EVIDENCE OF TACONIC OROGENY IN MATAPEDIA VALLEY, QUEBEC.*

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INTRODUCTION.

The Taconic problem.

Sir William Logan's classical memoir, "The Geology of Canada, 1863," describes in considerable detail the geological relations in the Appalachian province of eastern Canada. More intimate studies by later authors have occasioned a revision of Logan's maps, and an addition of valuable detail, but the basic conclusions at which he arrived remain to-day in only slightly modified form, and stand as a monument to that pioneer geologist. As a result of his own field work and that of his associates, in eastern Canada, particularly in Gaspé Peninsula, Logan concluded that the Gaspé Limestone (Silurian-Devonian) rests discordantly on the complexly folded Quebec group (Cambrian-Ordovician). The significance of these relations was fully appreciated by both Logan and Dana, so that the latter author, in naming and describing the Taconic orogeny in New York State (Dana, 1863)[1], pointed to the work of his contemporary in demonstration of the wide extent of such an orogeny through eastern Canada.

Since its original definition nearly seventy years ago, the problem of Taconic orogeny, its age and extent, has been the subject of considerable discussion and some controversy. T. H. Clark (1921), in a critical review of the problem, has shown that the supposed unconformities in eastern Quebec, particularly at Lake Temiscouata, Lake Matapedia, and Cape Gaspé, might be differently interpreted. As a result of Clark's analysis it became apparent that further field work was required in crucial areas before Logan's conclusions could be entirely accepted. Furthermore, the stratigraphy of the Silurian-Devonian series on the north coast of Gaspé was very imperfectly known and its relations to the typical sections on the Bay of Chaleur and at Cape Gaspé were problematical. In view of these circumstances, the writer undertook a survey of the

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[1] Refers to bibliography at the end of the paper.

Matapedia Valley during the summers of 1929 and 1930 for the Geological Survey of Canada.

The writer welcomes this opportunity to express his thanks for many helpful suggestions and guidance received from members of the Department of Geology in Yale Graduate School. He is particularly indebted to Prof. Charles Schuchert, who spent two weeks in the field with the writer in 1929. Professor Schuchert has incorporated his impressions gained at that time in a general paper on the orogenic times in the northern Appalachians (1930).

It is the purpose of this paper to present evidence from the area near Lake Matapedia and that at the mouth of Matapedia River to show that the unconformity between the Ordovician and Silurian is a pronounced structural break and that the Taconic orogeny, at least in Gaspé, is of major importance. A summary of the stratigraphy is also given as it entails a complete revision of the classification used on the existing maps of the area made by Ells in 1882. The formations assigned by Ells to the Silurian include strata of Ordovician, Silurian and Devonian ages, and in this group the Ordovician portion (Matapedia series) is separated from the Silurian and Devonian by a previously unsuspected unconformity correlative with the discordance described by Logan at Lake Matapedia. The date of the Taconic orogeny is limited as pre-Clinton (pre-Val Brillant formation) and post-Richmond? (post-Matapedia series).

General relations in the Matapedia region.

The Matapedia Valley forms the natural western boundary of Gaspé Peninsula, Quebec. Matapedia River rises in Lake Matapedia, 12 miles south of the St. Lawrence shore, and extends in a southerly direction for 65 miles to join Restigouche River at Matapedia Village. In this summary of the geology of the district, two areas are described in particular: Lake Matapedia, and the lower part of Matapedia Valley in the vicinity of Matapedia Village.

The Matapedia River area lies in a zone of folded rocks continuous with the so-called northern Appalachians of Vermont and New Hampshire, and extending through eastern Quebec to the eastern extremity of Gaspé Peninsula. This zone, or orogen, trends in a general northeasterly direction; but in its course there is a noteworthy sinuosity so that it

presents two prominent salients, one in northwestern Vermont and another in Gaspé Peninsula. Both are arcuate in form with convexity to the northwest. Associated with the salients are two reëntrants, one in the neighborhood of Quebec City, the other east of Anticosti Island. The latter is now covered by the Gulf of St. Lawrence but is indicated in Gaspé by the abrupt eastward deflection of the structural axes at Cape Gaspé. The area under consideration gives a section across

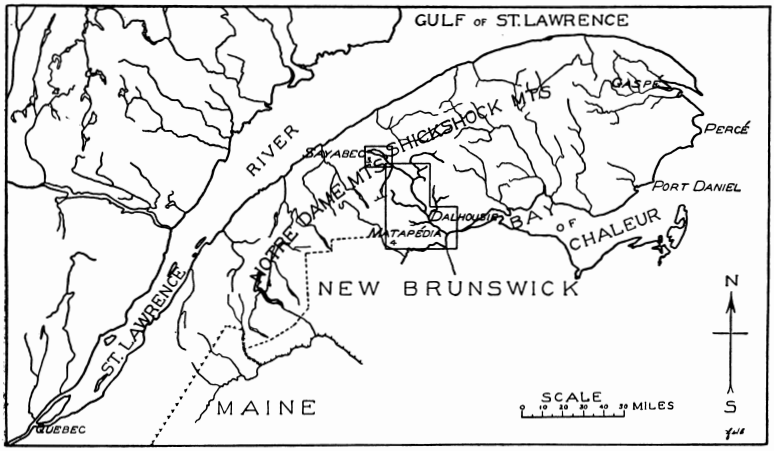

Fig. 1. Index map showing location of maps Figs. 3 and 4.

the Notre Dame Mountains of eastern Quebec, which together with the Shickshock Mountains make up the Gaspé salient.

The structural conditions in the area are such that the stratigraphic succession is not complete; there is a northern and a southern sequence between which correlations can not be made by direct tracing of beds. In the south, near Matapedia, the complexly folded Matapedia series (Ordovician) is overlain by the Dalhousie formation (Helderberg). The Silurian, Chaleur series, is thin and discontinuous here but to the north at Lake Matapedia its equivalents are at least 3,000 feet thick and are overlain by the Causapscal formation (Oriskany). These relations are summarized in Fig. 2.

STRATIGRAPHY OF THE LAKE MATAPEDIA AREA.

Lake Matapedia occupies a depression bounded on the north and east by the foothills of the Shickshock Mountains and on

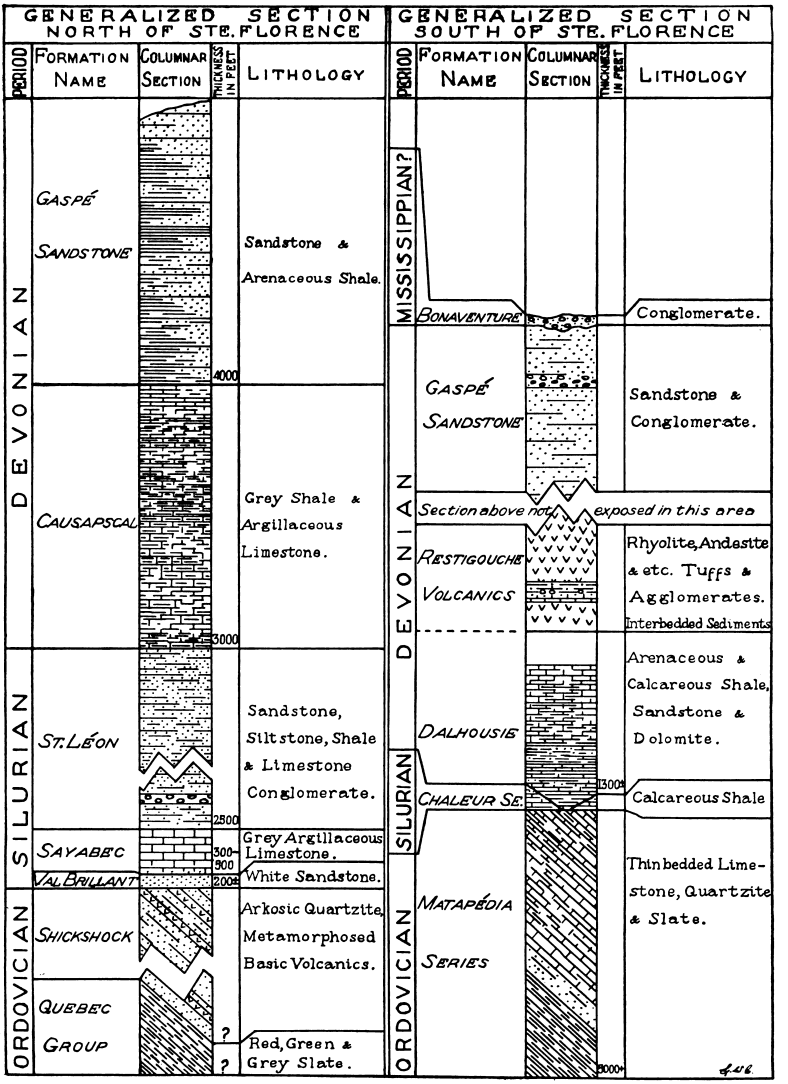

Fig. 2. Columnar sections to show stratigraphic sequence in Lake Matapedia area and in lower Matapedia Valley.

the south by the Notre Dame Mountains. On the west there is a broad valley occupied by several small streams tributary

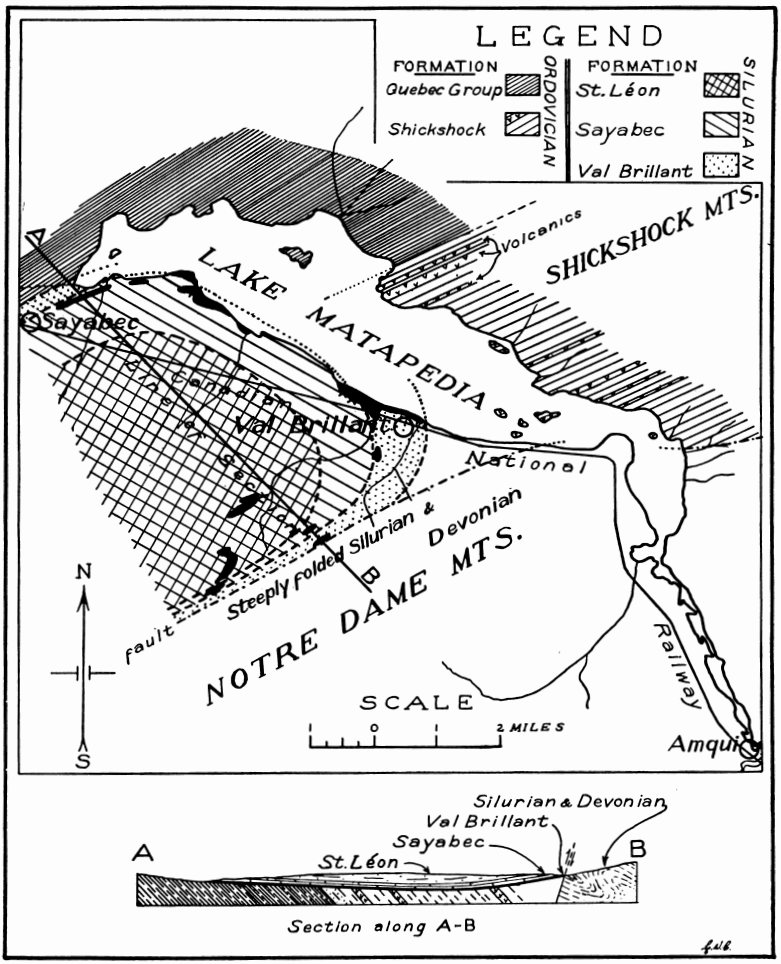

Fig. 3. Geological map of Lake Matapedia area. Outcrops in the Silurian basin are shown in black. The geology on the northeastern shore of the lake is after Alcock (1924).

to the lake. The lake itself is about 7 miles long and one-half to one and a half miles wide, with its length in a northwest-southeast direction so as to lie athwart the structure of the rocks which here strike northeast.

Ordovician.

Quebec Group. On the north side of the lake there is exposed a series of slates, gray, green, and red in color, with rarely layers of limestone conglomerate. No details of the stratigraphy of these beds has been attempted in the present study but it appears certain from the work of Logan and Ells that they belong in a belt of slates continuous from Quebec City, where they are collectively known as the Quebec group, to Cape Gaspé, where the designation Rosier slate (Clarke, 1908) is applied. Logan (1865) was of the opinion that the slates at Lake Matapedia belonged in the Sillery, that is, late Cambrian or early Ordovician, but in so far as no fossils have ever been found at this locality the correlation is based solely on lithologic resemblances.

Shickshock Formation. The summit of the Shickshock Mountains from Lake Matapedia to the Table Top Mountains is made up of a series of interbedded volcanic rocks and arkosic quartzite. This series is well exposed on the northeastern shore of Lake Matapedia as well as on several islands in the southern part of the lake. The formation is here designated the Shickshock formation and the section at Lake Matapedia is regarded as typical. Its age was thought by Ells (1884) to be pre-Cambrian but Alcock[2] (1924), who has given an excellent detailed description of the formation, has more recently reverted to Logan's classification, placing the formation above the Quebec group and probably of middle Ordovician age. The basis for this determination is rather insecure and the age of the formation remains more or less problematical.

Silurian.

On the south and west side of the lake, post-Ordovician rocks alone are exposed, ranging in age from middle Silurian to Lower Devonian. The Silurian section is at least 3,000 feet thick, consisting of three well-defined units which are here named in descending order:

St. Léon Formation
Sayabec Formation
Val Brillant Formation

[2] The name of the formation is here introduced on the advice of Dr. Alcock.

Val Brillant Formation. The Val Brillant formation is typically exposed along the shore of Lake Matapedia, from the village of Val Brillant, from which it receives its name, northwestward for one and a quarter miles. It consists of a series of alternately thinly and thickly bedded, white and buff sandstones, 200 feet thick. Cross-bedding is common. Thin sections show cleanly washed grains of rounded to sub-angular shape cemented by silica and limonite.

A number of fossils collected three quarters of a mile north of Val Brillant on the west side of the Canadian National Railway tracks include the following species:

Palaeocyclus n. sp. aff. *P. rotuloides* (Hall)
Zaphrentis sp.
Orthis n. sp. aff. *O. flabellites* Hall
Leptaena rhomboidalis (Wilckens)
Brachyprion sp.
Pentameroides sp.
Stricklandia sp. cfr. *S. gaspensis* Billings
Stricklandia sp. cfr. *S. brevis* Billings
Spirifer sp.
Poleumita n. sp. aff. *P. transversalis* Prouty
Phacops sp.

This fauna indicates that the formation is equivalent to the basal part of the Chaleur series (Clemville or Lavieille), (Schuchert and Dart, 1926), and to the Clinton of New York State.

Sayabec Formation. The Sayabec formation consists of a gray, dove-colored limestone typically exposed at a quarry on the shore of Lake Matapedia 3 miles east of Sayabec. At this locality the formation may be divided in two parts: a lower part made up of nearly unfossiliferous arenaceous limestone and dolomite, and an upper part of fossiliferous dense argillaceous limestone. The total thickness exposed is 290 feet but the formation may well be as much as 500 feet thick. The formation is exposed along the lake shore to within a mile and a half of Val Brillant. It overlies the Val Brillant formation conformably and the arenaceous lower part probably represents a transition from the sandstone deposition of the lower formation.

Fossils were found in this formation only at the type locality on the lake shore east of Sayabec. The writer's collections include the following:

Stromotopora sp.
Zaphrentis sp.
Favosites 2 sp.
Syringopora sp.

Halysites catenularis (Linnaeus)
Brachyprion profundum (Hall)
Amphistrophia n. sp. aff. *A. striata* (Hall)
Atrypa reticularis (Linnaeus)
Whitfieldella sp.
Camarotoechia 3 sp.
Poleumita sp.
Diaphorostoma sp. cfr. *D. niagarensis* (Hall)
Dalmanites sp. cfr. D. *limulurus* (Green)

The fossils are so poorly preserved that it is difficult to make specific identifications and it is not possible to establish exact correlation in the Chaleur section, but the position of the formation above the Val Brillant sandstone of Clemville or lower Lavieille age suggests that the limestone is equivalent to the Lavieille limestone of the Chaleur series.

St. Léon Formation. The St. Léon formation is typically exposed in the Amqui River valley north of the village of St. Léon. It consists of a series of fine-grained, argillaceous sandstones or siltstones of a gray or greenish gray color. About 1,000 feet from the base occurs a limestone conglomerate at least 100 feet thick and abundantly fossiliferous. The complete thickness of the formation is nowhere found because of structural complications, but it is computed that at least 2,500 feet is exposed in the Matapedia Valley north of Causapscal. This figure is, then, a minimum for the thickness of the formation.

The formation is exposed west of Val Brillant overlying the Sayabec formation with conformity of dip but the actual contact is not exposed. The basal part of the St. Léon formation contains limestone lenses indicating a transition from the Sayabec formation into the St. Léon. The formation is the only Silurian formation exposed in the folds south of Lake Matapedia.

The following fossils were collected from the limestone conglomerate, 3 miles southwest of Val Brillant and from the underlying beds further southwest along a road skirting the north side of the Notre Dame Mountains:

Monograptus 2 sp.
Heliolites interstinctus (Linnaeus)
Favosites sp.
Resserella sp. cfr. *R. waldronensis* (Foerste)
Sowerbyella n. sp. aff. *S. transversalis* (Wahlenberg)
Leptaena rhomboidalis (Wilkens)
Schuchertella sp.
Stropheodonta sp.
Chonetes novascoticus Hall
Conchidium sp.

Wilsonia 2 sp.
Atrypa reticularis (Linnaeus)
Eospirifer sp. cfr. *E. niagarensis* (Conrad)
Crispella sp. cfr. *C. crispus* (Hisinger)
Cyrtia n. sp. aff. *C. exporrecta* (Wahlenberg)
Encrinurus sp.

This fauna indicates a correlation with the middle part of the Chaleur series, that is, Gascons or Bouleaux formation. The combined thickness of the Gascons and Bouleaux, 2,750 feet, is roughly equivalent to that computed for the St. Léon formation.

Devonian.

The Silurian series is overlain conformably by Devonian shales, argillaceous limestones and sandstones in which two formations are recognized. These will now be described.

Causapscal Formation. The Causapscal formation, the lowermost member of the Devonian, has its type section immediately south of the village of Causapscal in the bluffs of Matapedia River. It is also well exposed on Causapscal River below Causapscal Falls, and on Matapedia River between Amqui and Lac au Saumon. It consists of shales and argillaceous limestones with a total thickness of about 3,000 feet. Throughout this thickness there are no sharp variations in lithology so that the whole series must be grouped in a single unit.

The formation contains but few fossils and these are sparsely distributed through its upper part. The following have been collected by the writer:

Eodevonaria hudsonicus Clarke
Coelospira dichotoma Hall
Leptocoelia cfr. *L. acutiplicata* (Conrad)
Spirifer modestus Hall

This fauna, while small, indicates a correlation with the Grande Grève limestone of Cape Gaspé (Clarke, 1908) and the Oriskany of New York. The St. Albans and Bon Ami formations, which come beneath the Grande Grève limestone, may be represented in the lower part of the series for its thickness is many times greater than the Grande Grève formation at Cape Gaspé. However, there are no fossils to indicate the presence of beds of Helderberg age. The name of the formation has been introduced here mainly because it designates a distinct lithologic unit covering a large area in the Matapedia Valley. Correlations are not sufficiently exact to use the term

Grande Grève, nor does it seem advisable to revive the more general but ambiguous term of Gaspé limestone.

Gaspé Sandstone. The Causapscal formation is overlain by a great series of sandstones and shales many thousands of feet thick and containing marine fossils at one horizon. These sandstones are equivalent to the Gaspé sandstone which covers large areas in the central portion of the peninsula (Alcock, 1921, 1926). In the eastern part of Gaspé, the Gaspé sandstone rests with slight angular discordance on the underlying Grande Grève formation (Clarke, 1908), but in the Matapedia Valley there appears to be complete accordance.

STRATIGRAPHY OF THE LOWER MATAPEDIA VALLEY.

Matapedia River joins Restigouche River at Matapedia Village, and the Restigouche forms the provincial boundary between Quebec and New Brunswick. Both rivers are incised 500 feet or more beneath a well-developed peneplane. The steep valley walls are well wooded and give few outcrops, but excellent exposures are to be found in the stream beds and along the valley roads.

Ordovician.

Matapedia Series. Along the course of Matapedia River for 28 miles above the mouth there is exposed a series of slates, quartzites and argillaceous limestones that the writer (1930) has designated the Matapedia series. The limestone beds, presumably representing the upper part of the series (the slate forming the base) occupy the area in the vicinity of Matapedia. They are for the most part made up of thin, dense gray, limestone beds 1 to 2 inches thick separated by argillaceous partings. The series is also well exposed along Restigouche River at least as far as the mouth of Upsalquitch River.

Fossils were collected from the series at two localities. On the south bank of Restigouche River opposite Matapedia the following were collected:

Plectatrypa sp. cfr. *P. gaspeensis* Cooper
Illaenus sp. cfr. *I. perceensis* Cooper
Calymene sp.

There are also many broken or imperfectly preserved tests that can not be placed generically. These include a nearly flat valve of a strophomenid, trilobite fragments, crinoid columnals, bryozoans.

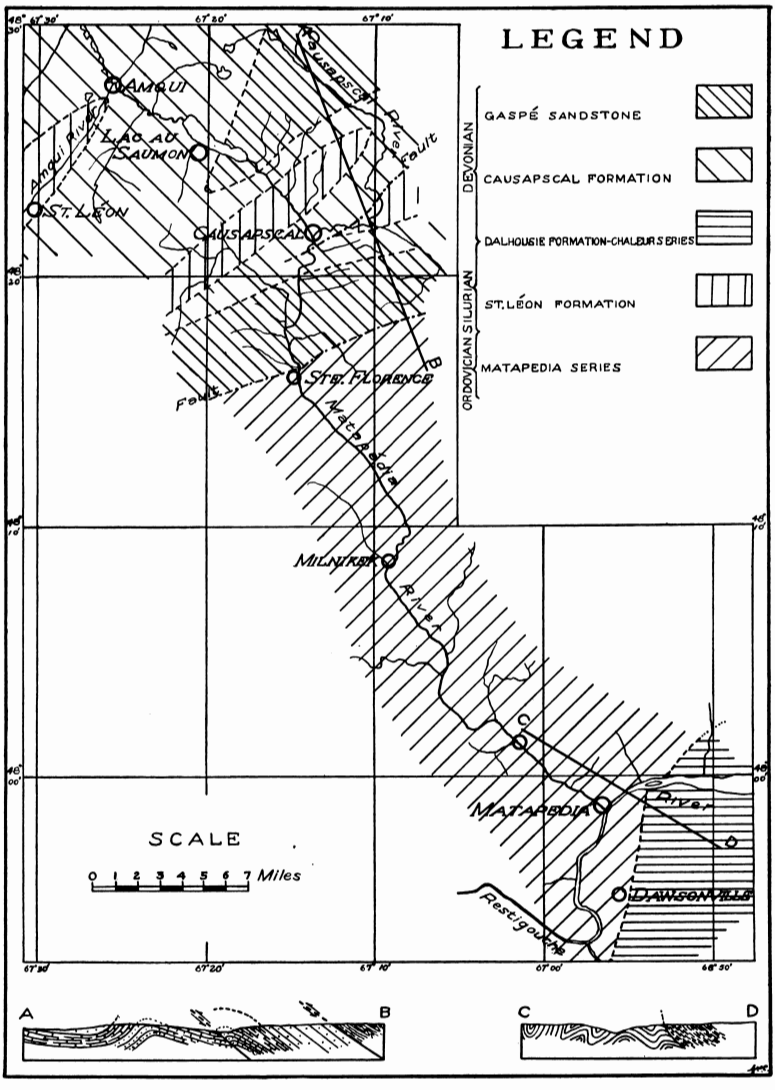

Fig. 4. Geological map of Matapedia Valley, with structure sections along A-B and C-D.

On the same side of Restigouche River, 3 miles upstream from Matapedia, the following were collected in dark calcareous slates through which a road is cut:

Cyclopyge sp. aff. *C. kindlei* Cooper
Cyclospira (?) *canadensis* Cooper
Winnepegoceras sp.

The fossils, in themselves, are not sufficient for definite correlations with the Ordovician succession in the interior of North America, but there can be little doubt that the beds from which they come are the direct equivalents of the late Ordovician at Percé, the Whitehead formation. The Whitehead formation according to Schuchert and Cooper (1930), is equivalent to the middle and upper Richmondian but not as late as the Gamachian. This correlation is of importance, for the Matapedia series, of age equivalent to the Whitehead formation, is involved in the Taconic orogeny.

Silurian.

Chaleur Series. Overlying the Matapedia series is a group of calcareous and arenaceous shales including beds of both Silurian and Devonian age. The Silurian portion is thin and discontinuous so that in many places the Dalhousie formation (Helderberg) forms the base of the series. Three miles east of Dawsonville Post Office calcareous shales outcrop with fossils of Silurian affinities. From this locality were collected:

Favosites hisingeri Edwards and Haime
Hindia sphaeroidalis Duncan
Heliolites interstinctus (Linnaeus)
Ptychopleurella n. sp.
Strophonella sp.
Atrypa reticularis (Linnaeus)
Calymene sp.

Although these rocks are very probably middle Silurian it is not known what position they hold in the typical Chaleur section at Port Daniel (Schuchert and Dart, 1926).

Devonian.

Dalhousie Formation. The Dalhousie formation has its type locality at Dalhousie, New Brunswick (Clarke, 1909), and has associated with it a series of volcanics and tuffs collectively known as the Restigouche volcanic series (Howard, 1926). Near Matapedia the interlayered volcanic rocks are

inconspicuous but the sediments are three times as thick as at Dalhousie. The fossils collected include many typical Dalhousie species, but there are some noteworthy absentees (e.g. *Sieberella pseudogaleatus*) and additions (e.g. *Eatonia medialis*). The best section is 4½ miles east of Matapedia at the mouth of Rivière André. Here 1,310 feet of beds are exposed. The following is a partial list of fossils collected at this locality:

Hindia sphaeroidalis Duncan
Isorthis perelegans (Hall)
Strophonella punctilifera (Conrad)
Strophonella continens Clarke
Leptaenisca concava (Hall)
Leptostrophia cfr. *L. beckii* (Hall)
Sieberella sp.
Eatonia medialis (Vanuxem)
Delthyris perlamellosus (Hall)
Crispella cyclopterus (Hall)
Nucleospira ventricosa (Hall)
Camarotoechia transversa (Hall)
Meristella sp.
Ambocoelia sp.

STRUCTURAL RELATIONS BEARING ON THE TACONIC OROGENY.

Lake Matapedia Area.

The structure of the Quebec group east of Quebec City has never received more than a general survey. From scattered observations there appears to be a series of tightly compressed folds in many cases overturned and thrust to the north and northwest. At Lake Matapedia the Quebec group dips at steep angles and commonly exhibits sharply overturned folds, but the lack of any distinctive horizons makes it nearly impossible to work out the details of structure. The rocks are cut by a strong slaty cleavage which has a more or less constant strike in a northeast direction.

The Shickshock formation, which apparently overlies the Quebec group, and which occupies most of the eastern shore of Lake Matapedia, also strikes in a northeasterly direction. The dip varies little from 45° to the southwest with no indication of overturning (Alcock, 1924).

On the southwestern side of the lake none of the Ordovician rocks are to be found, but only the Silurian. The strata form a shallow structural basin with the dip persistently away from the bordering hills. The steep structures which characterize the Quebec group are absent; the dip of the Val Brillant sandstone

and Sayabec limestone along the lake shore does not, with one notable exception, exceed 3°, and the dip of the St. Léon formation attains a maximum of 25° along the north side of the Notre Dame Mountains. Exceptional are the high dips of the Val Brillant formation at a prominent point on the lake shore, 3 miles east of Sayabec. Here the beds are sharply upturned for a short distance but this local flexure appears to be the result of drag folding on a fault striking northwest, parallel to the lake shore.

The Silurian-Devonian series south of Lake Matapedia are in broad open folds, generally asymmetrical with the axial planes dipping steeply to the south. One of the most persistent anticlines in the area, which crosses Matapedia Valley 2½ miles northwest of Causapscal, has dips on the north side of 40° and 50° but on the south side few dips of greater than 20° are to be found. Near Amqui the folds are more symmetrical but further north in the Notre Dame Mountains sharply overturned structures are present.

A thrust fault of considerable displacement crosses Matapedia Valley about half a mile north of Ste. Florence and brings the Matapedia series against the Gaspé sandstone. The dip of the fault plane can not be determined closely but it appears to be rather steep to the southeast. Another thrust fault in the lower part of Causapscal Valley brings the St. Léon formation on top of the Causapscal formation. Both faults are strike faults with the overthrust towards the north.

Unconformable overlap of the Silurian formations at Lake Matapedia.

The contact between the Ordovician and Silurian at Lake Matapedia is nowhere exposed but from a consideration of the field relations there can be no reasonable doubt that an angular unconformity separates the two series. The Silurian rocks are essentially unmetamorphosed. Secondary cleavage, which is so marked in the Ordovician rocks, is entirely absent from the overlying Silurian. The Silurian has nearly everywhere a very low dip while the Ordovician is everywhere steeply inclined. The Silurian overlaps both the Shickshock formation and the Quebec group, forming a shallow basin truncating the structures of the Ordovician. It is, therefore, concluded that a period of marked orogeny as well as considerable erosion is depicted by these unconformable relations.

In explanation of the many occurrences of an apparently unconformable overlap of the Silurian on folded Ordovician in eastern Quebec and Gaspé Peninsula, Clark (1921) suggests that the younger, more competent beds, were thrust on to the older shales. This anomalous position, he postulates, was obtained by the crumpling of the shales underlying the competent Silurian beds so that "a casual survey of the field evidence would lead the observer to suppose that it pointed toward an erosional unconformity—a series of highly plicated shales, capped by a series of gently folded more massive rocks" (Clark, 1921, p. 149). Under this interpretation the competent Silurian strata of Lake Matapedia are regarded as thrust over the incompetent shales of the Quebec group with all the intervening series omitted by crumpling under the competent cover.

The field relations at Lake Matapedia can not be explained on this basis. The Ordovician rocks are not made up of a single series of incompetent shales but include a very thick series of relatively competent rocks, the quartzite and volcanic rocks of the Shickshock formation. It is hardly possible to conceive of any system of overthrusting in a series of conformable beds which will place the Silurian on top of the lower Ordovician shales by omission of this thick intervening series of competent rocks. The complete lack of any cleavage in the Silurian rocks, and their slightly metamorphosed character, mark them as having suffered but little as a result of orogenic movements, and certainly preclude any idea that they form a thrust plate. There is no escape from the conclusion that the complex structures of the Quebec group are pre-Silurian and originated during the Taconic orogenic epoch.

Lower Matapedia Valley.

The Matapedia series has yielded to deforming forces in a most incompetent manner. The folds are small, innumerable and without regularity (the structure of the Matapedia series is shown on Fig. 4, Section C-D, in diagrammatic way). They are not continuous along the strike but in some cases die out in a very short distance. This is particularly noticeable in the slates and phyllites between Ste. Florence and Millstream where minor folds may be observed in the plane of the slaty cleavage. The limestones at Matapedia appear to be in larger folds than the phyllites to the north but drag folding and

innumerable faults effectively conceal the major structure. The series, like the Quebec group, lacks any distinctive horizons so that the determination of details of structure is rendered almost impossible.

A strong slaty cleavage is ubiquitous in the series but varies in degree of development according to the lithology it traverses. The strike of this cleavage averages N. 55 E. and deviates but little from this direction. Its dip, however, is quite variable; it is always steep, 60° to vertical, but as commonly to the north as to the south.

The Silurian-Devonian series is also folded but not in the intricate fashion of the Matapedia series. The Restigouche Valley, east of Matapedia, lies in a syncline, but only the steep northern limb is exposed in the area under consideration. The rocks do not possess a slaty cleavage although they are cut by a fracture cleavage having about the same direction as the slaty cleavage in the underlying rocks. The differences in metamorphism and induration are particularly noticeable where the two series are exposed close together as on the highway midway between Flatlands, N. B., and Matapedia.

Unconformable overlap of the Silurian formations in lower Matapedia Valley.

The contact between the Silurian-Devonian series and the underlying Matapedia series is nowhere exposed in the area but it is the writer's contention that a structural unconformity separates the two. The Matapedia series is made up, for the most part, of more competent beds than the overlying rocks, yet is far more crumpled. The metamorphism is so far more marked in the older series that the rocks may be mapped with some certainty on this basis alone. Near the contact the strike of the lower beds is oblique to that of the overlying series. Moreover, intrusives in the Matapedia series, which appear to be related to the lower Devonian Restigouche volcanic series, are later than the main folding of the intruded beds. The evidence is not as convincing here as at Lake Matapedia but when all the field relations are considered there can be little room to doubt that the unconformity between the Matapedia series and the Silurian-Devonian series is the same as that between the Quebec group and the Val Brillant sandstone, and represents folding and subsequent erosion during the Taconic orogenic epoch.

DATE OF TACONIC OROGENY.

The date of the Taconic orogeny can be determined within certain limits. It is certainly older than the Val Brillant formation which is of Clinton age. It is certainly younger than the Matapedia series which is to be correlated with the Whitehead formation at Percé. If the Whitehead formation is Richmondian (Middle and Upper) then the Taconic, at least in Gaspé, is post-Richmondian. The differences between the Whitehead fauna and that of the interior Richmond are a puzzle and leave room for some to doubt the correlation (Schuchert and Cooper, 1930). Until this correlation can be established to the satisfaction of all, there will be disagreement about the exact age of the Taconic orogeny in Gaspé Peninsula.

G. W. Stose, in a detailed discussion of the unconformity at the base of the Silurian in southeastern Pennsylvania, has shown that the Juniata formation (Richmondian) "partakes of the unconformity and is later than the folding, uplift, and erosion of the Ordovician shale" (1930, p. 657). There is then a discrepancy between the evidence from Gaspé and that from Pennsylvania. This may be due to mis-correlation of the Matapedia series,[3] or simply to a later date of the orogeny in the north. In this connection Clark (1921) has pointed out that the completeness of the Richmondian-Alexandrian section on Anticosti Island, the lack of any thick clastic sediments there, and the prevailing calcareous nature of the rocks are strong evidence against folding and uplift in Gaspé at the close of the Ordovician.

RELATIONS OF TACONIC AND ACADIAN OROGENIES.

The exact date of the folding that has affected the Silurian and Devonian strata, the Acadian orogeny (Williams, 1895), can not be determined in the Matapedia River area. The evidence from other parts of Gaspé (Clarke, 1908; Alcock, 1926) shows that the folding started as early as the lower Devonian and passed through several phases of quiescence and warping to reach a culmination in an orogenic disturbance before the deposition of the Bonaventure conglomerate supposedly of Mississippian age. The structural axes of the Acadian and Taconic orogenies are more or less parallel, which

[3] The difficulties in this correlation are emphasized by Schuchert and Cooper (1930) in the case of the Whitehead formation for the fossils were found to be more closely linked to Europe than to North America.

may be the result of Taconic structures influencing the direction of subsequent deformation, or it may be due to the fact that both were conditioned by the contour of the Canadian Shield, the foreland against which the geosynclinal sediments were squeezed.

SUMMARY.

1. The evidence at Lake Matapedia and at Matapedia Village substantiates Logan's belief that there was late Ordovician folding in Gaspé Peninsula. The date of the folding is determined as post-Richmondian? and pre-Clinton.

2. The phyllites, slates, and limestones between Ste. Florence and Matapedia, which Ells has mapped as Silurian, are in reality Ordovician and the limestones are probably Richmondian.

3. The Silurian section at Lake Matapedia is not the equivalent of the Gaspé limestone at Cape Gaspé (Devonian) as Logan was led to believe, but the direct equivalents of the lower part of the Chaleur series on the Bay of Chaleur. The Val Brillant sandstone represents the first clastic deposits of an invading Silurian sea following Taconic orogeny.

4. At Matapedia Village the Silurian is overlain by the Dalhousie formation (Helderberg) but north of Ste. Florence equivalents of the Helderberg are not known, and the Silurian is overlain by the Causapscal formation (Oriskany).

In conclusion the writer would like to point out that the Silurian succession on the north coast of Gaspé is known in detail only at Lake Matapedia where exposures are poor. Good sections are known to the east on Cap Chat River (Logan, 1863); to the west on Metis River, on Mt. Commis, at Ste. Blandine, at St. Gabriel, on Neigette River, and at Lake Temiscouata (Bailey and McInnes, 1891). F. M. Hutchins has started a stratigraphic study in these areas and it is hoped that his results will soon be forthcoming so as to complete a story that in the one area here described must be very incomplete.

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