PROBABLE AGE OF THE MEGUMA (GOLD-BEARING) SERIES OF NOVA SCOTIA¹

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INTRODUCTION

The gold-bearing rocks of the mainland of Nova Scotia have been under examination for more than fourscore years. Their structure and the methods of occurrence of their veins and the included metal have been studied in considerable detail; but from the earliest speculation of Gesner to the latest papers, references to the age of the series have been either vague or dogmatic without the requisite evidence to substantiate the statement. In recent years authors have for the most part been satis-

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fied with following the lead of earlier writers in calling the series Cambrian. The present paper aims to assemble whatever evidence is available bearing upon the age problem; and while the results are far from satisfactory and lack definiteness, they at least may indicate the extent of the existing uncertainty and possible lines of inquiry designed to eliminate that uncertainty.

Difficulties which lie in the way of establishing the age of the Meguma series appear early to the student; for he has to deal with a group of rocks nearly 30,000 feet in thickness, apparently conformable throughout, remarkably monotonous in texture, practically barren, and exhibiting neither a base beneath which is exposed an older series nor a summit above which lie any fossiliferous formations of such age as will aid much in establishing that of the gold-bearing rocks. In all the 30,000 feet there has been discovered but one horizon which can be traced far—the contact between the lower quartzitic Goldenville formation and the upper slates, the Halifax formation.

HISTORY OF OPINIONS

Without going into details, the fluctuations of opinion regarding the age of the Meguma series are as follows: Gesner (1843) called it Cambrian, without assigning reasons. Dawson (1850) regarded it as Lower Silurian or older (1855), perhaps equivalent to the Potsdam, Utica, and Hudson River; and later (1860) suggested that it corresponds to the Paradoxides zone in Newfoundland (see also Billings, 1860). The first edition of *Acadian Geology* (Dawson, 1855) places the series from Lower Silurian to Azoic; the second edition (1868) places it from the Chazy to Upper Potsdam “partly on evidence of an inferential character” (page 613). Marcou (1862) called the series Taconic.

In 1869 Hind made the first announcement of “fossils,” resembling *Palæotrochus major* and *minor* (Emmons), accompanying concretions in quartzite; and upon them he based a supposed age of Upper Potsdam to Lower Calciferous. In 1870 (1870^a, 1870^b, 1870^c, 1870^d) he described an underlying Huronian series which has proved to be a gneissoid portion of the Meguma. In 1872 Selwyn announced the discovery of *Eophyton* at the Ovens, near Lunenburg, and called the series Lower Silurian, equivalent to the Harlech grit and Lingula flag of Britain, now classed as Lower and Upper Cambrian.

In the third edition of *Acadian Geology* (1878^a) Dawson changed his designation of age to Cambrian, but merely because he had abandoned Murchison's classification. He speaks of “such fossils as have been found in it by Selwyn, Hind, and myself and those of its extensions in

New Brunswick and Newfoundland." It may be noted in passing that the rocks referred to in New Brunswick lie across the strike of the Meguma series and have no claim to be regarded as a continuation of it, and that on the east the strike of this series swings so far south as to clear southern Cape Breton completely; hence it is most unlikely that any rocks in Newfoundland so far to the northeast are continuations of the Meguma. This opinion of the age of the series Dawson held to the last; and the practice of Canadian geologists generally and of the Geological Survey of Canada officially is to call it Lower Cambrian. Murray (1881, pages 534-535) noted strong resemblance to the gold-bearing series of Newfoundland, which is "unconformable below the Primordial," the base of which is the Aspidilla or Saint Johns slate.

Faribault (1887, page 144) regarded the Eophyton of Selwyn as inorganic, and compared the series with the Cambrian of the eastern townships of Canada and with the rocks of the Lake of the Woods region studied by Lawson. Walcott (1891) thought that part may be Cambrian, but much is older. Van Hise (1892) regarded Eophyton as organic, and hence a valid fossil, but considered the series as probably Algonkian. Becker (1895), upon the basis of literature, concluded that the series is more probably Algonkian than Cambrian. Faribault (1899) still called the rocks Lower Cambrian, and this practice has continued largely to the present.

It will be seen from this summary that most of the writers have no special evidence in favor of their opinion as to the age of the series, and that those who do present testimony employ chiefly two classes—"fossils" and lithology. It is believed by the author that neither of these has been successful in establishing a probability of the Cambrian age of the Meguma, and that whatever evidence it is possible to adduce from other sources than these two indicates a probable pre-Cambrian age.

EVIDENCE

GRAPHITE

Both the formations composing the series contain small amounts of graphitic material. It is rarely in distinct layers or concentrated sufficiently to have any definite shape, but is diffused in minute grains and scales. In many of the mining districts the Goldenville formation contains it in the darker slates. Waverley, especially parts of East Waverley, and Salmon river near the contact with the Devonian are examples.

In the Halifax black slate formation above, the graphite is so widely distributed that no place can well be singled out. In the southeastern part of the Caribou gold district, Halifax county, close to the contact be-

tween the two formations, graphite occurs in seams up to 3 inches in thickness parallel with the stratification. In neither formation is it characteristic of any definite horizon.

It appears, then, that graphite is useful in the present connection only as showing an abundance of life in some small form or forms, distributed throughout the time occupied by the deposition of that part of the series now open to view, and entombed in its argillaceous sediments, chiefly in the upper formation.

LIME

There is little limestone in the Meguma. Faribault mentions one horizon. At the contact between the two formations lenticular bodies can be traced intermittently from the western side of Halifax harbor eastward for many miles. This is the only horizon known and is thoroughly crystalline.

There is a large amount of calcite in the quartzites as cement—an amount great enough to offer some difficulty of explanation. The quartzites are often feldspathic; but the feldspar is chiefly orthoclase, and plagioclases and basic lime-bearing silicates show no evidence of having been abundant in the rocks from which the quartzites were formed. Indeed, the general constitution of the latter requires acid progenitors. A more probable origin for this lime would be as a deposit of fine calcareous detritus from invertebrates mingled with a preponderating volume of sand and later turned into secondary interstitial calcite. But in any case it has no definite value in the age problem.

HISTORY OF RECORDED "FOSSILS"

The record of "fossils" begins with the announcement by Hind already mentioned.

"At Waverley the concretionary forms vary from half an inch to 4 inches in diameter. They are generally oval in shape, but sometimes round, with a depression in the center. Attached to some of them are numerous arms, all symmetrically arranged" (1869, page 62).

Palæotrochus has long since been shown to be of inorganic origin.

Of some forms found by Hind at Waverley, and presumably the same as the above, Dawson (1878, pages 82-83) gave the only specific description offered for any of the "fossils" of the series and invented for them the name *Astropolithon hindi*. The frequency with which such words as "seem" and "appear" occur in the description indicates the uncertain nature of the evidence.

The supposed land plant Eophyton, discovered by Selwyn (1872), has

FIGURE 1.—*Astropolithon hindi*, BEDFORD, HALIFAX COUNTY
Side view showing radial "arms." From Provincial Museum, Halifax

FIGURE 2.—*Astropolithon hindi*, BEDFORD, HALIFAX COUNTY
Surface view of a specimen without "arms." From Provincial Museum, Halifax

ASTROPOLITHON HINDI

been the subject of much controversy. Dawson (1878, page 82) says of the markings:

"They are of very doubtful origin, and in my judgment more akin to those trails of aquatic animals which I have named *Rhabdichnites*."

Faribault (1887) appears to have regarded the form as inorganic, while Van Hise (1892) considered it a true fossil. In any view of the case it has no value for determining age.

In 1891 (page 26) Dawson says of the series:

"It has unfortunately afforded no well characterized fossils. The markings called *Eophyton* and certain radiating bodies (*Astropolithon*) found in it are, however, similar to those occurring elsewhere in Lower Cambrian rocks."

Bailey mentions (1898, page 55) on the surface of quartzite at Lockport island, Shelburne county,

"despite their highly metamorphic character, numerous well marked remains of *Astropolithon*, the only evidence, if such they can be considered, of organic remains yet noticed in the Cambrian rocks of southwestern Nova Scotia."

PROBABLE INORGANIC CHARACTER OF THE FOSSILS

It is unfortunate that in these cases, as in all others of supposed fossils from the Meguma series with one exception, no illustrations have been published and no technical descriptions except the one noted from Dawson. Moreover, the authors for the most part are hesitant about accepting the forms as organic, even while mentioning them as perhaps important. But, whether the objects referred to under the names *Palæotrochus*, *Eophyton*, and *Astropolithon* are organic or not, they would appear to have no stratigraphic value, not being index or characteristic species or genera of any known horizons elsewhere.

Our present knowledge of natural fractures in the rocks, purely inorganic in origin, discloses a close similarity between some of these and certain of the supposed fossils. The description by Dawson could well be applied to many individuals of the type of fracture called by Professor J. B. Woodworth "*discoidal joints*." When it is remembered that the coarser strata of the Meguma series abound in cubical pyrite, the peculiarities of shape and staining of some of the "fossils" may be explained, as well as their presence. The weathering of pyrite involves an increase in volume and a consequent pressure upon the surrounding rock, which will account for many discoidal joints, and their shapes and topographic characteristics will depend largely upon the texture, cohesion, and homogeneity of the rock.

In passing from this subject it may fairly be considered that at the present time the "fossils" above mentioned have failed to establish their

status as organic forms, even the authors who described their occurrence having later expressed grave doubt of their validity.

Dawson (1878, page 83) noted the presence of *Scolithus* in loose blocks near the mouth of Saint Marys river. But this was not reported *in situ*, and the form, while more abundant in some ages than in others, is not characteristic, nor has it been proved to belong to any single species.

Bailey (1898, page 46) writes regarding western Nova Scotia:

"The only specimens we have as yet been able to obtain . . . are certain small circular or ovoidal pit-like depressions found in the black shale drift, in the vicinity of Bridgewater, in Lunenburg county, and again on the coast of the same county near Heckmans island. In outline they bear some resemblance to brachiopods of the genus *Obolella* or *Linnarsonia*, but they are lacking in markings or other distinctive features by which their nature can be definitely ascertained, and for the present at least they are unavailable as evidence."

Not only this, but as yet no specific description has established their claim as organic remains.

FOSSILS: MARKINGS AT GREENBANK, HALIFAX

A few years ago Dr H. S. Poole found some forms in the slates of Greenbank, Halifax, which resemble annelid tracks and burrows (1903, page 453). As they have not yet been described, it is impossible to refer to them here in detail, but an illustration of the slab containing them is appended. They do not appear upon examination likely to furnish any index to the age of the rocks; nevertheless they are organic, and may stand in importance above all other forms so far attributed to the series, perhaps excepting *Scolithus*.

CONCRETIONS

At many places in both formations concretions abound in the coarser strata.

Hind noted them at Waverley as early as 1869 (page 20). At both East Waverley and West Waverley he mapped "concretionary quartzites"; but recent study of the structure of this mining district indicates that these can hardly be the same stratum. Of the concretions he says: "They frequently resemble fossil forms, and it is subsequently shown that this quartzite is fossiliferous." It was from these beds that Palæotrochus came; but a close examination of the concretionary horizon at West Waverley in 1896 and 1897 failed to disclose any organic remains to the author.

South of Black point, near Liverpool, the strata hold concretions up to a foot in diameter, but there is no resemblance in them to distinct organic forms.

FIGURE 1.—SLATE FROM GREENBANK, HALIFAX,
WITH WORM-LIKE TRAILS OR BORINGS
Provincial Museum, Halifax

FIGURE 2.—CONCRETION FROM MOOSE RIVER GOLD MINES

FIGURE 3.—CONCRETION FROM MOOSE
RIVER GOLD MINES

FIGURE 4.—MARKINGS IN QUARTZITE,
LOWER ARGYLE

SPECIMENS OF SLATE AND CONCRETIONS

Concretions which appear at first sight of possible organic origin occur in the western part of the Moose River district (Woodman, 1904, page 24). It is unnecessary to redescribe them here, but it may be said that careful examination of slides failed to show the slightest organic trace.

The slates of the Halifax formation are highly altered by contact metamorphism west of the city of that name, on the shore of the harbor. As they were originally more varied in texture than most of the rocks of this group, the changes have emphasized the coarse and fine layers strongly. Near York redoubt, Halifax harbor, arenaceous strata abound in concretions up to the size of a hen egg, and isolated, although occurring persistently along the same beds. Finer sandy layers have smaller concretions closer together, often coalescing. The topography of these forms is varied, but in no case do they give evidence of organic origin or contents.

The best concretions yet found in the series by the author come from Gays River mines, locally also called Coldstream. They lie beside a brook in the horizon which marks at this place the contact of the Goldenville formation with the Lower Carboniferous gold-bearing conglomerate, the plane of their major diameters occupying the stratification planes. In appearance they are extremely regular, thickened, circular discs, averaging .3 to .5 by .2 inch. Each is clearly distinct from the inclosing slate, differing in this and other respects from concretions elsewhere in the series. The lamination of the rock bends around them, so that they stand out as eyes in the slate. Cleavage has not affected them, while rendering the adjacent layers thoroughly fissile. They are so well cemented as to withstand a strong percussion or compression. In color they are like the slate, but less greenish, and often stained copper brown from iron carbonate in the overlying conglomerate.

In the slide they appear with a comparatively clear center of quartz grains, coarser than in any other part of the mass. Surrounding this is a region of mixed quartz, calcite, kaolin, and a small amount of a grayish substance as yet undetermined. Outside of this is a ring, broadly elliptical in section, apparently of kaolin closely cemented by iron oxide. The greater ease of fracturing of the clear central part in comparison with this margin is noticeable. Adhering to the main concretion here and there are strips of the chloritic slate in which it was formed. Although apparently, when examined in the field, especially favorable as a possible resting place of fossils, these concretions have not been shown to contain any organic nucleus.

One mile south of Lower Argyle, on the west coast of the province, a ledge of slightly schistose quartzite beside the post-road has on its weathered surface pits which are of either concretionary or organic origin.

They are elliptical in outline, 2.5 to 5 inches long and 1.5 to 2.5 inches wide. Two have a slightly raised center. No structures are visible, and the forms are not such as have been described before, although in some ways similar to the mold of "Astropolithon." They may be concretionary, but the exposed surface is different from that found in weathered concretions elsewhere. They have no value as evidence at present, even though their appearance is more organic than that of most of the "fossils" from the series, and they and the concretions of Gays river are described in some detail, chiefly from the belief that nothing which may yield evidence should go unrecorded.

LITHOLOGICAL RESEMBLANCES AND BEDDED VEINS

Most of the lithological resemblances mentioned in literature have been noted already in this paper. In no case, according to the present ideas regarding correlation, can these likenesses be regarded as important at such geographical distances as have been spanned in the comparisons. The presence of stratified veins belongs to the same category of insufficient evidence. They occur to some extent in many parts of the world, in rocks varying in their age and physical characters, and their presence can no more be held to indicate the age of the country rock than can the presence of the red color in sandstones in other regions be employed as an index to the age of the formations.

Beyond these two classes of criteria—fossils and lithological resemblances—few writers have ventured in their search for the age of the Meguma series. But there are other data available, and it is believed by the author that they are more valid and important. These are chiefly (1) unconformities and the composition of younger rocks, (2) structure, and (3) accompanying igneous rocks.

UNCONFORMITIES

Unconformities which might be available for study are made by the contacts of the Meguma with various parts of the Carboniferous and with the Middle Devonian in the eastern part of the province, and in the Bear River basin of the west contacts of what has been called heretofore in literature Siluro-Devonian with a formation regarded by Bailey (1898) as part of the gold-bearing series. In the region between Torbrook on the west and the Avon river on the east are isolated areas at present considered by Messrs Fletcher and Faribault, of the Geological Survey of Canada, to belong chiefly to the Halifax formation, surrounded by strata of Silurian age. The contacts in this field have not yet been studied in sufficient detail to yield good evidence on the point in question. In the Bear River basin the lower rocks have not been proved to belong

CONTACT OF MEGUMA AND LOWER CARBONIFEROUS, GAYS RIVER GOLD MINE

to the Meguma series and present certain strong contrasts with it in lithology and history.

In the east, contacts with the Ordovician and Silurian can not be had because of intervening rocks of Devonian and Carboniferous age. In the valley of Salmon river, at the eastern end of the province, Middle Devonian adjoins the Meguma on the north, but the low topography gives no opportunities for visible contacts. As rocks containing Cambrian fossils are absent from the mainland portion of the province, it is impossible to work out relations between the Cambrian and the Meguma anywhere. Most of the remainder of the northern contact, as far west as the line of the Intercolonial railway, is with the Lower Carboniferous.

This contact is best seen in the artificial exposures at Coldstream (or Gays River mines), Colchester county, where an auriferous conglomerate has been worked intermittently for many years, the only fossil gold placer in the province. The upper strata are conglomerates and sandstones forming the southern edge of a large body of Lower Carboniferous rocks and composed chiefly of detritus from the Meguma series. The boulders include quartzite, slate, and quartz, the last perhaps 10 per cent of the whole. The difference between the composition of the boulders and the matrix is very marked, the latter being largely quartz. The cements are carbonate of lime, carbonate of iron, and iron hydroxide.

Gold of clastic origin is present in the conglomerate. The folding of the Meguma long preceded the erosion which gave the basal conglomerates above, and cleavage and jointing, well developed in the older series, stop short at the contact. The interbedded quartz veins characteristic of the Goldenville formation are present and their detritus furnishes much of the matrix of the conglomerate. The facet made by the plane of the floor of the Carboniferous and that made by the present erosion surface of the Meguma south of the margin form an angle of only a few degrees, indicating comparatively slight distortion and erosion since Lower Carboniferous time.

It will thus be seen that all the great events in the history of the series had been enacted before the deposition of this conglomerate.

COMPOSITION OF YOUNGER ROCKS

The testimony of sediments younger than the Meguma is inconclusive. The Carboniferous conglomerate contains much material from it, both igneous and sedimentary, showing that it was then in much the same condition as at present. At Salmon river the Devonian conglomerate holds pebbles of quartzite, often gneissoid, but no granite, according to Fari-bault (1887). In other places, however, the Devonian has much granite in its basal members. The supposed Ordovician conglomerate at Liv-

ington contains nothing referable in any way to the Meguma; nor do any other rocks of that age.

COMPARATIVE STRUCTURES

An important line of evidence as to the age of the series relative to other rocks comes from a study of its structure and that of the other series represented in the peninsula. Most of the younger groups of rocks show traces of local east and west or northeast and southwest folding here and there. It would be surprising not to find this; for they were laid down upon the flanks of the Meguma, which stood as a landmass probably to the south, and some folding has naturally taken place roughly parallel with the old land; but of systematic orogenic types of any sort they show nothing directly comparable to that of the Meguma.

In the region of the Salmon River lakes and West river Saint Marys, the Lower Carboniferous rests on both Devonian and Meguma, and holds, especially near its base, many boulders of quartzite from the latter; it shows obscure northeast anticlines. In a few places the Devonian exhibits a tendency to east and west folding, but a vague one. For the most part its folds are unsystematic. The most pronounced lack of agreement of the Meguma folds and those of other series is in the Ordovician. Some of the geological sheets of the province issued by the Geological Survey of Canada (documents 389 and 550) show this well. There is here no parallelism between the axial directions in the two systems; but in this part of North America deposition was not markedly discontinuous from early in the Cambrian to the end of the Ordovician. Such unconformities as have been found are trifling and do not mark a hiatus sufficient to allow time for large scale orogenic disturbance. The Ordovician has none of the structural or lithological features that characterize the Meguma. There are not the north and south faults nor the even east and west folds.

The difference between the Ordovician and the Meguma in this respect is extremely important. It is not a trifling disagreement in the strike of the beds; it is the difference on the one hand between a type of orogeny characterized by remarkably persistent folds, comparable to those of the Jura and the Appalachians, and on the other hand an almost entire absence of type in the Ordovician.

Only a few periods of disturbances so severe as to warrant calling them mountain building can be found in this part of the country before the Mesozoic. The Appalachian revolution is outside the present discussion, as shown by the Lower Carboniferous contacts and contents. The next older catastrophe was the Acadian revolution, separating the Devonian from the Carboniferous throughout most of Acadia; but the Devonian

is younger than the Meguma, for it holds detritus from it, especially in the east. Earlier than this came the Taconic revolution, separating the Ordovician from the Silurian. This was moderate in the maritime provinces, but is shown by unconformity at the top of the Ordovician wherever observable. But it can not be this which effected the folding of the Meguma, for neither Silurian nor Ordovician reflects the type of folding which characterizes that series. It is true that between the catastrophic epochs named unconformities were made in Nova Scotia. These can be seen or inferred in various places between the different series of rocks lying north of the Meguma sediments; but they are not profound, nor can they be traced over any considerable distance, and in no case does either series affected by the unconformity resemble the Meguma in lithological or structural characteristics.

In all the maritime region of British North America a great unconformity separates the Cambrian and pre-Cambrian wherever they are found in contact. This is true in the eastern townships, in New Brunswick, and in Newfoundland. The very general distribution of this unconformity and the great hiatus which it represents render it probable that a similar break separates the Cambrian and pre-Cambrian in Nova Scotia, and that it is marked in this instance by the total unlikeness in appearance, and especially in orogeny, between the Ordovician and Meguma, or, to go farther afield, between the latter and the Cambrian of southern Cape Breton. Not only this, but the folding had been accomplished in the older series before the erosion interval, and this may place other phenomena in the series as pre-Cambrian, such as the formation of the bedded veins.

THICKNESS

The thickness also is too great when comparison is made with any known Cambrian in the east. It is four times as great as any of the Cambrian in eastern Canada or Newfoundland, even under the liberal definition of the term followed by Canadian writers, and it is twice as great as any known Cambrian section in the United States. In southern New Brunswick, but a comparatively short distance away, the thickness of the Cambrian is slight, although all three of its main subdivisions are represented. It is unexpected, to say the least, to find in the midst of fossiliferous sections nowhere more than 6,000 feet in thickness an enormous area nearly 30,000 feet thick and almost absolutely barren, as far as known at present.

INTRUSIVES

Another line of evidence is offered by the intrusives. Except a remarkably small number of basic dikes, no intrusives but granites and

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marginal diorites are known in the Meguma strata, all abyssal and exhibiting no tendency to become rhyolitic. None of the younger rocks are thus characterized. The lavas of the Cambrian in Cape Breton are basaltic. The Ordovician has much contemporaneous volcanic material, largely basic, the most acid being a few syenites and aporhyolites and not granites. The Silurian in the eastern part of the province has a noticeable lack of intrusives, the chief ones being a narrow coast belt west of Malignant cove, and in the west the so-called diorites, regarded as originating in the great western bysmalith of Meguma granite. In the east the intrusives of the Devonian are chiefly basic. The Carboniferous is relatively free from igneous rocks, most of those that do occur lying near the margin of Silurian, Devonian, and Ordovician areas and possibly associated with the igneous masses in those strata.

Thus it appears that none of the rocks of known Paleozoic age in the province have passed through the same or a comparable history of invasion from molten matter as the Meguma. The pre-Cambrian of southern Cape Breton contains an abundance of rhyolitic material, affording the nearest approach to the igneous history of the Meguma shown by any of the Nova Scotian series.

CORRELATION WITH OTHER GROUPS

Correlation of the Meguma series, direct or implied, has been made with the Saint John River slates of New Brunswick and eastern Maine, with several other unfossiliferous slate and sandstone belts of Maine and New Hampshire, with the Taconic of the Green mountains in New England and New York, with the gold-bearing slates of North Carolina, with the gold-bearing pre-Cambrian of Newfoundland, with similar slates and sandstones in the eastern townships of Canada, and with several British formations.

It may appear presumptuous to criticise such correlations without having seen in the field all the rocks compared, but certain safe conclusions can be drawn from general principles. In the first place, the age of some of the series has not yet been determined, through the absence of just such evidence as is needed in the Meguma; others have been classed as young as the Carboniferous. In the second place, thus far all correlation has been on two bases, neither of which can be regarded as adequate—similar position with reference to rocks of known age and similar lithological character. The first has no force, from the indefinite position of the Meguma itself. The second is invalid because of the great distances over which it has been obliged to do duty. The conditions under which strata similar to those of the Meguma might form are so easily repeated

in nature that general lithological resemblances should be used sparingly. They are unsafe, even within the Meguma series, and are really available only where the gap or unknown area is short. The nearest of the correlative series is many miles away; and without data now unobtainable, such as exactly similar stratigraphic relations and fossil remains, the Meguma should not at present be correlated, even roughly, with any other known series of rocks.

CONCLUSIONS

It is evident from Dawson's statement in 1878 that he had not for many years, if ever, regarded the Meguma series as really Silurian. Few have done so at any time, according to the present understanding of the limits of the Silurian, and in recent references among students of the field the series has been labeled Lower Cambrian. What tangible evidence there is upon which this opinion is based, it is difficult to discover. A few doubtful markings in the rocks, a resemblance to certain other rocks thought by the authors to be Cambrian, but in part of unknown age, an indefinite position below the adjacent Silurian and Devonian—these are the inadequate grounds for this judgment. With the exception of a few American authors, writers appear merely to have followed the lead of earlier ones, and no new evidence has been offered in support of the opinion expressed.

The conclusion here reached, from the evidence at present at hand, is that the Meguma series is probably pre-Cambrian. All the data appear to lead to this; and while one or another of them is inconclusive by itself, the evidence is cumulative and, along the line of structures and intrusions, measurably direct. Moreover, from the characteristics of the Ordovician it appears probable that the main chapters in the structural history of the series—namely, the folding and doming and the formation of the interbedded veins—were enacted in the interval before the Ordovician, and are thus at least as ancient as the Cambrian.

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