EARLY PROTEROZOIC (APHEBIAN) PLAN-VIEW ALGAL MATS IN THE LOWER ALBANEL BLACK SHALE ON LAKE MISTASSINI, CENTRAL QUEBEC

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OVERVIEW

Unusual Precambrian fossils seen along Lake Mistassini appear to be algal mats preserved in plan view (ie, as seen from above their substrate), rather than as the more ordinary laminae seen edge-on in vertical or thin sections.

These were **independently discovered by DCM** while examining slightly younger stromatolites nearby.

These fossils are **best interpreted as** prokaryotic **blue-green algae** (Cyanophyta/Cyanobacteria) **in** radially organized **algal mats**, previously unknown but related to what built the stromatolites in the overlying dolomites.

Cree and Canadian/Quebecois collecting restrictions force **reliance on field photos** for documentation.

Keywords: algal mats, blue-green algae, Cyanophyta/Cyanobacteria, Proterozoic, Paleoproterozoic, Aphebian, Lower Albanel shale, Quebec, Lake Mistassini

EXPANDED ABSTRACT

Precambrian algal mats are ordinarily seen as thin dark laminae in or between stromatolites cut in vertical or thin-section. Unusual fossils seen along Lake Mistassini may be such mats but preserved in plan view (ie, as seen from above their substrate).

These were independently discovered by DCM while examining slightly younger stromatolites nearby. Later search of Mistassini literature found two earlier brief mentions of similar possible fossils in the area (Chown & Caty '83 fig 2D, Mirota '89 Tbl 2).

These probable fossils occur at 50°40'N, 74°00'W, along the NW shore of Lake Mistassini, 30 km/18 mi NNW of Mistissini village, 90 km/55 mi NNE of Chibougamau, and 585 km/365 mi N of Montreal. Their horizon is the black shale low in the Lower Albanel Formation (Aphebian = Paleoproterozoic) which has been dated to 2.1 (Chown & Caty '83, Mirota '89) or 1.8 (Evangelatos '08) Ga/BY. Cree and Canadian/Quebecois collecting restrictions force reliance on field photos for documentation.

The best-preserved specimen seen in the field is 5 cm long by 3 cm wide, and consists of 39 apparently overlapping, semicircular, nearly flat, low, thin lobes 5-13 mm wide, 3-9 mm long, and only 1-3 mm thick, arranged in a fish-scale-like pattern with the rounded edge being the apparent growth direction. This suggests a life history starting with a single cell in the center of each semicircle, and proceeding by many cell divisions both distally and laterally pushing out the semicircular edge. Each lobe consists of dark gray-black massive homogeneous claystone; the rounded edge is enhanced by a thin quartz-filled fissure.

These lobes look vaguely lichen-like, and seem somewhat more organized than the slimy dark-green coatings on the tops of living stromatolites (Royal Ontario Museum tank; Shark Bay, Western Australia).

At the earliest-formed end of this specimen, the semicircular shape of the lobes grades into squarer blocks.

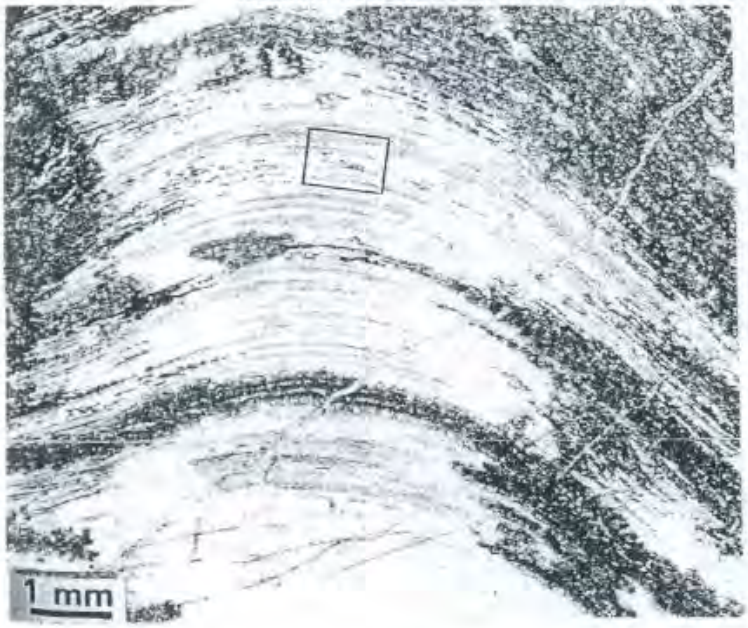
Many other specimens along the shore consist entirely of such small square to rectangular blocks (up to 200/specimen), 4-19 mm wide by 3-11 mm long, arranged in a concentric segmented pattern, reminiscent of septarian concretions 9-30 cm long by 6-11 cm wide, but quite thin/flat (<1 cm), suggesting diagenetic alteration obscuring their organic origins.

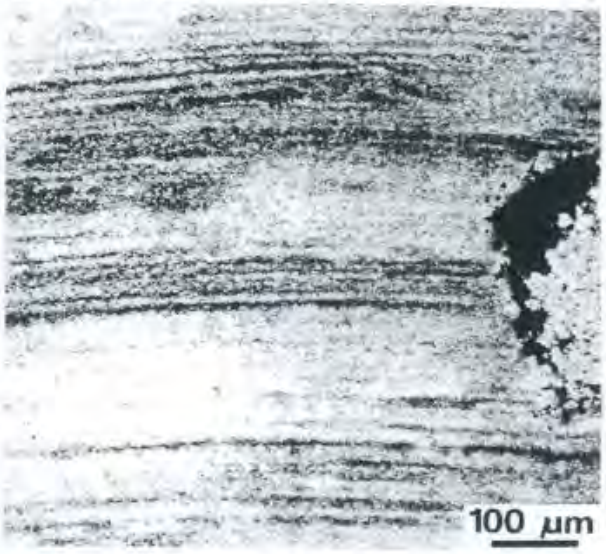
All these fossils are developed on top of very thinly laminated, hard, black shale, composed of alternating dark clay and light quartz-silt layers, indicating quiet-water conditions. The black shales overall are both carbon-/organic-/graphite- and disseminated-pyrite-rich, according to previous workers, and could possibly represent shallow coastal lagoons or off-shore deep water.

Because of their macroscopic size, these fossils might be argued as being multicellular, colonial, or eukaryotic (Han & Runnegar '92, El Abani et al '10); however, no evidence suggests such advanced affinities here. Their early (Paleoproterozoic) age supports best considering them as prokaryotic blue-green algae (Cyanophyta/Cyanobacteria) in radially organized algal/ microbial mats, previously unknown but related to the stromatolites nearby in the overlying dolomites (Hofmann '78).

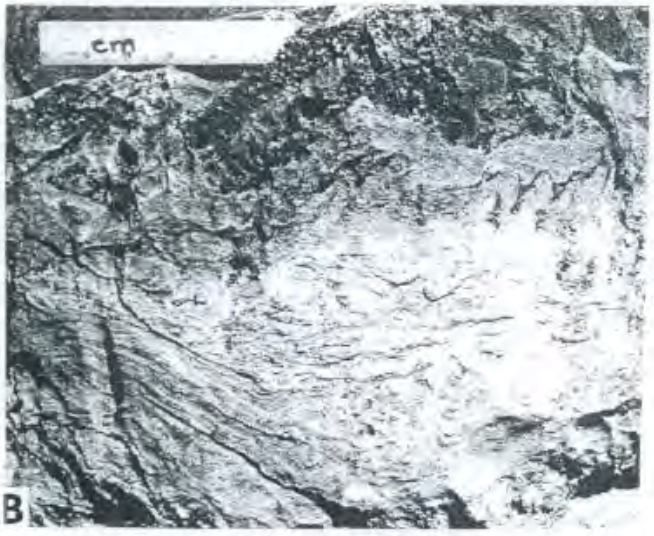
Precambrian algal mats are usually seen as thin dark laminae in or between stromatolites cut in vertical or thin-section.

laminae within stromatolites in vertical thin-section (Hofmann '78 p. 583)





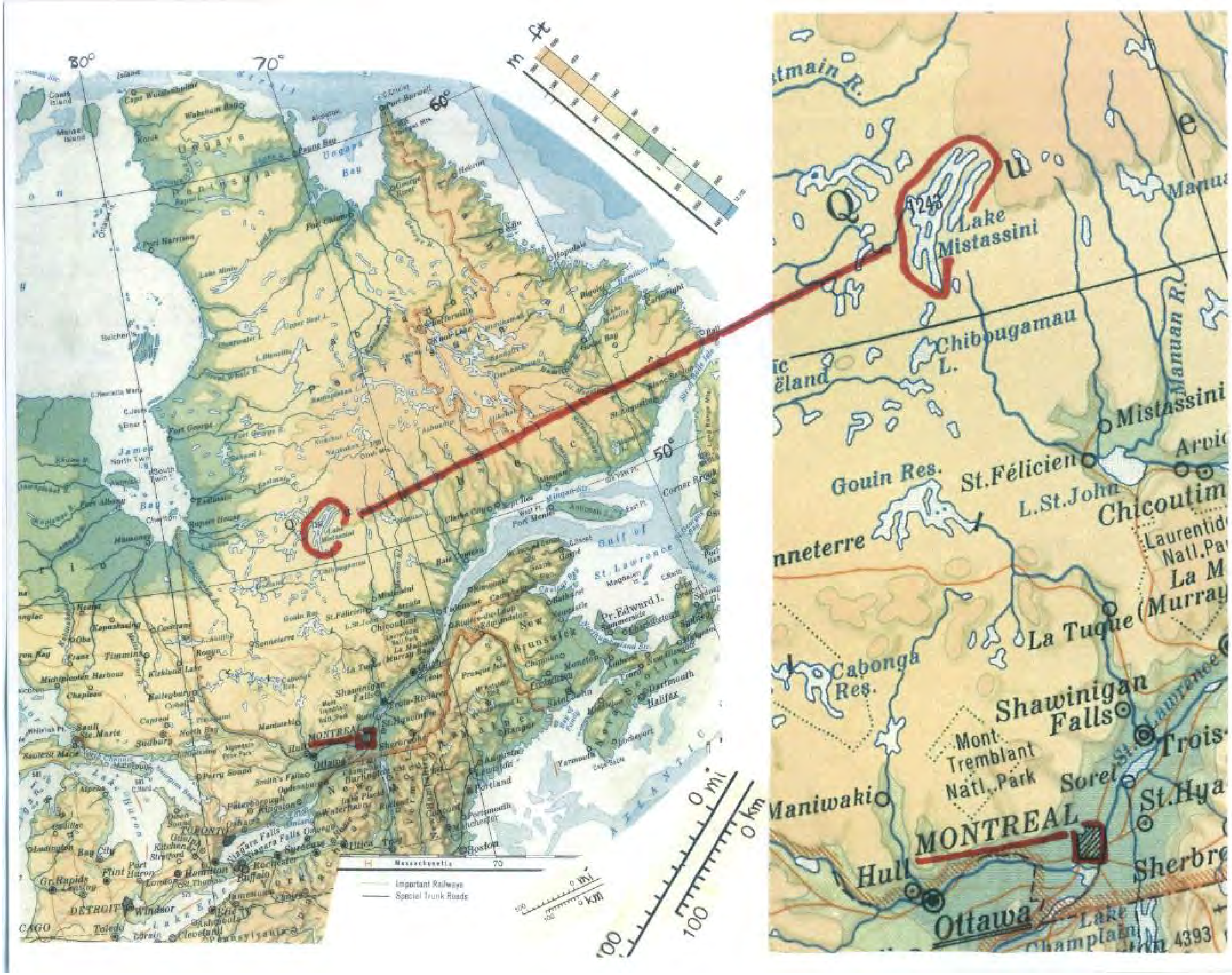
laminae between stromatolites on vertical outcrop face (Hofmann '78 p. 574)



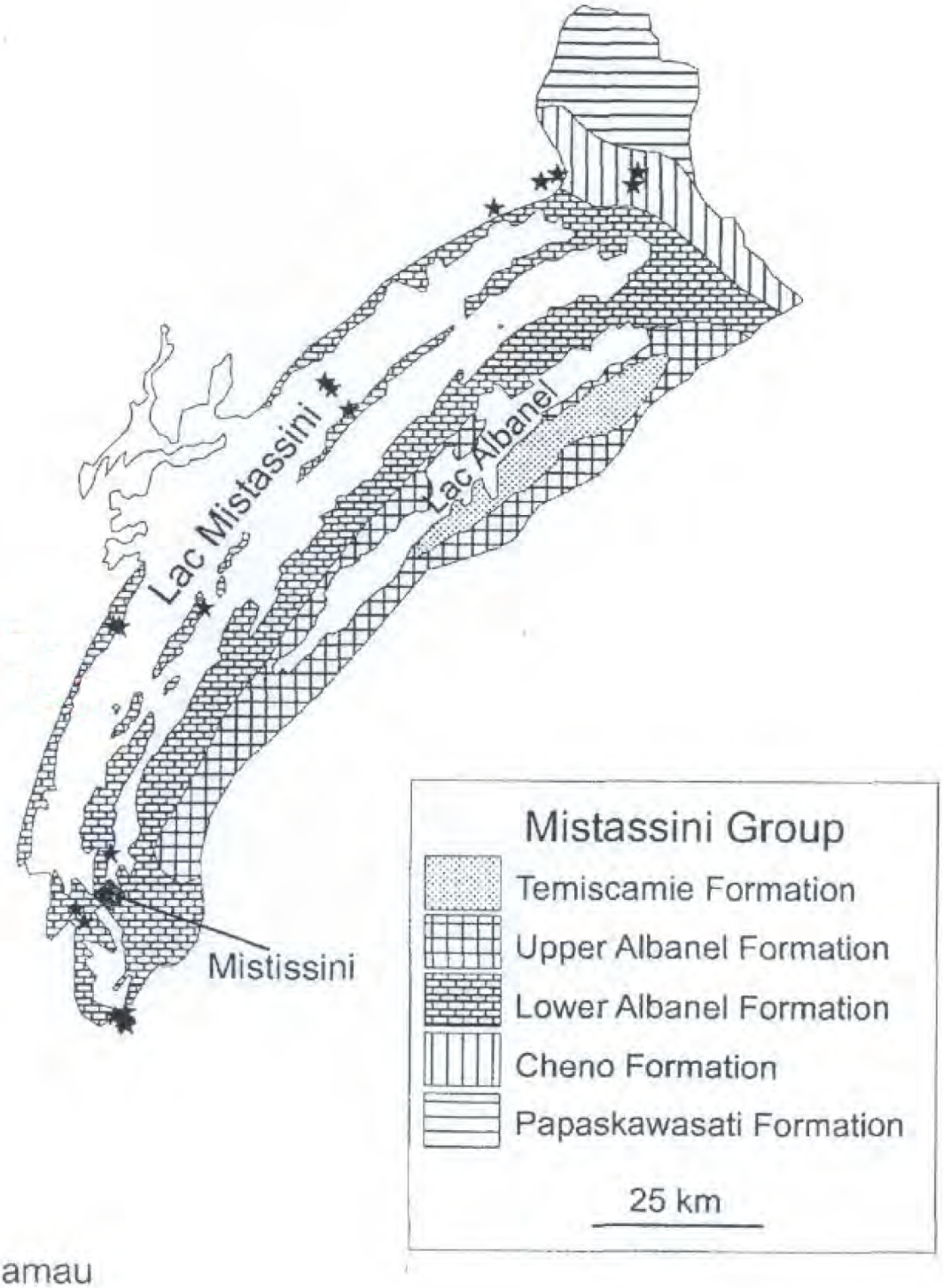
vertical outcrop surface with mat growing on regolith (fossil soil) (Chown & Caty '83 p. 288) (field 50 cm wide)

These probable fossils occur at 50°40'N, 74°00'W, along the NW shore of Lake Mistassini, 30 km/18 mi NNW of Mistissini village, 90 km/55 mi NNE of Chibougamau, and 585 km/365 mi N of Montreal.

geographic **location** of algal-mat fossils which can be seen on the NW shore of Lake Mistassini (base from Williams '60 p. 29; modified from Evangelatos '08 p. 43)

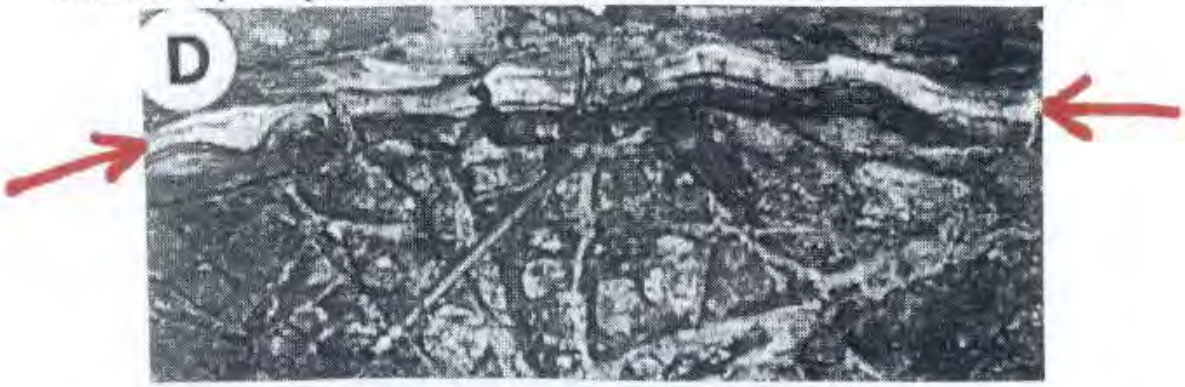


Lake Mistassini
Chibougamau L.
Mistassini
St.Félicien
L.St.John
Chicoutimi
Gouin Res.
La Tuque
Cabonga Res.
Shawinigan Falls
Mont Tremblant Natl. Park
Sorel
MONTREAL
Hull
Ottawa
Maniwaki
Manuan R.
Important Railways
Special Trunk Roads
Massachusetts
Gulf of St. Lawrence
James Bay
Ungava Bay
0 mi 100
0 km 100
80°
70°
60°
50°
m ft


Lac Mistassini
Lac Albanel
Mistissini
Mistassini Group
Temiscamie Formation
Upper Albanel Formation
Lower Albanel Formation
Cheno Formation
Papaskawasati Formation
25 km
Chibougamau

After discovery, later search of Mistassini literature found two earlier brief mentions of similar probable fossils in the area.

Chown & Caty '83 fig 2D: **algal mat encrusting regolith** (seen on vertical outcrop face).



Mirota '89 Tbl 2: **lower part of Lower Albanel Fmn** (thicknesses in m).

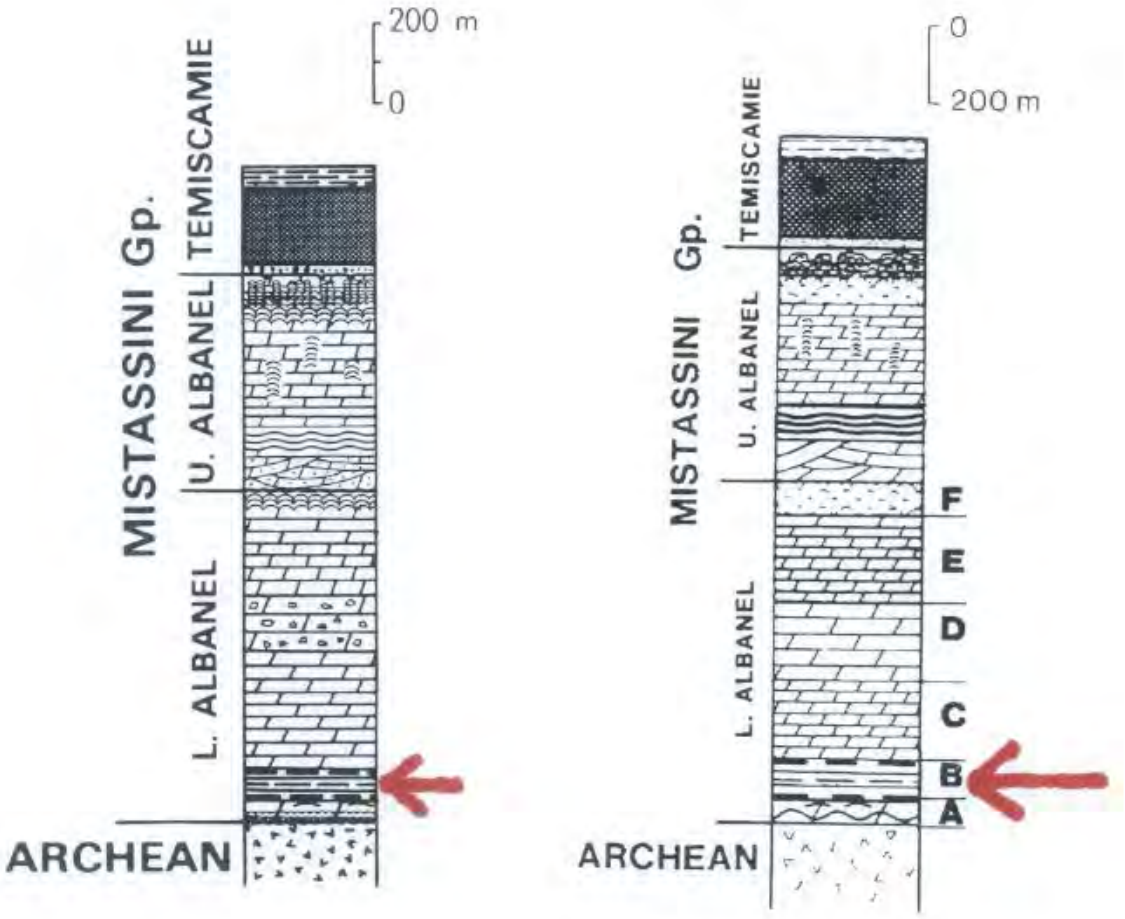
	-erosional features	
	BANDED DOLOSTONE UNITS	
>457.2	-Light & dark grey banded dolostone inter-bedded with argillaceous dolostone. Increasing % dolomitic limestone near base -parallel laminations & bedding -cross-laminations -cut & fill, convolute bedding	Shallow to deeper subtidal marine
	LOWER BLACK SHALE COMPLEX	
45.7-147.8	-Black graphitic shale inter-bedded with argillaceous dolostone & dolomitic limestone to limestone. Local algal mats (?). - 2 to 5 shale beds -parallel bedding & laminations -local disrupted & brecciated bedding; crenulated laminations -pyrite lenses & disseminations	Deep subtidal marine (below wave base?)
	BASAL STROMATOLITIC DOLOSTONE	
4.6-21.3	-Algal dolostone breccia inter-bedded with sandy dolostone. -lithoclaste & irregular laminations; mottled texture -quartz-carbonate & hydrocarbon vug fillings -erosional surfaces, slumping	Supratidal to shallow subtidal
0-27.7	-LLH & SH-V algal stromatolites -mottling & brecciation at base -quartz-carbonate vugs & veins	Unprotected intertidal zone
	REGOLITH	
0-.6	-Regolith overlying basement intrusives, gneisses & metavolcanics.	

Mistassini on Precambrian Time Scale
(Geol Soc Amer, 2013)

Eon/Era		**BY ago = Ga**
	Present/Recent	0.00
Phanerozoic		0.55
	Ediacaran	0.65
	Cryogenian	0.8
Late Proterozoic (Neoproterozoic/*Hadrynian*)		1.0
Middle Proterozoic (Mesoproterozoic/*Helikian*)		1.6
Early Proterozoic (Paleoproterozoic) (= ***Aphebian***)	*Lake Mistassini rocks* ***Lower Albanel Fmn (lower blk shl)***	1.8 or **2.1**
		2.5
Archean/Archeozoic		4.0
Hadean/Azoic		4.5

Their horizon is the black shale low in the Lower Albanel Formation (Aphebian = Paleoproterozoic) which has been dated to 2.1 (Chown & Caty '83, Mirota '89) or 1.8 (Evangelatos '08) Ga/BY.

stratigraphic **horizon** of algal-mat fossils, in Early Proterozoic around Lake Mistassini (Hofmann '78 p. 572; Chown & Caty '83 p. 287)



Shoreline/beach where fossils can be seen:

mostly **black-shale cobbles**, occasional dolomite and granite clasts; NW side of Lake Mistassini (field-photos; trees and keys for scales)

The best-preserved specimen seen in the field is 5 cm long by 3 cm wide, and consists of 39 apparently overlapping, semicircular, nearly flat, low, thin lobes 5-13 mm wide, 3-9 mm long, and only 1-3 mm thick, arranged in a fish-scale-like pattern with the rounded edge being the apparent growth direction.

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At the earliest-formed end of this specimen, the semicircular shape of the lobes grades into squarer blocks.

best-preserved algal-mat specimen: mostly semicircular lobes; on beach, Lake Mistassini (field-photo; scale in cm)


1
2
3
4
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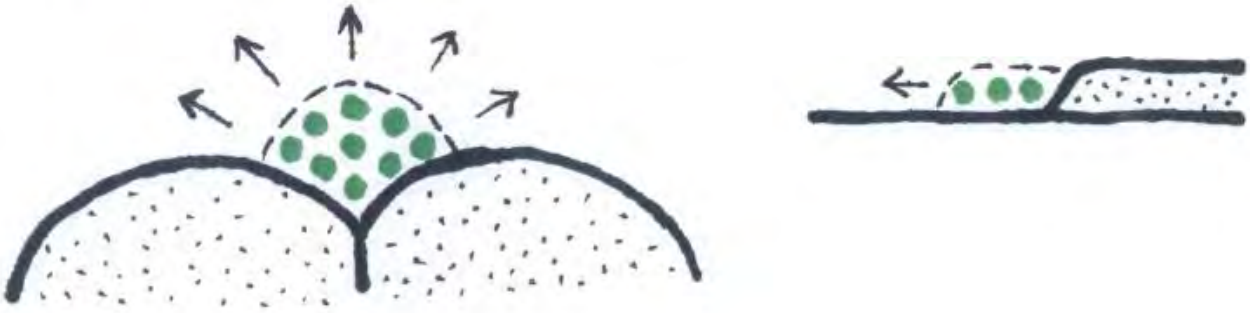
6
7

The shape of the lobes suggests a life history starting with a single cell in the center of each semicircular lobe, and proceeding by many cell divisions both distally and laterally pushing out the semicircular edge.

Life history/possible **growth model** (looking down on substrate; in vertical section):

1 – single parent algal cell between 2 earlier-formed lobes

2 – cell divisions distally and laterally



3 – new lobe completed

Gradational spectrum showing progressive diagenetic alteration of algal mats, proceeding from best-preserved lobes through squarer blocks to septarian-like condition.

(scales in cm/mm)

1 – semicircular lobes, youngest/last-formed end of best-preserved specimen

2 – squarer blocks, oldest/earliest-formed end of best-preserved specimen

3 – square/rectangular blocks, edges flush with overall surface

4 – square/rectangular blocks, now with raised edges, in most septarian-like condition

At the earliest-formed end of the best-preserved specimen, the semicircular shape of the lobes grades into squarer blocks.

Many other specimens along the shore consist entirely of such small square to rectangular blocks (up to 200/specimen), 4-19 mm wide by 3-11 mm long, arranged in a concentric segmented pattern, reminiscent of septarian concretions 9-30 cm long by 6-11 cm wide, but quite thin/flat (<1 cm), suggesting diagenetic alteration obscuring their organic origins.

probable algal mats diagenetically altered to septarian-like condition: square to rectangular blocks in concentric-segmented pattern; on beach, Lake Mistassini (field-photos; scales in cm)


CM 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


CM 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


CM 1 2 3 4 5 6 7 8 9 10 11 12


CM
1
2
3
4
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6
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CM 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

All these fossils are developed on top of very thinly laminated, hard, black shale, composed of alternating dark clay and light quartz-silt layers, indicating quiet-water conditions. The black shales overall are both carbon-/organic-/graphite- and disseminated-pyrite-rich, according to previous workers, and could possibly represent shallow coastal lagoons or off-shore deep water.

very thinly laminated black shale: underlying probable algal-mat fossils; vertical edge of cobble; on beach, Lake Mistassini (field-photo; scale in cm)


M
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6

Because of their macroscopic size, these fossils might be argued as being multicellular, colonial, or eukaryotic (Han & Runnegar '92, El Abani et al '10); however, no evidence suggests such advanced affinities here. Their early age (Paleoproterozoic) supports best considering them as prokaryotic blue-green algae (Cyanophyta/Cyanobacteria) in radially organized algal/microbial mats, previously unknown but related to the stromatolites nearby in the overlying dolomites (Hofmann '78).

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