THE GEOLOGY OF A PORTION OF SHELBURNE CO., SOUTH WESTERN NOVA SCOTIA.—BY SIDNEY POWERS, *Geological Museum, Cambridge, Mass.*

Read 16 February 1914.

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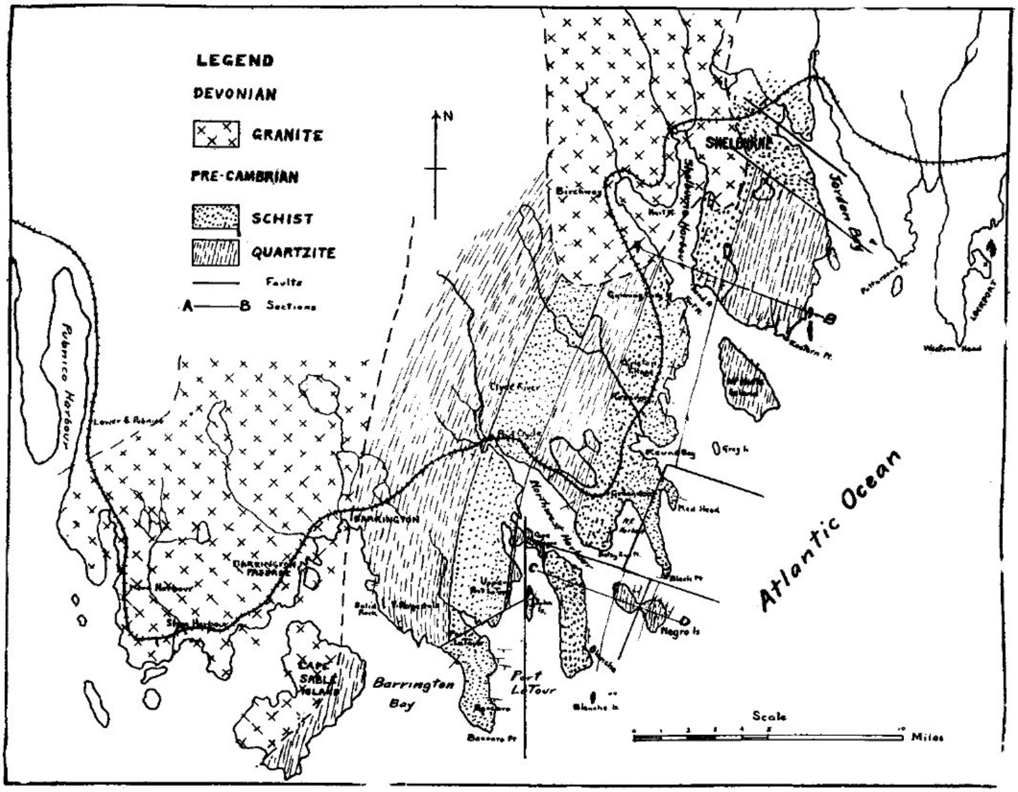
INTRODUCTION.

This paper represents the results of a brief geological reconnoissance along the shore of Southwestern Nova Scotia from Jordan Bay to Barrington Passage, made during June 1913. The object of this reconnoissance was to study the structural geology, but outcrops were found to be few in number, and to be practically confined to the wave-beaten ends of the peninsulas, and therefore the work was not extended farther. As the only detailed previous examination of the region was made by Dr. L. W. Bailey in 1891 to 1896*, it is thought that this paper may form a contribution to the knowledge of the region. The structural details and the petrography of the igneous rocks were not considered in Dr. Bailey's report.

The general geologic features of the region consist in a series of pre-Cambrian metamorphic quartzites and schists intruded by Devonian granites which have produced extensive contact metamorphism in the already regionally metamorphosed and folded sediments. Glacial deposits now cover the surface allowing the geologist only an occasional glimpse at bed rock.

* Report on the Geology of Southwestern Nova Scotia; Canadian Geological Survey, Ann. Rept. Vol. 9, Pt. M, 1898.



PHYSIOGRAPHY AND GLACIAL GEOLOGY.

Southwestern Nova Scotia is a low, rolling country indented by an embayed shoreline. Numerous lakes, often of large size, and more numerous peat bogs representing former lakes cover the low-lying areas. Where these are absent, boulders characteristically cover the land, representing the ground moraine. Such a topography determines the occupation of the inhabitants of the country, preventing agriculture and promoting fishing and boat-building. The low hills are covered by a dense, but low, forest of spruces and balsams which effectually conceal the view. Frequent forest fires, due to the carelessness and wilfulness of the inhabitants, prevent the growth of mature forests and leave in their wake a scene of desolation—burned villages and square miles of charred tree trunks laying bare the boulder-strewn ground moraine.

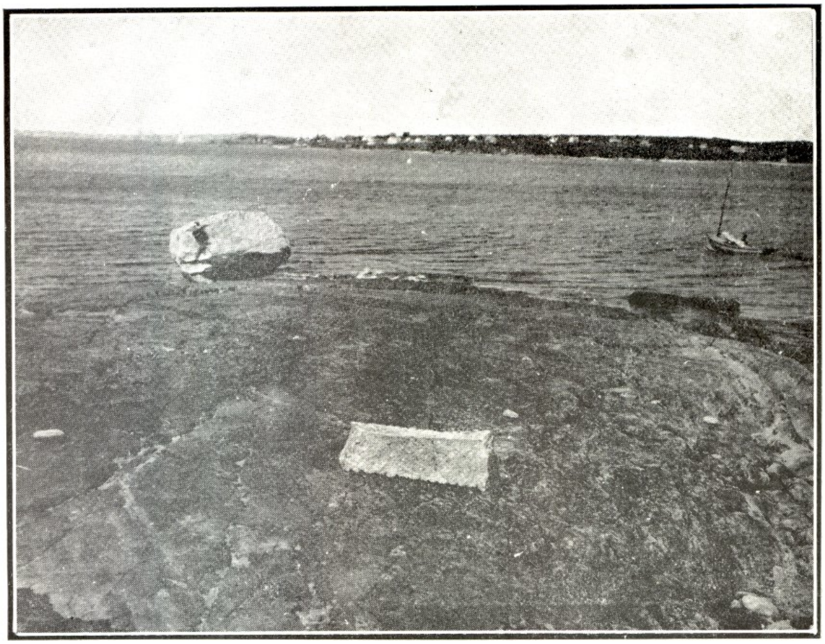
The present topography of the region is due to the dissection and drowning of the Cretaceous peneplain and to glaciation. The peneplain was uplifted probably toward the middle of the Tertiary and suffered erosion throughout the remainder of the Tertiary. The land during this period appears to have stood higher than at present, long valleys being formed which are now drowned. These valleys were formed without respect to geological structure because the rocks have about a uniform hardness and have been sufficiently metamorphosed to obliterate the primary structure and yet not to produce pronounced cleavage. The submergence of the land to its present level took place at about the time when the Pleistocene ice sheet advanced over Nova Scotia. The submergence did not go below present sea level because there are no marine beaches or wave-cut terraces above those being formed at present. In the Bay of Fundy region there is evidence of a recent uplift as is shown by the presence of marine fossils in beaches 200 feet above water level. It is therefore evident that there has been a differential uplift of the land in the latter region. This tilting must have been at least as great as two feet to the mile, as it is 108 miles from Shelburne to St. John where the elevated beaches are found.

The effect of glaciation has been to modify the topography. Glacial erosion can be measured in at least tens of feet, for everywhere the pre-Glacially weathered rock has been removed, and the bed rock scoured and channeled. Roches moutonnées are very frequent where wave action has removed the glacial deposits. These rounded knobs are especially noticeable at Port La Tour, forming islands at the entrance to the harbour.

Glacial deposits, other than the ground moraine, are largely of stratified drift. Eskers are the most striking phenomenon, but kames are also present. The character of the deposits must depend upon the kind of material with which the ice has to work. In the peninsula of Nova Scotia are soft Triassic sandstones and hard traps, developed only in a narrow band; fossiliferous Lower Devonian shales; and pre-Cambrian quartzites, slates and schists; the latter two series being invaded by the micaceous granitic rocks which form the central axis. The Triassic and Lower Devonian sediments would not furnish material for distant transportion and the traps would suffer little from glacial erosion. Therefore, for Shelburne County there was available a large quanity of sand derived from the granite and quartzite, and some sand and clay from the schist and slate, as well as massive material of each of these rocks. Hence, the ground moraine in this region is composed almost entirely of sand and boulders, drumlins being absent. Large deposits of sand are found at Villagedale, south-east of Barrington, forming numerous sand dunes 30 feet in height. The grains of sand consist largely of quartz with some pink feldspar, muscovite, and biotite, showing that they were derived from the granite nearby. Sandplains do not occur.

Eskers were observed at Shelburne, Roseway, Cape Negro and Port Clyde. The esker in Shelburne extends from near the Shelburne House in a N 10° E direction for about 1,000 feet. Its height varies from five to fifteen feet. Boulders and gravel appear on top of the ridge, the boulders having a length of two to three and a half feet. Near Roseway there are several eskers running nearly due south, the most prominent one being near the shore. This esker is about one-quarter of a mile long, 25 feet high and 75 to 100 feet wide. It forks at the south into two ridges. On the top of the esker are boulders 4 feet long, 3 feet wide and 3 feet thick. North of Port Clyde are abundant eskers, some of which have an east-

PLATE I



View of Shelburne Harbor and Sand Point taken from Fort Point. In the distance, on the left, is the lighthouse on Sand Point and beyond it is Shelburne. The peneplained hills in the distance rise to an elevation of 200 feet. In the foreground is a glaciated ledge of staurolite schist whose bedding strikes toward Sand Point. The two erratics on the roche moutonnée are Shelburne granite. One has been almost quarried away—the usual fate of erratics in this country.

west elongation. North of Cape Negro is an esker two miles long with the main highway running on the crest. It runs across a swamp in a north-south direction, turning S 10° W at the southern end. In one place the ridge disappears for 50 feet, and in another it divides to pass around a kettle hole 100 feet long and 60 feet wide. At the south end it apparently expands into a poorly defined gravel plain. Another esker connects Cape Negro with the Blanche peninsula. Here again the road follows the esker ridge for three-quarters of a mile. The esker is 5 to 25 feet high and 50 to 100 feet broad. Northwest of Baccaro Point is an esker crossing a marsh, with a road on its top. This esker runs in a southerly direction for half a mile with a height of 20 feet and a width of 60 feet.

Everywhere in Shelburne County boulders are to be found. The largest are west of Shelburne. At the side of the railroad here, may be seen granite boulders 35 feet long, 25 feet broad and 20 feet high. This size of boulder is not infrequent, but more abundant are somewhat smaller ones, 10 to 25 feet long, lying not far apart, yet not forming a boulder moraine. To emphasize the size of the boulders, it may be stated that all the granite for the two story granite post-office building in Shelburne was quarried from a single one.

In the region between Barrington and Roseway, which was burned over in August 1911, boulders about two feet in length are everywhere scattered over the surface, as abundantly on the eskers as elsewhere. They are composed principally of the kind of rock found nearby. It is everywhere characteristic of these boulders to have rounded surfaces, and yet not to evidence distant transportation. Only one boulder was found of a rock not represented in the area by a closely allied type. This was a diorite found north of Gunning Cove.

The direction of ice movement in the region was, judging from the striae in a S 10° E direction in general. The striae noted are: in the vicinity of Sand Point and Fort Point (opposite Sand Point) N-S to N 5° W; a mile east of Greenwood N 5° W; at Black Point N 15° W; Negro Island N 8° W with an apparently earlier set of striations in one place of N 40° W; a mile north of Blanche N 10° W; near Port La Tour N 27° W; near Baccaro N 12° W to N 27° W; near Baccaro Point N 25° W and one outcrop N 40° W; at Barrington N 12° W.

SEDIMENTARY ROCKS

The southern and western portions of Nova Scotia are largely underlain by a series of quartzites, slates and schists, called the Meguma or Goldbearing Series. The age of these rocks is pre-Cambrian. The series has been divided lithologically into two conformable formations, the quartzite division at the base being called the Goldenville formation, and the slate above, the Halifax formation. The thickness of the former has been found by Faribault to exceed 23,700 feet, and the thickness of the latter is 11,700 feet, giving a total thickness to the series of nearly 7 miles with no base exposed

In Shelburne County these two formations are represented by quartzites, some of which show the effects of contact metamorphism, and by schists, all of which are filled with metamorphic minerals. The exposures are so few and the faults so numerous that it is impossible to measure the thickness of the series. Their general distribution may be seen on the accompanying map.

The first exposure of the metamorphic rocks south of Shelburne is found on the shore halfway to Sand Point. Very fine-grained grey mica schist cut by aplite veins occurs here within a short distance of the granite. Approaching Sand Point, staurolites and large mica crystals begin to appear in the rock. At the point are large ledges and roches moutonnées of a lustrous schist containing numerous staurolite prisms a quarter of an inch in length, very abundant smaller biotite crystals all orientated parallel to the schistosity, and very small garnets. Certain harder places in the surface of the rock stand up as small rectangular pinnacles one inch in diameter and three to four inches high, undercut below the hard capping which is only one quarter of an inch thick. The top of these caps are remnants of the smooth surface left by the ice. Such deep post-Glacial erosion is favored in this locality by the soft nature of the sericitic ground mass of the schist. The strike of these rocks averages N 25° E with a dip of 75° S.

A half mile east of Sand Point the schist is replaced by quartzite of light grey color and fine grain in which are occasional quadrangular biotite crystals about one quarter of an inch on a side (perhaps secondary after hornblende), staurolite crystals one half inch long, and occasional pink andalusites one inch long. The dip of the beds changes from 70°-85° S to vertical.

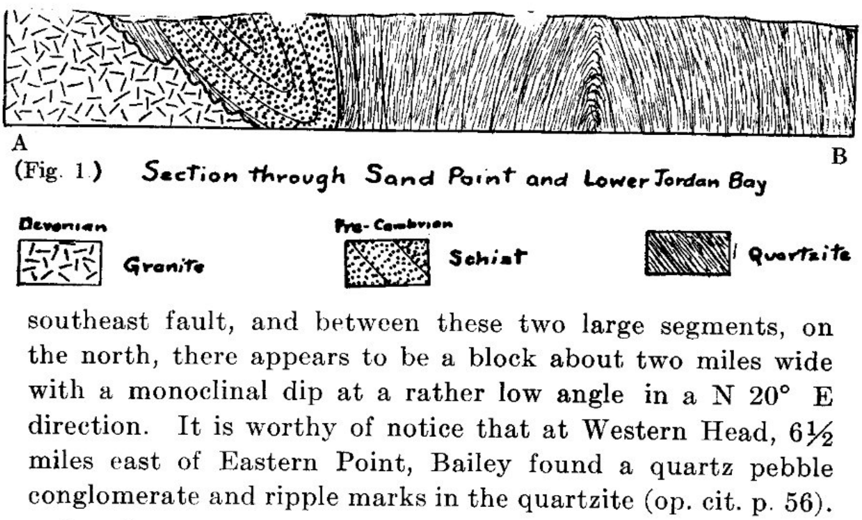
For a mile to the south much of the quartzite does not show large metacrysts*, though small biotites still persist. At one locality a mile and a half south of Sand Point,staurolite-biotite quartzite reappears. The staurolites are of usual size, but few in number. The biotite metacrysts are about one-sixteenth of an inch in length. Under the microscope the rock shows a fine ground-mass of quartz and sericite, metacrystals of biotite free from quartz inclusions, a few garnet crystals, and accessory chlorite, apatite and iron ore. The sericite is more abundant near the biotite than elsewhere. The strike of these rocks is N 15° E, the dip 75° N.

From the outcrop just described to the end of Eastern Point, the rock is everywhere a dense grey quartzite free from metacrysts. Interbedded in the quartzite are a few bands of mica schist one to three feet wide. The structure here is anticlinal, the dip of the bedding being vertical near the "Tea Chest", a mile and a quarter north of Eastern Point with a dip of about 75° N on the north, as above stated, and

*A term introduced by Lane to designate the phenocrysts of metamorphic rocks which are formed after the groundmass. See the Bull. Geol. Soc. Amer. Vol. 14, 1903, p. 369.

a dip of about 80° S on the south. The strike is persistently N 15° E. The southern limb of this fold has been traced on the southwest through McNutt's Island and on the northwest through the towns of Lower Jordan Bay and Jordan Bay, but north of here a fault apparently cuts off the beds, as the strike changes to N 70° W and the dip to 40° N.

The structure of the peninsula is interpreted as a syncline in the schists on the north and an anticline in the quartzites on the south as shown in the section, Fig. 1. The pitch of the axis of the syncline is about 70° S. The syncline is cut off on the north by the granite, and the southern flank of the anticline disappears under the sea. On the opposite side of the Jordan fiord, Bailey found a few outcrops which indicate an anticlinal axis running in a N 60° E direction and starting about a mile north of Patterson Point. This anticline is separated from the one at Eastern Point by a northwest-



(Fig. 1.) Section through Sand Point and Lower Jordan Bay

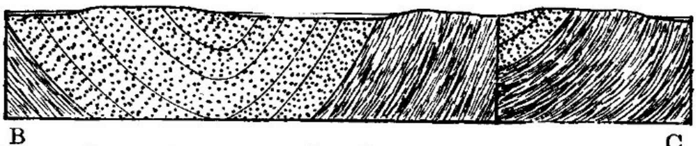
southeast fault, and between these two large segments, on the north, there appears to be a block about two miles wide with a monoclinal dip at a rather low angle in a N 20° E direction. It is worthy of notice that at Western Head, 6½ miles east of Eastern Point, Bailey found a quartz pebble conglomerate and ripple marks in the quartzite (op. cit. p. 56).

On the west side of Shelburne Harbor, the first outcrop south of Birchtown is of quartzite, free from metacrysts, at Gunning Cove. The strike is N 10° E, dip 55° S, indicating that this quartzite is folded up on the north limb of the syncline seen on the other side of the bay. It is noteworthy that this outcrop is within two miles of the granite, but shows no development of contact metamorphic minerals, owing probably to the dense texture and low alumina content of the rock. From Gunning Cove to Red Head (south of Round Bay); staurolite schist occurs in which the staurolites are of large size (one inch long), but not very abundant. The strike remains about the same, the dip being at a high angle toward the south until it changes to 75° N, east of Round Bay, on the southern limb of the syncline.

At Red Head staurolite schist outcrops, the staurolites being more abundant and of larger size than anywhere else in the region. Abundant biotites and small garnets are associated with the staurolites, and bands of the rock contain only biotite metacrysts. The strike is due E-W, and the dip at 3° N. indicating an east-west fault north of here. The same strike and a 10° N dip of the bedding is found at Black Point, three miles to the south. Here, also, the staurolites are abundant.

Negro Island consists of two islands joined by a sand bar. On the north shore of the eastern island staurolite schist appears on the west, near the lighthouse, and quartzite free from metacrysts on the east. The strike is about N 30° E with a variable dip of 15°-40° N. On the western island quartzites, locally containing a few staurolites, outcrop with a strike N 15° E, dip 70°-85° N. There is evidently a fault between the islands with a downthrow on the east, and also an east-west fault between the islands and the mainland.

On the mainland near Betsy Ann Point (separating Northeast and Northwest Harbors), a spotted grey ottrelite schist appears, with a strike of N 25° E, dip 30° N. It is a continuation of the southern flank of the syncline which has been traced from Sand Point. A fine-grained garnetiferous schist occurs a mile to the northeast and micaceous quartzite a mile and a half to the northwest. The same structure probably continues into the Blanche peninsula, where mica schists with small garnets and occasional staurolites outcrop at Blanche and on the western side of the peninsula. In both places the strike was within a few degrees of due N-S, and the dip in the latter case 33° E. It is probable that the axis of an open syncline underlies Blanche as shown in the section, Fig. 2.



(Fig. 2.) Section through Cape Negro and Negro Island

John Island, west of the Blanche peninsula, is underlain by staurolite schists striking N 30° E and dipping 40° S.

At Port Clyde dark mica schist interbedded with micaceous quartzite forms an anticline with its axis striking N 20° E. Near Villagedale, on the western side of the Baccaro Peninsula, highly micaceous quartzite reappears striking N 15° E to N 15° W and dipping at a very high angle eastward. This is probably the same quartzite as at Port Clyde, appearing on the limb of a syncline. At Villagedale the quartzite is highly contorted by the granite which outcrops a short distance to the north. The large amount of muscovite and biotite and the small garnets in the rock were formed by recrystallization at the time of the granitic intrusion. Similar quartzite is reported by Dr. Bailey on the south eastern end of Cape Sable Island, indicating that part of that island consists of granite.

Near Port LaTour quartzite outcrops in several places but does not show any bedding. On the islands to the south, a number of roches moutonnées are found in which staurolite schist is exposed. The staurolites are about an inch in length

PLATE II.

The barren boulder-covered land north of Roseway, laid bare by the destructive fire of August, 1911. The boulders of this ground moraine consist of Shelburne granite, but the region is underlain by staurolite schist. Many square miles in Shelburne County consist of such land which is only good for forests.

PLATE III.

A detailed view of the staurolite schist at Crows Neck, south of Port LaTour. The staurolite prisms are mostly one to two inches long. At the base of the picture may be seen rounded masses of chlorite. The extent of post-glacial weathering is shown by the relief of the staurolites.

and quite numerous. The peculiarity of the rock hereabouts is the abundance of large patches of chlorite three to four inches in diameter, with rounded or quadrangular outlines. They have probably been formed as a replacement of hornblende, but no trace of the original mineral was discovered. A thin section of the rock from one of the islands shows a fine groundmass of quartz and sericite in which are large metacrysts of staurolite which enclose numerous quartz grains, large crystals of biotite which enclose small grains of quartz and titanite, metacrysts of garnet, some pennine and small amounts of iron ore and apatite. The strike of the rocks is due E-W with a dip of 20° S. The same staurolite schist continues around Baccaro Point, but quartzite appears on the Barrington Bay shore a mile west of Port LaTour.

Igneous Rocks

Micaceous granitic rocks occupy the central part of the peninsula of Nova Scotia, smaller masses appearing in numerous places from Halifax northeastward to Cape Canso, and also south of the main area. Two of the latter enter the area under consideration, at Shelburne and at Barrington. These batholiths consist respectively of biotite-muscovite granite and of quartz (biotite) diorite, with some pink aplitic granite in the immediate vicinity of Barrington.

The age of these granites is Middle Devonian; they cut the fossiliferous Lower Devonian slates of Clementsvale and of Torbrook-Nicteau, and the arkose derived from the weathering of these granites at Horton Bluff is found abundantly in the Horton Series which is of basal Mississippian age (Pocono, according to David White). The granites were intruded at the time of the Middle Devonian revolution which folded the Canadian Appalachian geosyncline and the region now embraced in the Maritime Provinces. The folding was not completed at the time of the intrusion of the granite because the latter shows the effect of a moderate amount of shearing.

Concerning the character of the granite in the neighborhood of the gold mines in Lunenburg and Halifax counties, where it has been studied the most, Mr. E R. Faribault writes*:

"The composition and texture of the granite varies much with the locality and mode of occurrence. The rock consists for the most part of a light grey or reddish grey coarse porphyritic biotite granite, generally studded with large phenocrysts of white or pink-white feldspar. In the west, a light pearl-grey or pinkish-white fine-grained muscovite granite occupies small areas penetrating the biotite granite as well as the sediments. With the muscovite granite are associated dikes of coarse pegmatite often passing to quartz, and bearing a large variety of minerals."

The Shelburne granite was observed in outcrops three miles south of the town, just south of the first outcrops of schist on the shore. The granite is porphyritic and includes fragments of schist. The schist is micaceous, a feature common to the sediments whenever near a granite contact, and it is cut by aplite veins one to three inches wide. Frequent outcrops of granite are found in railroad cuts southwest of Shelburne and at a quarry near Hart Point. The granite in the railroad cuts is cut by pegmatite dikes, the largest of which is three feet wide. Numerous pegmatite dikes are also found in boulders in this vicinity. The pegmatite consists of large pink orthoclase crystals (4 inches long, 3 inches wide and thick), masses of quartz in smaller quantities than the feldspar, plates of muscovite one inch in diameter, less abundant biotite crystals, a white feldspar showing albite twinning (probably oligoclase), garnets one-quarter of an inch in diameter, and occasional masses of tourmaline. One crystal of beryl, one and one half inches in width and length, was found.

The Shelburne granite is a light grey, fine-grained, micaceous granite with biotite generally predominating over

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* International Geological Congress, Guide Book, 1, pt. 1. p. 168, 1913.

muscovite. When the mica, especially the muscovite, becomes more abundant, the rock has a slightly yellow tinge. The feldspar and quartz both occur in small grains, the former being white, and hence less conspicuous than the flakes of mica. Under the microscope the rock is seen to consist principally of xenomorphic crystals of feldspar and quartz, the latter showing undulating extinctions due to shearing, biotite in very numerous shreds and flakes between the other grains, accessory muscovite in occasional shreds both inside and outside the feldspars, and a few apatite crystals inside feldspars and muscovite crystals. The feldspar consists largely of oligoclase, with some albite-oligoclase (Ab_9 An_1) and albite-microcline microperthite. The results of a Rosiwal measurement of the rock will be found below. One slide shows a number of mermycitic intergrowths of the quartz and oligoclase feldspar. Some of the latter show zonal growths and occasionally undulating extinctions. The muscovite appears to be largely secondary, probably being developed by pneumatolytic action. In some cases it shows the same amount of shearing as the remainder of the rock and is therefore thought to be primary.

The Barrington batholithic area contains two kinds of rock, a pink aplitic granite at Barrington, and a biotite quartz diorite elsewhere. The relation of these two rocks is not known, only two exposures of the former being found, and a few of the latter. It is to be inferred from the relation of similar rocks elsewhere, as shown by the quotation given above, that the aplitic granite is the younger, yet probably intruded during the same diastrophic period.

The aplitic granite outcrops an eighth of a mile northeast of the Barrington railroad station. The same granite cuts micaceous quartzite at the crossing of the railroad and the road north from Villagedale. Between this outcrop and Villagedale, at Solid Rock and also for a mile south of Solid Rock. micaceous quartzite is cut by numerous stringers of aplite, belonging to this granitic intrusion. The quartzite is highly contorted and the mica is a phase of the exomorphic metamorphism.

In a hand specimen the rock is seen to be a pinkish, very fine-grained granite, minutely porphyritic. The feldspar shows albite twinning in the larger crystals. Mica is distributed unevenly through the rock in small quantities, both muscovite and biotite being present. The quartz lies between the feldspar and is less conspicuous. In thin section the rock is seen to consist of feldspar in hypidiomorphic crystals, a much smaller amount of quartz, rather abundant secondary muscovite, an occasional biotite flake, and some chlorite and titanite. The feldspar is largely a microcline microperthite with smaller amounts of oligoclase. The centers of many of the feldspar crystals are filled with specks of sericite.

The quartz diorite appears to form the remainder of the igneous rock of the area. Outcrops were noted a half mile west of Barrington, at Barrington Passage and to the southward in railroad cuts, and at Shag Harbor. It is a light grey, fine grained rock and shows the effect of shearing, the biotite flakes being orientated into parallelism. Albite-twinned white feldspar and colorless quartz in small amount may be seen in the rock. The grain of the rock is fine, but a few feldspar phenocrysts one-half inch in length may be seen. Under the microscope the constituents are found to be hypidiomorphic crystals of feldspar, a small amount of brecciated quartz showing undulating extinctions, large plates of biotite often clustered in the more brecciated places, accessory titanite in small granular aggregations, quite numerous long rods of apatite occurring in association with the biotite, and a very small amount of iron ore, zircon and muscovite. The feldspar is principally oligoclase twinned after the albite and pericline laws, with smaller amounts of microcline microperthite and albite-oligoclase. The more acid feldspars do not appear in sufficient abundance for the rock to be called a quartz monzonite.

Rosiwal measurements of the mineral composition by weight of this quartz diorite and of the Shelburne granite are given for comparison:

Barrington quartz diorite	
Oligoclase	54.6
Albite-oligoclase	.8
Quartz	21.2
Biotite	23.1
Muscovite	.3
	100.0

Shelburne granite	
Oligoclase	35.2
Microperthite	3.1
Albite-oligoclase	17.1
Quartz	33.6
Biotite	7.8
Muscovite	3.1
Apatite	.1
	100.0

From these measurements the chemical composition has been calculated:

	Barrington quartz diorite	Shelburne granite
SiO_2	63.6	72.3
Al_2O_3	16.8	15.2
Fe_2O_3	2.0	.6
FeO	3.0	1.1
MgO	3.1	1.0
CaO	3.3	2.5
Na_2O	4.8	5.0
K_2O	2.1	1.5
Rest	1.3	8
	100.0	100.0

The most important characteristic of the granite and quartz diorite is the high soda content. The two rocks are petrographically related, the feldspar being of the same composition and differing only in amounts as do the other constituents.

Dynamic Geology.

The first question which arises in considering the dynamical history of the region is the date of the folding and faulting of the pre-Cambrian sediments. The folding probably took place in pre-Cambrian times, and the faulting in the Devonian diastrophism. The goldbearing series is unconformably overlain by Silurian and by Lower Devonian sediments.

The effect of the folding of the Goldbearing series, was to produce a series of closely folded anticlines and synclines. The axes of these folds are parallel. In Queens County northeast of Shelburne County, the axes trend in a N 45° E to a N 55° E direction, and this direction is characteristic of axes of folds in Lunenburg and Halifax counties to the east. In Yarmouth County, on the west of Shelburne, the trend is N 20°-30° E. In Shelburne County, however, the main axes, according to Dr. Bailey's map, turn toward the Atlantic Ocean in a N 15°-20° E direction. The major axes of the batholiths as shown on the same map, are about N 5° E. In the coastal region considered in this paper, the principal folds are obscured by block faulting*, but the axial direction is N 20° E. It is therefore evident that these axes of mountain-building turn from a S 45° W direction to one of S 20° W, which is toward the Atlantic Ocean and not parallel to the coast line of North America. In "La Face de la Terre" Vol. 1 (fig. 103) Suess and de Margerie plot the tectonic axes of eastern North America, and show the axis of southwestern Nova Scotia turning from a S 65° W direction to one of S 15° E. In view of the above data, it is clear that a turn as great as 80° does not exist. The existing turn is comparable to that of the axis of the Canadian Appalachians into the axis of the Taconic Mountains.

The Goldbearing series throughout Nova Scotia has undergone extensive metamorphism which appears to be entirely

*The faulting is dated, from evidence found elsewhere, as later than the batholithic intrusion, and therefore does not concern the question at hand.

dynamic and contact metamorphism. The former, as shown in Lunenburg and Halifax counties, produced thick-bedded compact quartzite, usually showing minute flakes of mica, and siliceous slates, usually of a grey-green color and very fine grain with no metacrysts. The metamorphism of these beds was not quite completed when the granitic intrusions of Middle Devonian age took place, for the igneous rock is everywhere more or less sheared. The contact metamorphism near the granite has produced recrystallized schist and quartzite, and farther away has caused the formation of metacrystals of staurolite, andalusite, biotite, hornblende, garnet and sillimanite.

In the southern portion of Shelburne County, the contact metamorphism has been so extensive as to be almost regional. On Negro Island, which is 10 miles fron the nearest granite outcrop, the staurolites still persist in the schist although the quartzite is free from metacrysts. The characteristic features of the metamorphism are the development of either staurolite or mica or both in the schist everywhere, the recrystallization of the quartzite near the granite with the development of the muscovite in large quantities and some biotite, and the lack of alteration of the quartzite elsewhere, except near Sand Point where within three miles of the granite some metacrysts appear.

The date of the block faulting, which is shown on the map, is probably late Carboniferous. This diastrophic period did not develop intense folding in the Maritime Provinces, but it was accompanied by faulting. In Kings County the faulting is later than the intrusion of igneous rocks of Devonian age. The details concerning these faults have been sufficiently discussed above. Faults are characteristic of the Goldbearing series throughout its extent, but this block faulting is uncommon in the districts near the gold mines.

Economic Geology.

The most valuable economic resource of the district is granite. West of Shelburne near Hart Point and not over a mile from the Halifax and South-Western Railroad is a granite quarry in bed rock. This quarry has been worked for a number of years, the activity fluctuating with the demand for the product. The granite was loaded on boats within a short distance of the quarry. Also, an extensive quarry business has been carried on in granite boulders here as well as in other parts of the County. At present, granite is being quarried from boulders near the railroad track and transported by rail. The granite appears to split easily and should be very good for building purposes

Ochre is reported at Upper Port LaTour. It occurs on the north side of a hill west of the town. Ochre has also been found a mile and a half south of this town, at the bottom of a well hole 10 feet deep. Neither occurrence was investigated.

Although quartz veins occur in this vicinity, no gold mines have been opened. The saddle reefs of quartz, from which most of the gold is secured in the Halifax district, could not have been formed in a region so highly metamorphosed as the one here considered.

Summary.

The pre-Cambrian Meguma or Goldbearing series was folded into a number of parallel anticlines and synclines and dynamically metamorphosed in the Middle Devonian diastrophism. Granites, quartz diorites and aplitic granites were intruded at this time, being caught in the last of the mountain building movements. These intrusions produced extensive contact metamorphism, staurolite schist being developed ten miles from the nearest granite outcrop. Later, and probably in late Carboniferous time, extensive block faulting took place.

PLATE IV.

A view of Cape Sable Island showing the dissected and downwarped Cretaceous peneplain. This large island is completely covered by glacial deposits, only one bed rock outcrop being found by Dr. L. W. Bailey. A large fire was burning on the island at the time this picture was taken.

The trend of the axes of mountain building, which have determined the outlines of Nova Scotia, turns in Shelburne County from about S 45° W to S 20° W. The axes therefore point away from the land as they dip under the sea, but not at such an angle as given by Suess and de Margerie.

Probably since the end of the pre-Cambrian at least part of the rocks of the Goldbearing series has been exposed to denudation. At the time the ice sheet advanced over the region in the Pleistocene, long valleys had been formed in the Cretaceous peneplain. The land was depressed at about this time to its present level, drowning the ends of the valleys and making the fiords and islands which now characterize the coast line. The action of the ice was to bevel off the rock, but also to leave a thick veneer of sandy ground moraine and boulders over the entire country. Many islands and peninsulas consist, above the present sea level, almost wholly of glacial deposits. Along the depressed shore line the sea is reworking these deposits with the formation of abundant beaches and bars, and in only a few places has the sea cut through the thick veneer and attacked the bed rock.