of events that

produced the structures in the Sherbrooke series and its relationship to the St. Francis, Beauceville and Caldwell series, the following facts observed in the field will be enumerated:

1) The Sherbrooke series is overturned in the vicinity of the Bunker brook fault, and that this overturning is only found in the proximate area of the fault suggests some relationship between the two.
2) Along the northwest shore of Lake Massawippi, which is also on the northwest side of the Bunker brook fault, the Caldwell (Bennett) schists have been intensely drag-folded, and these drags show the northwest side to have moved up relative to the southeast side. No actual direction of movement could be ascertained. These drags had been imposed on the schistose structure after its development because the quartz veins that are usually found between the foliation layers have been intensely crushed by the drags. These observations are in harmony with Clark's suggestion (1934, p.15) that the fault is an underthrust.
3) On the southeast side of the fault we have the St. Francis series differing from the Sherbrooke on the northeast side lithologically and in age. This is

evidence that a fault actually exists, along with the topographic feature of a distinct scarp bordered on the southeast by a lower land surface.

4) In Stanstead, Range VI, lot 22, on the southeast side of Bunker Hill the contact between the Sherbrooke and the Beauceville is a fault contact which strikes 45°, approximately parallel to the Bunker brook fault.

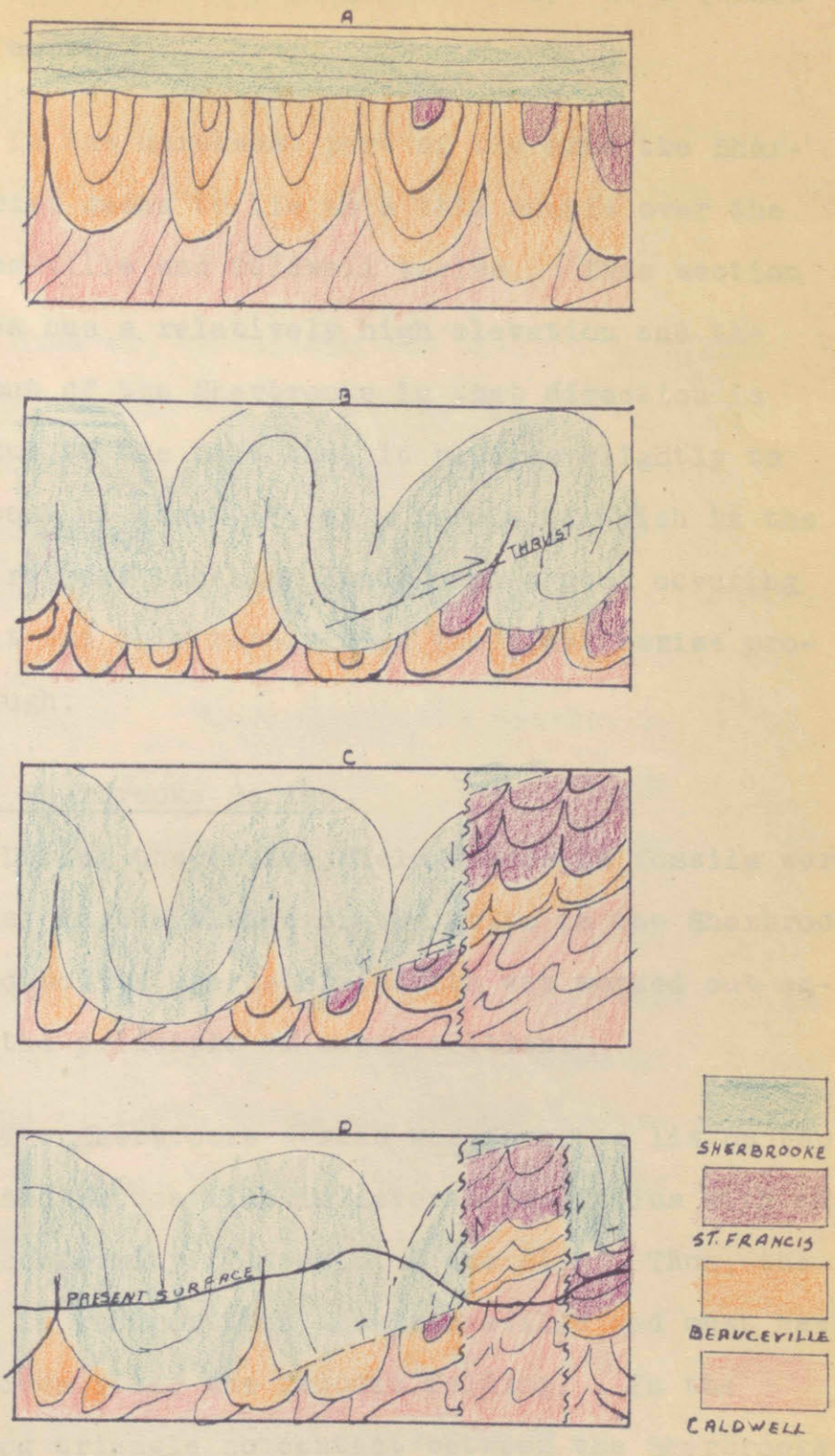
5) The areal distribution of the various series as we go from the northwest to the southeast across the fault could not have occurred as a result of ordinary sedimentation, folding and subsequent erosion. A section along the line A B on the accompanying map (in pocket) will show the distribution mentioned above.

In accordance with the above field observations, and utilizing the assumption regarding the St. Francis series, I propose the following sequence of events to explain the present structural relationships of the Sherbrooke series to the older formations of the area.

The St. Francis series was laid down conformably upon the Beauceville with its greatest thickness in the southeastern section of the map. The Taconian orogeny

then folded the Caldwell, Beauceville and St. Francis series into tight isoclinal folds. Following this, erosion set in, and, in the northeastern section of the area wore away all the St. Francis series and a good part of the Beauceville, cutting down even into the Caldwell. Then came the deposition of the Sherbrooke conglomerate, grits, and slates (Plate No. 11A). These were then compressed from the northwest producing isoclinal folds that in the area of Bunker Hill become overturned. Overturning gave way to thrust faulting towards the southeast (Plate No. 11B). When the forward movement of the thrust had halted subsequent crustal adjustment took place in the form of vertical faulting. The first vertical fault moved the southeast side up bringing the Beauceville and the Caldwell to their present locations next to the Sherbrooke (Plate No. 11C). Evidence for this can be seen in the fault contact between the Sherbrooke and the Beauceville in Stanstead, Range VI, lot 22. Finally, another vertical fault occurred and the southeast section of the block was dropped down bringing the St. Francis into its present position opposite the Caldwell on the southeast side of the first fault (Plate No. 11D). Erosion then planed the region down to its present level, leaving the areal distribution of the formations as it is shown on the accompanying map. A

PLATE - No 11


A
B
THRUST
C
D
PRESENT SURFACE
SHERBROOKE
ST. FRANCIS
BEAUCEVILLE
CALDWELL

cross-section also shows diagramatically the sequence described above.

In the northeast part of the area the Sherbrooke series seems to lie as a thin mantle over the older Beauceville and Caldwell series. This section of the area has a relatively high elevation and the thinning out of the Sherbrooke in that direction is possibly due to the fact that it plunges slightly to the southwest at about 5°, as a result of which in the southwestern part the high lands have a good covering of the grit and only rarely does the older series protrude through.

Age of the Sherbrooke Series

During the entire field season no fossils were found either in the slates or the grits in the Sherbrooke series, and so its age determination was worked out entirely by the principle of superposition.

The Sherbrooke series was found to lie on top of the folded Beauceville in several localities with an angular unconformity (Plates 6, 7 and 8). Thus, the Sherbrooke is younger than the Beauceville and must have been laid down after the Taconic folding. In the Memphremagog triangle no contact between the Sherbrooke and the Silurian-Devonian formation was found, but the

fact that the former is folded places it at least in pre-Acadian disturbance time, for the Acadian folding which occurred in middle Devonian is the only orogeny for which there is evidence in this region after the Taconic folding.

However, in tracing the Sherbrooke series into the Sherbrooke map sheet, the Sherbrooke conglomerate was found (Orford, Range III, lot 6) to be plunging about 20° to the southwest, and about 20 chains along the direction of plunge of the Sherbrooke the basal conglomerate of the Devonian was found with a similar plunge. This places the Sherbrooke stratigraphically below the Devonian. The Devonian basal conglomerate was identified by Dr. H. C. Cooke who had traced it from the Lake Aylmer region.

Two miles northwest of this last location in Orford, Range II, lot 4, the basal conglomerate of the Devonian was found to be on top of the Sherbrooke grit and slate. There was no marked unconformity between the two, but rather a disconformity. Again, about 2 miles northwest across the St. Francis River in Richmond, Range I, lot 12, a large fragment (6' x 4') of the Sherbrooke slate, identified by the presence of a grit bed,

was found in the Devonian conglomerate. The occurrence is not remarkable because the Sherbrooke slate is found about 500 yards southeast of this location and also a mile northwest at Beauvoir (Plate 10A, B and C).

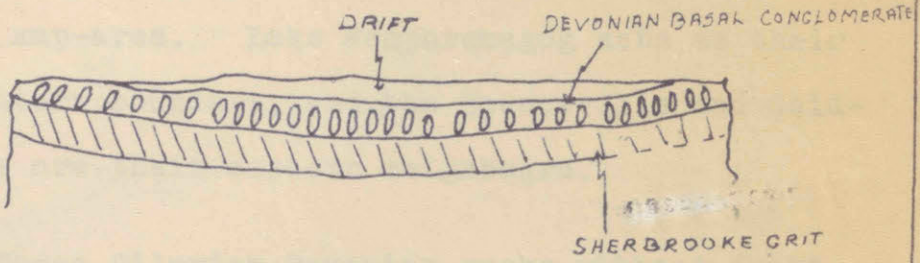
From the above evidence it is clear that the Sherbrooke is older than the Devonian, which latter was determined by Clark (1937, p.42) to be Helderberg in age. Hence the age of the Sherbrooke series is somewhere between the late Ordovician and the lower Devonian.

According to a personal communication from Dr. T. H. Clark, the Peasely Pond formation (Clark, 1936) has a similar relation to the Beauceville-Magog slates on the western side of Lake Memphremagog as the Sherbrooke has to the Beauceville in the Memphremagog triangle. Lithologically, some of the conglomeratic phases in the Sherbrooke series are similar to the Peasely Pond conglomerate which is basal to the Silurian Glenbrooke series. This is further evidence that suggests a Silurian age for the Sherbrooke.

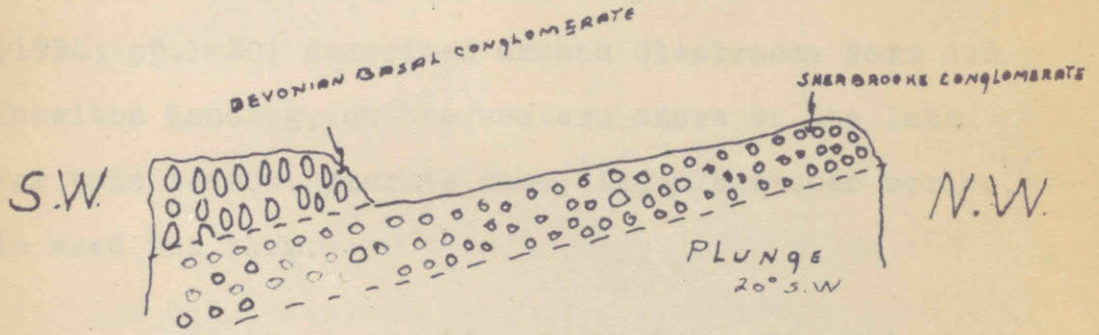
PLATE- No 10

VERTICAL SECTIONS

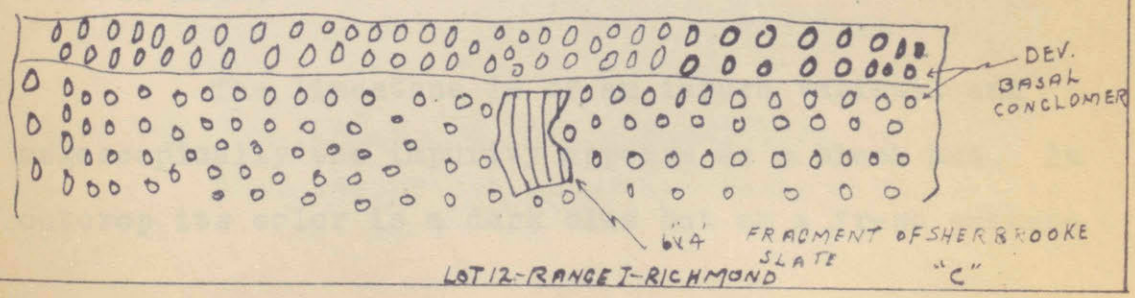
UNCONFORMITY BETWEEN SHERBROOKE SERIES AND DEVONIAN BASAL CONCLOMERATE



LOT 4-RANGE II-ORFORD "A"



LOT 6- RANGE III-ORFORD "B"



LOT 12-RANGE I-RICHMOND "C"

SILURIAN-DEVONIAN FORMATIONS

The Silurian-Devonian rocks occupy the western side and boundary of the Memphremagog triangle. They occupy a belt which ranges in width up to a mile and extends from McGoon Point northwards to the top of the map-area. Lake Memphremagog acts as their natural western boundary, and the Beauceville and Caldwell series are their eastern neighbours.

These Silurian-Devonian rocks without doubt belong to the Silurian-Devonian syncline that Clark (1934, pp.1-20) described around Glenbrooke Farm and Knowlton Landing, on the western shore of the lake. For this reason, Clark's name, the Glenbrooke series, is used for them.

On the east side of the lake, the Silurian-Devonian formation consists of limestones and slate members. In some localities the slates are more of the order of shales, but no attempt to differentiate the two was made.

The limestone is of an impure variety, and megascopically the impurity appears as a black mud. In outcrop its color is a dark blue but on a fresh surface

it is a light grey. Fossils were found in two localities, but were deformed beyond recognition, except for a few crinoid stems, which are useless for age determination. These fossil localities are situated as follows:

a) 75 yards south of the cemetary in Stanstead, Range II, lot 25.
b) One quarter of a mile south of Oliver Corner on the west side of the road in Magog, Range XVI, lot 7.

The limestone member is always found as the most easterly unit of the series. The slates occupy the shore line and intermediate regions between the shore and Beauceville series. No actual distances can be quoted because the belt varies in width. The slates range in color from black to dark grey, and always have a high calcareous content, as determined by the application of acid. In the slates west of the bend in the road in Stanstead, Range I, lot 17, an abundance of corals can be seen, but these were all too highly deformed as a result of folding and shearing to be identifiable.

Structure and Age of the Silurian-Devonian

The average strike of the Sherbrooke in this

area is from 20° to 30°, and the dip is usually vertical. On the map (in pocket) the Glenbrooke-Beauceville contact is shown as a fault contact. The reason for invoking a fault was due to the peculiarity observed in both series as we approach the contact. Along its entire length the Beauceville becomes intensely sheared as we approach the Glenbrooke. Similarly, the Glenbrooke is more highly deformed than is usual. In Stanstead, Range I, lot 24, a mile and a half east of Georgeville, the position of the contact lies in the vicinity of a brook which runs north and south. No outcrops were found in the gravel-filled bed of the brook, but as we approach the brook from either side, both formations become intensely sheared. In Magog, Range XVI, lot 5, a half mile south of Oliver Corner, a similar situation was observed. In the area of McGoon Point, Stanstead, Range I, lot 15, about 400 yards east of the road, the Glenbrooke and Caldwell are in contact. Both are highly sheared, and from a cleavage-bedding relationship the tops in the Glenbrooke were to the east with a dip to the east, and the Caldwell had a similar eastward dip, but tops were overturned to the west. This situation could only be brought about by a fault contact.

From the above evidence, it is assumed that a

fault exists throughout the entire length of the contact.

Clark (1934, pp.1-20) gave the Glenbrooke series a Silurian-Devonian age on the evidence of fossils. During the present investigation fossils found in the Glenbrooke on the east side of the lake yield no definite age determination. Ami (in Ells 1896, p.133) claimed that fossils found around Georgeville belong to the Devonian.

There is another small limestone area in the southern part of the McGoon Point area, in Stanstead, Range XI, lots 10 and 11. Lithologically the rocks here resemble the Glenbrooke limestones, and are intensely deformed where they outcrop along the shoreline. These might possibly belong to the Ordovician limestone of the St. Francis series extensively developed south of the Bunker Brook fault, but nothing could be ascertained to place them definitely in either the St. Francis series or the Glenbrooke series. For purposes of mapping they will be considered as a section of the St. Francis series.

INTRUSIVES IN THE MEPHREMAGOG TRIANGLE

Gabbro

A gabbro dike or sill occurs on the north-eastern end of Bunker Hill. It shows up in a road cutting in Hatley, Range IX, lot 4. It is fairly coarse-grained and the original texture is well preserved, though the mafic minerals have since been replaced by carbonates and sericite.

The gabbro strikes southeast from the road cutting for a distance of a mile and a half, where it is terminated by a cross fault striking northwest with an apparent displacement of 1000'.

The gabbro may either be a dike or sill, for it follows more or less the vertical attitude to the Caldwell which it intrudes. It was never found to cut across the Caldwell but rather parallels the gentle flexure in the strike of the latter. It might possibly have been intruded as a sill into the Caldwell slates and rhyolites and then have been brought into its present position in the Taconic folding, or it might have been injected concordantly into the vertical beds of the Caldwell. It was not found intruding any formation

later than the Caldwell series and so from these data it has been called post-Cambrian and pre-Beauceville.

Serpentine

In the northeastern section of the map-area, two elliptical hilss rise above the countryside. These two hills occur in Hatley, Range VI, lot 9, and Hatley, Range VII, lot 12, and are composed of serpentine.

Both these serpentine bodies intrude the Caldwell (Bennett) schists of that area. They were without doubt intruded as a fluid peridotite magma, for small dykes can be found radiating from the main masses, cutting across the foliation of the Caldwell schists. Examples of these dykes can be seen in Hatley, Range VI, lot 11, about 600' west of the 90° turn in the side road which leaves the main road on the east side.

From the data found in this area only an age of post-Cambrian can be given to the serpentine hills, but they doubtless originated at the same time as the other serpentinized peridotite bodies of the serpentine belt which runs from the Mansonville area in the southwestern part of the Memphremagog sheet northeastward to the Thetford sheet. Cooke (1937, p.70) found the peridotite cutting the Beauceville series and Clark (1936, p.16) found pieces

of the peridotite in the breccia basal to the middle Silurian. These observations place the peridotites somewhere after the Taconic orogeny and prior to the middle Silurian.

Granite

Only one small area of granite was found in the Memphremagog triangle. This occurs in the south-west portion of McGoon Point in Stanstead, Range I, lot 11. This granite is lithologically similar to the Stanstead granite found to the south of this area in the region of Graniteville and Stanstead. In the main the rock is medium grained, and is composed of quartz, orthoclase, albite and biotite.

The granite was found to intrude the Sherbrooke grit, and at the contact the former displays a chilled edge, and the grit is baked to a hornfels, proving that the granite is at least post-Sherbrooke. Doubtless this small body is an offshoot of the larger masses to the south in the area of Graniteville. The latter intrude the limestones of the area, but these limestones are of Ordovician age. Thus, the most that can be said for the granite in the Memphremagog triangle is that it is post-Sherbrooke, i.e. post-middle Silurian. However, had the

granite been intruded prior to the Middle Devonian, it would have been deformed in the Acadian orogeny. On the contrary the granite is totally undeformed and massive. This indicates that the granite can be no older than the middle Devonian.

ECONOMIC GEOLOGY

Mineral resources of an economic value are entirely lacking in the Memphremagog triangle. This is due partly to the lack of important intrusive bodies in the area that might act as sources of mineralized solutions. The peridotites have been altered to serpentines, but no quantities of asbestos were found associated with these bodies. A few small veins filled with asbestos slip fibres can be found in the serpentine, but because these are the result of movement they are not of the commercial variety. The latter almost invariably results from the recrystallization of serpentine along tension cracks.

The granite in the area of McGoon Point was quarried many years ago for local use, but neither its volume nor its accessibility renders it of a commercial value.

The main resource of the area is the glacial gravels. In the northeastern section of the map triangle nearly all the hills are composed of glacial sands and gravels, which have been extensively dug into for road construction throughout the area, and yield a large portion of the yearly income of the inhabitants.

The northern half of the triangle represents good farming land with the most advantageous areas along the lake shore. In the southern part the top soil is poor and scarce, and only a farm here and there ekes out an above subsistance level of living.

A second important feature of the area is its scenic beauty which attracts a large number of summer vacationists. Lake Memphremagog is long and narrow, with small mountains rising from its western shore line, giving it a beauty unsurpassed in any part of eastern Canada.

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SHERBROOKE SERIES
IN THE
MEMPHREMAGOG AREA

Scale:- 1 inch to ½ mile

MEMPHREMAGOG

STANSTEAD

MAGOG

HATLEY

LAKE MASSAWIPPI

LAKE MEMPHREMAGOG

Georgeville

Magoon Point

Whitestone I.

Long I.

Fitch Bay

FITCH BAY

BUNKER HILL

I II III IV V VI VII VIII IX X XI

XVII XVI XV XIV XIII XII XI X IX VIII VII VI

IGNEOUS GROUP

SEDIMENTARY GROUP

LEGEND

SILURIAN — BOLTON LAVAS

UPPER ORDOVICIAN — SERPENTINE

POST-MID.-DEVONIAN — BIOTITE-GRANITE

POST CAMBRIAN — GABBRO

SIL-DEVONIAN — 7 — GLENBROOKE — SHALES, LIMESTONE

6 — SLATES

SILURIAN (?) — 5 — SHERBROOKE — CONGLOMERATE

4 — GREYWACKE

ORDOVICIAN — 3 — ST. FRANCIS — SHALES, LIMESTONE

2 — BEAUCEVILLE — SLATES, CONGLOMERATE

CAMBRIAN (?) — 1 — CALDWELL — SLATES, RHYOLITE, QUARTZITE

FAULT

OUTCROP BOUNDARIES

ASSUMED GEOLOGICAL BOUNDARIES

DRIFT COVERED AREAS

A — B — 900' ELEVATION