CANADA
DEPARTMENT OF MINES
GEOLOGICAL SURVEY BRANCH
HON. W. B. NANTEL, MINISTER; A. P. LOW, DEPUTY MINISTER;
R. W. BROCK, DIRECTOR.

MEMOIR No. 28

THE GEOLOGY OF STEEPROCK LAKE, ONTARIO

BY
Andrew C. Lawson.

NOTES ON FOSSILS FROM LIMESTONE OF STEEPROCK LAKE, ONTARIO

BY
Charles D. Walcott.

OTTAWA
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16279—1

LETTER OF TRANSMITTAL.

R. W. Brock, Esq.,
Director Geological Survey,
Department of Mines,
Ottawa.

Sir,—I beg to submit herewith a memoir on the geology of Steeprock lake, Ontario; together with notes by the Hon. Charles D. Walcott, on certain fossils found in the limestone of the same area, which have a peculiar interest in that they are apparently the oldest forms of life yet discovered.

I have the honour to be, sir,
Your obedient servant,

(Signed) **Andrew C. Lawson.**

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THE GEOLOGY OF STEEPROCK LAKE, ONT.

BY

Andrew C. Lawson.

In the year 1891, Mr. H. L. Smyth published an interesting paper[1] on the geology of Steeprock lake, in which he classified the rocks there exposed into three principal groups:—

(1) The Basement Complex, consisting of granites and gneisses which typically are medium grained, hornblendic and granitoid with faint foliation. Locally they present considerable variations in composition and very great variations in structure.

(2) The Steeprock series, showing a thickness of 5,000 feet.

(3) The Atikokan series, a succession of later granitoid porphyries and massive hornblende rocks.

The Steeprock series rests unconformably upon the basement complex, and is subdivided into nine formations, according to the following scheme, arranged in ascending sequence:—

I. Conglomerate.
II. Lower limestone.
III. Ferruginous formation.
IV. Interbedded crystalline traps.
V. Upper calcareous green schist.
VI. Upper conglomerate.
VII. Greenstones and greenstone schists.
VIII. Agglomerate.
IX. Dark grey clay slate.

The sequence of these formations and their structural relations formed the chief subject matter of Mr. Smyth's paper, and the discussion of his third division, the Atikokan series, was deferred. The paper was not only interesting, but it was important from a general point of view as an announcement and description of a

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[1] Structural Geology of Steeprock lake, Ontario, Am. Jour. Sc. XLII, 1891.

series of rocks hitherto unrecognized in the Archæan of that part of Canada. This fact has attracted a number of geologists to Steeprock lake, and several references to the series are to be found in the literature of the region. The general question raised in all of these is the relation of the Steeprock series to the Keewatin. Smyth made perfectly clear that the Steeprock series rested unconformably upon his basement complex with a basal conglomerate reposing upon an eroded surface. But in that basement complex he recognized no Keewatin, but only those granites and gneisses which are usually referred to as Laurentian. The areal limits of the Steeprock series to the south and southwest were left undefined. In these directions, however, the rocks of the series are continuous with and indistinguishable from the Keewatin, and to any geologist who became familiar with this fact the whole implication of Smyth's interpretation of the geology was that the series was in part a local facies of the Keewatin and in part a normal facies, and that the Keewatin was, therefore, unconformable upon rocks of the Laurentian type and habitus.

Mr. W. H. C. Smyth,[1] after an examination of the series, accepted Smyth's descriptions and classification, saying: 'The work done by the writer in connexion with the rocks of this series suggests no important modification of them.' But he expressed the opinion that the Steeprock series was later than the Keewatin; a question upon which H. L. Smyth was silent. He did not, however, locate the contact of the Steeprock and Keewatin: 'The unconformity above the Keewatin schists of the Seine river to the southwest is not at all obvious. Lithologically the green traps and schists of the two series are strikingly similar and could not probably be separated by the most careful study.'

Coleman,[2] in 1897, regarded the Steeprock series as part of the Keewatin. He says: 'The water-formed clastics of the Keewatin are of great variety, including limestones, quartzites, slates, grits, graywackes, breccias, and pebble and boulder conglomerates. The limestones are, however, of limited extent, being found in any thickness only at Steeprock lake, 70 miles east of Rainy lake, where there is a small area differing both petrographically and structurally from the rest of the region. These limestones have a

[1] Bull. G.S.A., Vol. 4, 1893, pp. 344-347.
[2] Bull. G.S.A., Vol. 9, p. 225. Also Rept. Bureau of Mines, Ontario, Vol. VII, Pt. II, 1898, p. 152.

very modern look, being scarcely at all crystalline in appearance, having cherty layers in grey limestone at some points and black, very carbonaceous beds at others. One almost expects to discover fossils in them, but none have been found.' He makes no dissent from the ninefold subdivision of the series proposed by Smyth, and accepts the latter's interpretation of the structure.

McInnes,[1] in 1899, accepts Smyth's ninefold subdivision of the Steeprock series, and classifies the rocks of the series with the Keewatin as forming the upper division of the latter; although they are believed to be of later age than the great bulk of the Keewatin strata.

In 1911, Van Hise and Leith[2] give a summary statement of the geology of Steeprock lake, in which the Steeprock series is correlated with the lower Huronian, and is said to rest unconformably upon the Laurentian and Keewatin. But the series is said to be principally exposed on the south and west shores of the lake, where, as a matter of fact, the rocks are nearly all Keewatin, so that it is evident that the areal distribution of the series given by Smyth is accepted, the unconformity upon the Keewatin being inferred from the presence of Keewatin pebbles in the basal conglomerate. Smyth's ninefold subdivision of the series is quoted; but 'Some of the greenstones and greenstone schists included by Smyth in the lower Huronian are regarded by the authors as, at least in part, Keewatin.'

During the past summer I took occasion to spend a few days at Steeprock lake for the purpose of acquainting myself with some of the features described by Smyth, and for my guidance I had a copy of his paper, and the map that accompanies it. As a result of my visit, I am happily able to confirm the most important part of his conclusions, particularly as to the existence of the series as a distinct member of the Archæan, and its unconformable relation to a granite-gneiss of the basement complex. On the other hand, the observations that I made, while by no means exhausting the field, compel me to place an interpretation upon the stratigraphy and structure quite different from that of Smyth, and enable me to clear up the question of the relation of the series to the Keewatin,

[1] Geological Survey, Canada, Ann. Report, Vol. X, Pt. H.
[2] The Geology of the Lake Superior Region, U.S.G.S. Mon. LII, 1911, p. 147.

the latter being a large part of the basement upon which the Steeprock series was unconformably deposited.

I approached Steeprock lake from the west, coming up the Seine river from Rainy lake. In doing so I traced out nearly continuously the geological boundary between the Keewatin of Rainy lake and a series of quartzites and slates which for convenient reference I shall here call the Seine series. The Seine series lies to the south of the Keewatin, and is post-Keewatin in age. The contact between the two series is marked not only by the striking contrast in the general character and physical appearance of the rocks, but also by the occurrence of several lenses of conglomerate, of which the most important is that of Shoal lake. To the south of the quartzites and slates are the mica schists of the Coutchiching series. The relations of the Seine and Coutchiching series will not here be discussed.

It was my expectation in following the basal conglomerates of the Seine series eastward, that they would prove to be the same as one of the conglomerates described by Smyth on Steeprock lake. This expectation was, however, not realized. The boundary line between the Keewatin and the Seine series was followed with a steady E.-W. strike along the Atikokan river as far as the iron mines east of Sabawe lake. The east and west strike of the base of the Seine series is transverse to the more nearly N.W.-S.E. folds, which have involved the Steeprock series in vertical attitudes a little to the north of the Atikokan river. This stratigraphic and structural relationship indicates that the folding which involved the Steeprock series as a sharp trough sunk down into the older Archæan had taken place anterior to the deposition of the Seine series; since no such folding affects the even trend of the strike of the latter. It is, therefore, inferred tentatively that the Steeprock series is older than the Seine series, an inference which should be confirmed by a careful search in the conglomerates of the Atikokan river for pebbles of the Steeprock series. To the south of Sabawe lake the Seine series is cut by the granite gneiss which forms so large a feature of the geology of the Seine River and Shebandowan sheets. The phenomena of intrusion and the metamorphism of the Seine series consequent upon the intrusion are splendidly exemplified. No one who is at all familiar with the geology of the Thunder Bay district will question the unconformable superposition of the Animikie upon the complex of which this granite gneiss forms a part. From the foregoing statements, we arrive at the probable position of the Steeprock series in the geological scale; and this may conveniently be presented in the form of a tabulation in chronological sequence:—

Algonkian......	10 Keweenawan.
	Erosion internal.
	9 Animikie.
	EPARCHEAN INTERVAL.
Archæan.... ...	8 Granite gneiss, intrusive in the Seine series.
	Irruptive contact.
	7 Seine series.
	6 Acute deformation and erosion interval.
	5 Steeprock series.
	4 Erosion interval.
	3 Granite gneiss, intrusive in the Keewatin.
	Irruptive contact.
	2 Keewatin.
	1 Coutchiching.

The position of the Steeprock series, well down in the Archæan, is of interest from a general point of view, since, as will appear in the sequel, the limestone of which it is chiefly composed is fossiliferous. The fossils appear to be the oldest forms of life as yet discovered.

Before proceeding with the statement of the observations which necessitate a change in the interpretation of the geology of Steeprock lake, it may be said that the exposure of the rocks about the lake is probably much better than it was at the time of Smyth's visit in 1891. The region has been extensively, and in places very thoroughly denuded of its forests by fires, so that one may walk inland from the shores of the lake at many localities over bare glaciated rock surfaces. Smyth's observations were confined to the shores of the lake, and his mapped distribution of the formations away from there was conjectural, as was generally the case with maps made at that period in the Archæan terranes of western Ontario. His observations as to the extent and distribution of the two most important members of the Steeprock series: I, the basal conglomerate, and, II, the limestone about the shores of the lake, appear to have been most careful and accurate. The only modification which I was able to make in his mapping of these formations on the actual shore line was the extension of the conglomerate (I) to the main shore on the northeast side of Northwest bay. I also found no evidence of the fault which he places through Birch point.

Inland from the lake shore, however, I found the distribution of the rocks in certain localities, which are decisive for the interpretation of the structure, to be otherwise than Smyth had conjectured. This is notably the case, for example, in regard to his formation IX—described as a dark grey clay slate. An east and west section across the peninsula which terminates in Jackpine point, made from the shore about three-fourths of a mile south of that point, showed clearly that no such formation exists as mapped. The rocks in the area mapped as clay slate are coarse agglomerate schists, cut by great dykes of greenstone. The surface here is particularly open and well exposed, and one may walk freely over the bare rocks. The supposed clay slates which crop out on the shore at Smyth's locality 81, appear to be a local facies of the agglomerate formation particularly well sheared, and having a very limited distribution at and close to the shore, and grading into the agglomerate. Formation IX, as distinct from VIII, appears, therefore, to be non-existent; and the syncline which is based upon the supposed distribution of clay slate and agglomerate can no longer claim recognition.

The agglomerate VIII, and the belt of greenstones and greenstone schists VII—which lies to the east of it—are typical Keewatin formations, indistinguishable from and continuous with the belt of Keewatin rocks of the north side of the Seine river which has been traced through from Rainy lake. To the east of the belt of greenstones and greenstone schists VII, is a narrow belt of conglomerate—Smyth's 'Upper conglomerate' VI. This conglomerate was conjecturally, but approximately correctly, mapped by Smyth. I have confirmed his mapping by tracing the conglomerate through from its outcrop on the end of the peninsula west of East bay to the south end of Straw Hat lake. This lake was evidently unknown to Smyth, although the exposures on its shores are of the utmost importance for the interpretation of the structure. It lies parallel to East bay, two-fifths of a mile west of its south end. The course of the conglomerate belt for the distance indicated is parallel to that of Smyth's conglomerate I, on the east side of East bay. East of the conglomerate is a limestone, which occupies for the most part a depression extending through from Falls bay to the south end of Straw Hat lake. The limestone is exposed at both ends of Straw Hat lake, and is identical in character with the limestone on the east side of East bay, Smyth's formation II. It evidently underlies the waters of the lake. Between the north end of Straw Hat lake and Falls bay it is exposed at intervals, and numerous blocks of it occur in the depression. The depression ends in a little bay where a small creek flows into Falls bay. To the west of the creek is a carbonated green schist lying against the conglomerate. This is Smyth's formation V—the 'Upper calcareous green schist.' This is probably a local impure facies of the limestone or detrital material that has been carbonated by reason of its proximity to the limestone.

On a small island on the east side of Straw Hat lake the rock consists of a comparatively little altered volcanic ash which is identical with Smyth's formation III on the west side of East bay of Steeprock lake, which he refers to as a 'ferruginous formation,' but describes as an impure volcanic ash. It is a soft rock, prone to disintegration, and like the limestone, lies chiefly beneath the waters of Straw Hat lake and in the depression which extends through from Straw Hat lake to Falls bay. Between these two occurrences of the volcanic ash, the one on East bay and the other on Straw Hat lake, lies Smyth's formation IV, 'Interbedded Crystalline traps.' This I found to consist very largely of rather massive green schists of detrital origin, with abundant angular fragments of quartz, traversed parallel to the strike by what appeared to be great dykes of diabase, but which may possibly be massive flows.

On the east side of East bay the formations are as Smyth described and mapped them, viz.: a basal conglomerate, I, of quite moderate thickness, resting on the granite gneiss of the east shore, followed to the west by bedded limestone, II, for a thickness of several hundred feet, the whole in nearly vertical attitudes.

From the facts above stated, it is evident that in a section transverse to East bay and Straw Hat lake we have to deal with a twofold repetition of the same set of beds; and the unavoidable conclusion is that the structure is a simple, closely folded syncline. The three lowest formations of the Steeprock series as described by Smyth on East bay are repeated on Straw Hat lake in reverse order. The duplication of formation IV has not been made out, and it is doubtful if it can be, owing to the character of the rocks, which renders it difficult to distinguish one horizon from another, and to the dykes which cut it. The conglomerate VI is, therefore, the same as I, and it is a basal conglomerate resting upon the Keewatin. This conglomerate was deposited upon an eroded surface across the contact of the Keewatin and the granite gneiss. The insunken syncline happens to cover the contact, so that on one limb of the syncline the conglomerate rests upon the granite gneiss and on the other limb, upon the Keewatin.

This interpretation of the structure greatly simplifies the geology of Steeprock lake. The Steeprock series is reduced to four formations, viz.: Smyth's I, II, III, and IV. Formation V is identified with II, and VI with I. Formations VII and VIII are Keewatin below the basal conglomerate, and IX is non-existent as mapped.

With reference to the dykes which traverse the region, it may be said that the greenstone pebbles in the basal conglomerate, which Smyth supposed to have been derived from an earlier system of dykes, are derived from the Keewatin, and that nearly all the dykes belong to his second class, i.e., are later than the Steeprock series.

A word in regard to the Atikokan series also may not be out of place. I examined, very cursorily, the shores of Margaret lake, and found no reason to segregate the rocks there exposed from those of the basement upon which the Steeprock series rests. Mr. Smyth regards these rocks as of later age than the Steeprock series lying across the edges of the latter. It seemed to me that following the Steeprock formations southerly along their strike they abutted upon the rocks of Margaret lake by reason of a N.E.-S.W. fault with resultant down-throw on the N.W. side; the formations of the Steeprock series having been entirely removed on the south side.

The simplification of the structure, and the reduction of the number of its constituent formations detracts nothing, however, from the interest attaching to the Steeprock series. There is enough of it left to make it a most important member of the Archæan Complex. The fact that it is definitely segregated from the Keewatin, only adds to the interest. But perhaps the most interesting fact connected with this series is that its dominant formation, the limestone, which is estimated by Smyth to be not less than 500 feet, nor more than 700 feet in thickness, is fossiliferous. The rock is, in part, almost an aggregate of fossils, but, in part, it is also composed of calcareous detritus derived from the waste of organisms, as may be clearly determined from the cross-bedded structures which are quite apparent in it.

In part the fossils are wholly calcareous, and in part they are wholly silicified, and there are intermediate conditions due to partial silicification. Where not silicified the fossils appear on the weathered surface of the limestone as radial structures, the rays extending out to a limit which is approximately circular in sections normal to the axis of the organisms. In oblique sections the periphery may be more or less elliptical. The diameter of these circular boundaries varies in the hundreds of specimens observed, from about 1 inch to about 15 inches. This variation in size is probably due partly to differences in the stage of development of the organism, and partly to the position of the random section of the surface of the limestone exposing the form. For when viewed in three dimensions and not merely in section, some of these fossils appear to have a tapering and more or less curved or cornucopia shape. The radial structure is due to the presence of rays which diverge from the axis of the cornucopia. Occasionally, it may be observed that these are interrupted by one or more cylindrical or conical septa concentric with the axis of the cornucopia, but in most cases no such concentric septa can be detected In other cases, particularly in regard to the larger forms, it cannot be observed that they are cornucopia shaped, and the rays appear to radiate in all directions from a centre.

Often these fossils are so crowded together that they abut one against another; but in no case are the individual rays observed to cross. In the larger forms the limits of the radial structure are much less definite than in the case of the smaller cornucopia shaped forms, and on the weathered surface the rays appear to fade away into the general matrix of limestone. The clearly apparent structure is, however, contained within a circular area on the surface of the rock.

Where these forms have been silicified they commonly project prominently above the surface of the limestone, and the structure can be more easily observed. In these silicified forms the rays and the tapering or cornucopia shape are commonly apparent. It is evident from the sudden passage from conglomerate to limestone and from the cross-bedded character of some of the limestone, that the organisms which contributed their remains to the building up of this important formation thrived in shallow water, and that the accumulation of their structures gave rise to some sort of a fringing reef along the shore, which from time to time was reduced by the waves to a calcareous sand which was scoured by the currents.

The fossils collected were submitted for study to the Hon. Charles D. Walcott, the eminent authority on the earliest forms of life, and he has very kindly supplied the descriptive notes which follow.

NOTES ON FOSSILS FROM LIMESTONE OF STEEPROCK SERIES, ONTARIO,[1] CANADA.

BY

Charles D. Walcott.

Through the courtesy of Dr. Andrew C. Lawson, I have had the opportunity of studying some organic remains occurring in the Steeprock series of Steeprock lake, northwest of Atikokan, on the Canadian Northern railway, west of Port Arthur, Ontario, Canada.[2]

Mr. H. L. Smyth concluded from his studies that the Steeprock series rested unconformably upon a basement complex, and Van Hise and Leith, in their great memoir on the Geology of the Lake Superior Region, have included the Steeprock series of Smyth in the lower Huronian.[3]

The Steeprock Lake region was studied by Dr. Lawson during the season of 1911, who found in the lower limestone above the conglomerate of the Steeprock series the remains of fossils described in these notes; and from his field observations placed the Steeprock series above an erosion interval beneath which occurs the Keewatin of the Archæan.

After a preliminary study of the material, I was inclined to the view that the remains indicated the presence of the *Archæocyathinæ*[4] of the lower Cambrian; but after making thin sections and treating the silicified specimens with acid, I decided that they

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[1] Presented to the Geological Society of America, December 28, 1911, by permission of the Director of the Geological Survey, Canada.

[2] Structural Geology of Steeprock lake, Ontario, by Henry Lloyd Smyth. American Jour. Sci., Vol. XLII, 1891, pp. 317-331, Pl. XI.

[3] The Geology of the Lake Superior Region. Monogr. U.S. Geol. Surv., Vol. 52, 1911, p. 148.

[4] For definition of this family and review of the Archæocyathinæ, consult memoir by Wm. T. Griffith Taylor, "Archæocyathinæ from the Cambrian of South Australia." Mem. Royal Soc. South Australia, Vol. 2, Pl. 2, 1910.

It is unfortunate that in this otherwise very full memoir there is no reference to the genera and species noted and illustrated in the Tenth Annual Report of the U. S. Geol. Surv., 1891, pp. 599-602, Pls. 50-55.

represented a group of organisms related to the sponges, or possibly to forms possessing characters of both the sponges and *Archæocyathinæ*.

The central cavity, radiating tubes, and general form of *Atikokania lawsoni* (Pl. 1, figs. 1-5), recall at once the lower Cambrian genus *Syringocnema* of Taylor.[1] In each there is a cylindrical inner cavity, an outer and inner wall with radiating tubes connecting them; the tube walls are perforate in *Syringocnema*, and they appear to be so in *Atikokania*. The presence of irregular septa in *Atikokania* serves to distinguish the genus from *Syringocnema*, and to cause a comparison to be made with irregularly septate genera of the *Archæocyathinæ*, such as *Pycnoidocyathus* Taylor (Pl. XII, fig. 68), and *Sprirocyathus irregularis* Taylor (Pl. XVI, figs. 93 and 94).[2]

A second and possibly a third species of *Atikokania* is associated with *A. lawsoni*.

If the interpretation of the stratigraphic position of these interesting fossils is correct they are probably older than the Pre-Cambrian *Beltina* fauna of Montana[3] and quite unlike it; with the possible exception of a fragment (Pl. II, fig. 3) that suggests *Crytozoan ? occidentale*.[4] The genus *Atikokania* has more of a Cambrian aspect than we should expect to find in a very ancient Pre-Cambrian fauna. The *Archæocyathinæ* are of late lower Cambrian age, and if the stratigraphic position were not well determined I should be inclined to consider *Atikokania* as a lower Cambrian genus.

DESCRIPTION OF FOSSILS.

Genus ATIKOKANIA, *new genus*.

General form cylindrical, pear-shaped or somewhat irregularly elongated, semi-globose. Central cavity more or less cylindrical and of varied form and proportions.

Walls.—The outer and inner walls are more or less well-defined, and they are united by a series of small, more or less hexagonal

[1] Loc. cit., p. 153, Pl. 14.
[2] Loc. cit. Footnotes 1, preceding page, and 1, above.
[3] Pre-Cambrian Fossiliferous Formations, Walcott. Bull. Geol. Soc. America. Vol. 10, 1899, pp. 235-239.
[4] Loc. cit., p. 233. Pl. XXIII, figs. 1-4.

tubes that radiate outward and upward at varying angles. The walls of the radial tubes are perforate, and divided by more or less irregular incomplete septa.

Growth.—The mode of growth appears to have been essentially the same as that of *Archæocyathinæ,* where individuals press against each other that appear to have united at the point of contact by a more or less confused compact growth.

Affinities.—For the present and awaiting larger collections and possibly much better material, a relation may be assumed with the *Porifera* on the one hand and the *Archæocyathinæ* on the other, with a strong tendency towards the first.

Observations.—There are two species now referred to the genus: *A. lawsoni,* n. sp., and *A. irregularis,* n. sp. One or two other species are indicated, but the material is not sufficiently complete for specific description.

Genotype.—Atikokania lawsoni, n. sp.

Atikokania lawsoni, n. sp.

(Pl. I, figs. 1-5; Pl. II, fig. 2.)

The general form of this species is elongate conical or cylindrical as far as can be determined from several fragmentary specimens. Central cylindrical cavity relatively small and expanding towards the upper outer portion of the central cavity.

Walls.—The outer and inner walls are fairly well defined, but owing to the condition of preservation none of their details of structure are preserved.

Tubes.—The walls of the tubes are pressed one against the other so as to form a practically solid mass of tubes that have a more or less hexagonal outline. The tubes are so arranged in the cylindrical specimens that they radiate like the spokes of a wheel from the inner to the outer walls and increase in number by interpolation of additional tubes. In one vertical section (fig. 1, Pl. I) the tubes rise from the inner wall with a slope of about 10°–15°. In other sections the slope is greater. The tubes vary in size from a sharp elongate point where they start between other tubes to 2 mm. in diameter at their outer end.

Septa.—Incomplete, irregular septa occur in the tubes at irregular distances.

Pores.—Pores appear in the walls between the tubes, but none have been seen in either the inner or outer wall.

Exothecal Growth.—The presence of exothecal tissue somewhat similar to that so common in *Archæocyathus* is suggested by some specimens, but it is not sufficiently clear to warrant giving it as a character of the genus or species.

Growth.—The mode of growth appears to have been individual, although, as illustrated by fig. 5, Pl. I, two central cavities appear in what would otherwise have been considered an individual. The radial tubes are more or less confused where those that radiate from the two cavities come in contact. My present impression is that the two grew side by side, with only a very slight distance between them, when small; as they grew, the central cavities were crowded farther apart.

Formation and Locality.—Limestone of Steeprock series, Steeprock lake, west-northwest of Lake Superior, Ontario, Canada.

ATIKOKANIA IRREGULARIS, N. SP.

(Pl. II, Fig. 1.)

The specimen representing this species is a weathered, oblique section, 6·5 cm. in height and 11 cm. in width. The radiating tubes are more irregular and smaller than those of *A. lawsoni*, and the general appearance of the specimen is more like that of a portion of a large semi-globular sponge.

A second fragment that may be referred to this species indicates that the central cavity was very small.

This species is associated in the same limestone with *A. lawsoni*.

DESCRIPTION OF PLATE I.

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Fig. 1.—Natural size. A naturally weathered cylinder or pipe that is silicified in its limestone matrix. This shows quite clearly the central cavity at the summit, also where it is cut across below by the erosion of the specimen. U.S. National Museum, Catalogue No. 58313. Geological Survey, Canada, Catalogue No. 8059*a*.

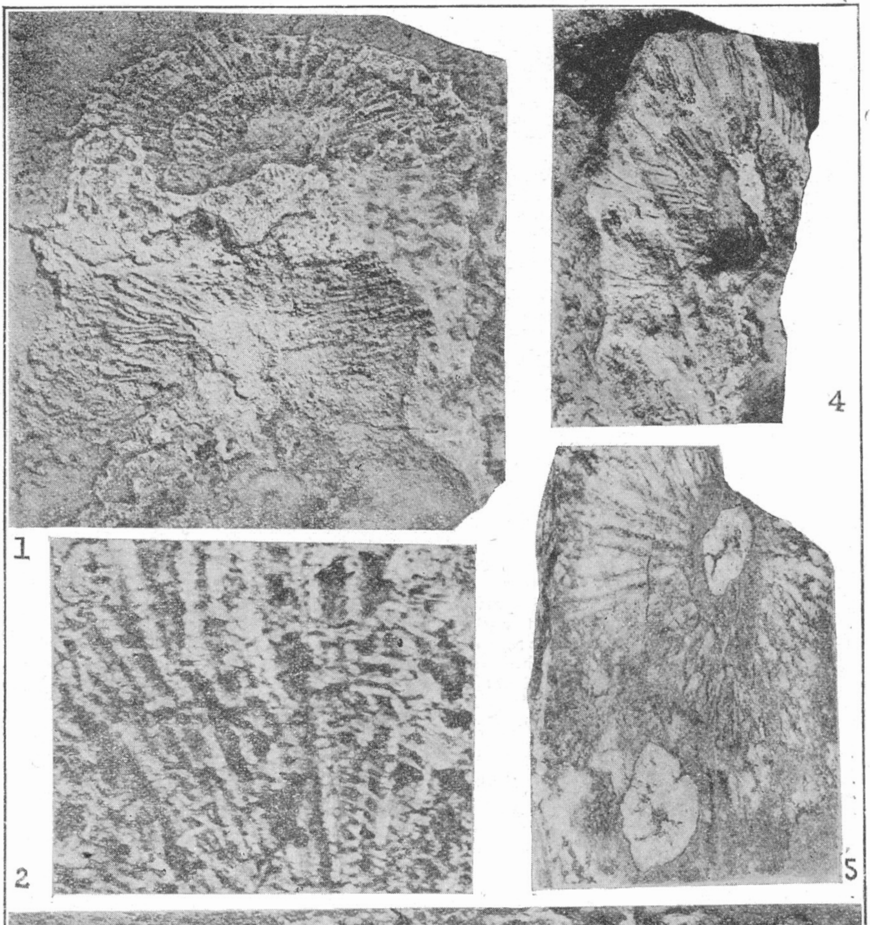
" 2.—Enlargement × 6, of a portion of the weathered section in Fig. 1, which shows the walls of the tubes with pores at *a*, also somewhat irregular septa crossing the tubes.

" 3.—Enlargement × 3, of the upper surface of Fig. 1.

" 4.—Natural size. A weathered specimen where erosion has worn down into the central cavity. U.S. National Museum, Catalogue No. 58314. Geological Survey, Canada, Catalogue No. 8059*b*.

" 5.—Natural size. An oblique transverse section, cutting across the central cavities of two individuals that occur side by side. U.S. National Museum, Catalogue No. 58315. Geological Survey, Canada, Catalogue No. 8059*c*.

PLATE I.



Figs. 1–5. ATIKOKANIA LAWSONI Walcott.

DESCRIPTION OF PLATE II.

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ATIKOKANIA IRREGULARIS, Walcott 23

Fig. 1.—Natural size. A weathered section, showing irregular tubes radiating from what was probably a portion of the central cavity. U.S. National Museum, Catalogue No. 58317. Geological Survey, Canada, Catalogue No. 8059*d*.

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Fig. 2.—Natural size. Polished section of a piece of limestone where the radiating tubes are cut across at different angles. The sections of the tubes on the right half are nearly at right angles to the tubes, while those on the left are more or less oblique. All of the sections of the tubes appear to have been more or less disturbed by the compression of the limestone in which they are embedded. U.S. National Museum, Catalogue No. 58316. Geological Survey, Canada, Catalogue No. 8059*e*.

CRYPTOZOAN ?? sp. undt.. 23

Fig. 3.—Natural size. Photograph of a thin section of what may be a form allied to the Pre-Cambrian Cryptozoan of the Grand Canyon section of Arizona. U.S. National Museum, Catalogue No. 58318. Geological Survey, Canada, Catalogue No. 8059*f*.

PLATE II.

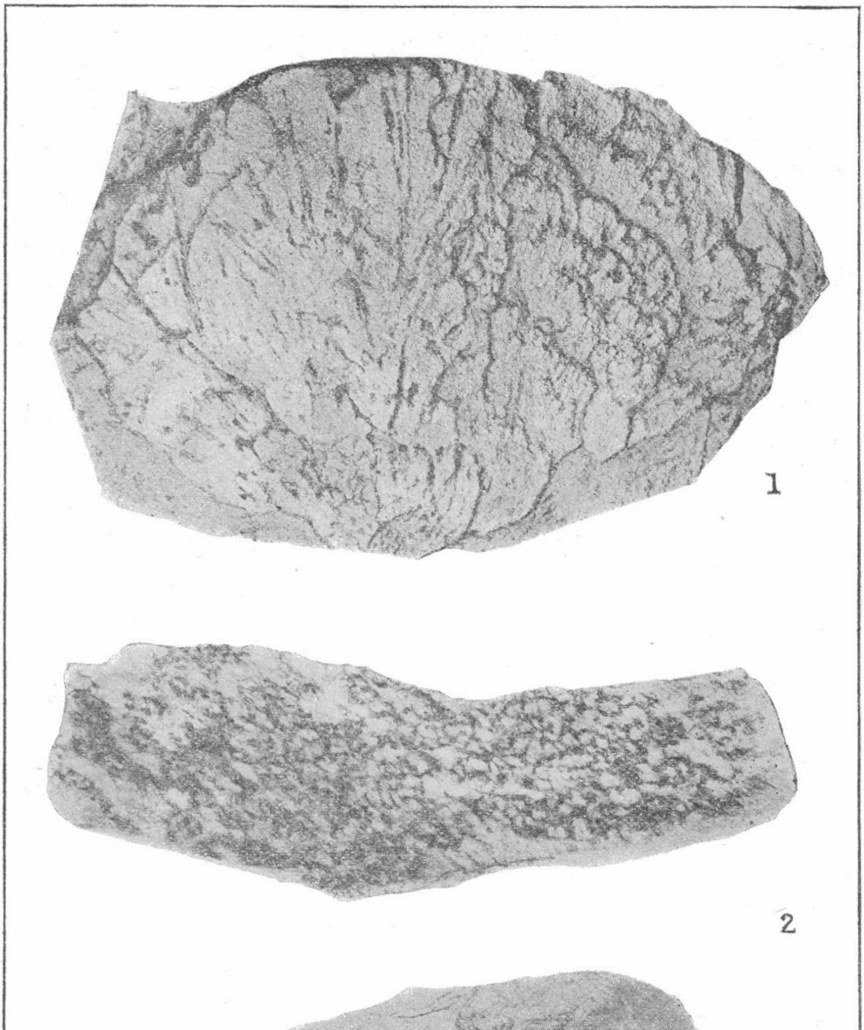

Fig. 1. ATIKOKANIA IRREGULARIS Walcott.
" 2. " LAWSONI Walcott.
" 3. CRYPTOZOAN ?? sp. undt

CANADA

DEPARTMENT OF MINES

GEOLOGICAL SURVEY BRANCH

Hon. W. B. Nantel, Minister; A. P. Low, Deputy Minister;
R. W. Brock, Director.

SELECTED LIST OF REPORTS AND MAPS

(SINCE 1885)

OF SPECIAL ECONOMIC INTEREST

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THE GEOLOGICAL SURVEY.

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No. 245.	Report of Mines Section, 1886.	No. 662.	Report of Mines Section, 1897
272	" " 1887.	698	" " 1898
*300	" " 1888.	718	" " 1899
301	" " 1889.	744	" " 1900
334	" " 1890.	800	" " 1901
335	" " 1891.	835	" " 1902
360	" " 1892.	893	" " 1903
572	" " 1893-4	*928	" " 1904
602	" " 1895.	971	" " 1905
625	" " 1896.		

Mineral Production of Canada:—

No. *414.	Year 1886.	No. *422.	Year 1893.	No. 719.	Year 1900.
*415	" 1887.	*555	" 1894.	719a	" 1901.
*416	" 1888.	*577	" 1895.	813	" 1902.
*417	" 1889.	*612	" 1896.	861	" 1903.
*418	" 1890.	*623	" 1886-96.	896	" 1904.
*419	" 1891.	*640	" 1897.	924	" 1905.
*420	" 1886-91.	*671	" 1898.	981	" 1906.
*421	" 1892.	*686	" 1899.		

Mineral Resources Bulletin:—

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851.	Coal.	869.	Mica.	882.	Copper.
*854.	Asbestos.	872.	Molybdenum and Tungsten.	913.	Mineral Pigments.
857.	Infusorial Earth.	*877.	Graphite.	953.	Barytes.
858.	Manganese.	880.	Peat.	984.	Mineral Pigments (French).
859.	Salt.				

Report of the Section of Chemistry and Mineralogy:—

No. *102.	Year 1874-5.	No. *169.	Year 1882-3-4.	No. 580.	Year 1894.
*110	" 1875-6.	222	" 1885.	616	" 1895.
*119	" 1876-7.	246	" 1886.	651	" 1896.
*126	" 1877-8.	273	" 1887-8.	695	" 1898.
*138	" 1878-9.	299	" 1888-9.	724	" 1899.
*148	" 1879-80.	333	" 1890-1.	821	" 1900.
*156	" 1880-1-2.	359	" 1892-3.	*958	" 1906.

* Publications marked thus are out of print.

REPORTS.

GENERAL.

745. Altitudes of Canada, by J. White. 1899.
*972. Descriptive Catalogue of Minerals and Rocks, by R. A. A. Johnston and G. A. Young.
1073. Catalogue of Publications: Reports and Maps (1843-1909).
1085. Descriptive Sketch of the Geology and Economic Minerals of Canada, by G. A. Young, and Introductory by R. W. Brock. Maps No. 1084; No. 1042 (second edition), scale 100 m. = 1 in.
1086. French translation of Descriptive Sketch of the Geology and Economic Minerals of Canada, by G. A. Young, and Introductory by R. W. Brock. Maps No. 1084; No. 1042 (second edition), scale 100 m. = 1 in.
1107. Part II. Geological position and character of the oil-shale deposits of Canada, by R. W. Ells.
1146. Notes on Canada, by R. W. Brock.

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BRITISH COLUMBIA.

212. The Rocky mountains (between latitudes 49° and 51° 30′), by G. M. Dawson. 1885. Map No. 223, scale 6 m. = 1 in. Map No. 224, scale 1½ m. = 1 in.
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ONTARIO.

215. Lake of the Woods region, by A. C. Lawson. 1885. Map No. 227, scale 2 m. = 1 in.
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992. Report on Northwestern Ontario, traversed by National Transcontinental railway, between Lake Nipigon and Sturgeon lake, by W. H. Collins. Map No. 993, scale 4 m. = 1 in.
998. Report on Pembroke sheet, by R. W. Ells. (French). Map No. 660, scale 4 m. = 1 in.
999. French translation Gowganda Mining Division, by W. H. Collins. Map No. 1076, scale 1 m. = 1 in.
1038. French translation report on the Transcontinental Railway location between Lake Nipigon and Sturgeon lake, by W. H. Collins. Map No. 993, scale 4 m. = 1 in.
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579. Eastern Townships, Montreal sheet, by R. W. Ells and F. D. Adams, 1894. Map No. 571, scale 4 m. = 1 in.
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975. Report on Copper-bearing rocks of Eastern Townships, by J. A. Dresser. (French).
998. Report on the Pembroke sheet, by R. W. Ells. (French).
1028. Report on a Recent Discovery of Gold near Lake Megantic, Que., by J. A. Dresser. Map No. 1029, scale 2 m.=1 in.
1032. Report on a Recent Discovery of Gold near Lake Megantic, Que., by J. A. Dresser. (French). Map No. 1029, scale 2 m.=1 in.
1052. French translation report on Artesian wells in the Island of Montreal, by Frank D. Adams and O. E. LeRoy. Maps No. 874, scale 4 m.=1 in.; No. 375, scale 3,000 ft.=1 in.; No. 876.
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983. Mineral resources, by R. W. Ells. Map No. 969, scale 16 m.=1 in.
1034. Mineral resources, by R. W. Ells. (French). Map No. 969, scale 16 m.=1 in.
1113. Memoir No. 16-E: The Clay and Shale deposits of Nova Scotia and portions of New Brunswick, by H. Ries and J. Keele. Map No. 1153, scale 12 m.=1 in.

NOVA SCOTIA.

243. Guysborough, Antigonish, Pictou, Colchester, and Halifax counties, by Hugh Fletcher and E. R. Faribault. 1886.
331. Pictou and Colchester counties, by H. Fletcher. 1890-1.
358. Southwestern Nova Scotia (preliminary), by L. W. Bailey. 1892-3. Map No. 362, scale 8 m.=1 in.
628. Southwestern Nova Scotia, by L. W. Bailey. 1896. Map No. 641, scale 8 m. = 1 in.
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MAPS.

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YUKON.

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894. Sketch Map Klause Mining district, scale 6 m. = 1 in.
*916. Windy Arm Mining district, Sketch Geological Map, scale 2 m. = 1 in.
990. Conrad and Whitehorse Mining districts, scale 2 m.=1 in.
991. Tantalus and Five Fingers coal mines, scale 1 m. = 1 in.
1011. Bonanza and Hunker creeks. Auriferous gravels. Scale 40 chains =1 in.
1033. Lower Lake Laberge and vicinity, scale 1 m.=1 in.
1041. Whitehorse Copper belt, scale 1 m. = 1 in.
1026. 1044-1049. Whitehorse Copper belt. Details.
1099. Pelly, Ross, and Gravel rivers, Yukon and North West Territories. Scale 8 m. = 1 in.
1103. Tantalus Coal area, Yukon. Scale 2 m. = 1 in.
1104. Braeburn-Kynocks Coal area, Yukon. Scale 2 m. = 1 in.

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278. Cariboo Mining district, scale 2 m. = 1 in.
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*771. Preliminary Edition, East Kootenay, scale 4 m. = 1 in.
767. Geological Map of Crowsnest coal-fields, scale 2 m. = 1 in.
*791. West Kootenay Minerals and Striæ, scale 4 m. = 1 in.
*792. West Kootenay Geological sheet, scale 4 m. = 1 in.
828. Boundary Creek Mining district, scale 1 m. = 1 in.
890. Nicola coal basin, scale 1 m. = 1 in.
941. Preliminary Geological Map of Rossland and vicinity, scale 1,600 ft. = 1 in.
987. Princeton coal basin and Copper Mountain Mining camp, scale 40 ch. = 1 in.
989. Telkwa river and vicinity, scale 2 m. = 1 in.
997. Nanaimo and New Westminster Mining division, scale 4 m. = 1 in.
1001. Special Map of Rossland. Topographical sheet. Scale 400 ft. = 1 in.
1002. Special Map of Rossland. Geological sheet. Scale 400 ft. = 1 in.
1003. Rossland Mining camp. Topographical sheet. Scale 1,200 ft. = 1 in.
1004. Rossland Mining camp. Geological sheet. Scale 1,200 ft. = 1 in.
1068. Sheep Creek Mining camp. Geological sheet. Scale 1 m. = 1 in.
1074. Sheep Creek Mining camp. Topographical sheet. Scale 1 m. = 1 in.
1095. 1A.—Hedley Mining district. Topographical sheet. Scale 1,000 ft. = 1 in.
1096. 2A.—Hedley Mining district. Geological sheet. Scale 1,000 ft. = 1 in.
1105. 4A.—Golden Zone Mining camp. Scale 600 ft. = 1 in.
1106. 3A.—Mineral Claims on Henry creek. Scale 800 ft. = 1 in.
1125. Hedley Mining district: Structure Sections. Scale 1,000 ft. = 1 in.
Deadwood Mining camp. Scale 400 ft. = 1 in. (Advance sheet.)
1164. 28A.—Portland Canal Mining district, scale 2 m. = 1 in.
Beaverdell sheet, Yale district, scale 1 m. = 1 in. (Advance sheet.)
Tulameen sheet, scale 1 m. = 1 in. (Advance sheet.)
1136. 16A.—Phoenix Boundary district. Geological sheet. Scale 400 ft. = 1 in.
1136. 16A.—Phoenix Boundary district. Geological sheet. Scale 400 ft. = 1 in.

ALBERTA.

594–596. Peace and Athabaska rivers, scale 10 m. = 1 in.
*808 Blairmore-Frank coal-fields, scale 180 ch. = 1 in.
892. Costigan coal basin, scale 40 ch. = 1 in.
929–936. Cascade coal basin. Scale 1 m. = 1 in.
963–966. Moose Mountain region. Coal Areas. Scale 2 m. = 1 in.
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804. Part of Turtle mountain showing coal areas. Scale 1½ m. = 1 in.
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