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Publications in this series have not been edited; they are released as submitted by the author.

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INTRODUCTION AND GEOLOGICAL CONTEXT

The lower Silurian Sayabec Formation in eastern Quebec consists of a shallow water carbonate platform that was formed at the end of the first 2nd order shallowing-upward event following the end of the Taconian orogeny in the northern Gaspé – Matapédia – Témiscouata region (Bourque et al., 1995). The presence of the Sayabec Formation in the Témiscouata region was known for many years from regional and local mapping and stratigraphic surveys (Lajoie et al., 1968). However its detailed internal stratigraphy and paleoenvironmental models are largely unknown as the last sedimentological study of that unit only covered the Matapédia – Gaspé areas to the east of the Témiscouata region (Lavoie et al., 1992).

In the adjacent domain to the east, the Sayabec Formation consists of 4 informal members of alternating shallow subtidal to peritidal carbonate facies with deeper subtidal offshore carbonate muds (Lavoie et al., 1992). In the Lac Matapédia area, to the immediate east of the Témiscouata region, Lavoie and Morin (2004) and Lavoie and Chi (2010) documented the presence of an exhumed hydrocarbon reservoir hosted by fault-controlled porous hydrothermal dolomite.

Ressources et Énergie Squatex drilled a number of stratigraphic holes in the Témiscouata area targeting the Sayabec Formation for porous carbonate – dolomite facies. Oil and gas occurrences were found, primarily associated with porous and fractured dolomite intervals. A joint industry – academia (INRS-ETE) project supported in part by a National funding program (Mitacs) part of the Canadian Network of Centres of Excellence was designed to provide stratigraphic, sedimentologic and tectonic understanding of the Sayabec Formation over the Témiscouata in order to help with oil and gas exploration.

This report presents the detailed description of one of the well drilled by Ressources et Énergie Squatex Inc. (Massé No. 2; Fig. 1) which serves as the reference section for the detailed analysis of paleo-environmental evolution and regional correlation of the Sayabec Formation to be presented in a peer-reviewed contribution. Furthermore, the newly defined fine-scale stratigraphy (Fig. 2) for the Sayabec Formation in the Témiscouata area will serve as the cornerstone for detailed understanding of pore space distribution, fluid storage capacity and thermal-stratigraphy of the unit in the context evaluation of geothermal potential of the lower Silurian carbonates.

Figure 1: Location of the Massé No. 2 well on the regional geological map (adapted from Malo et al., 2015).

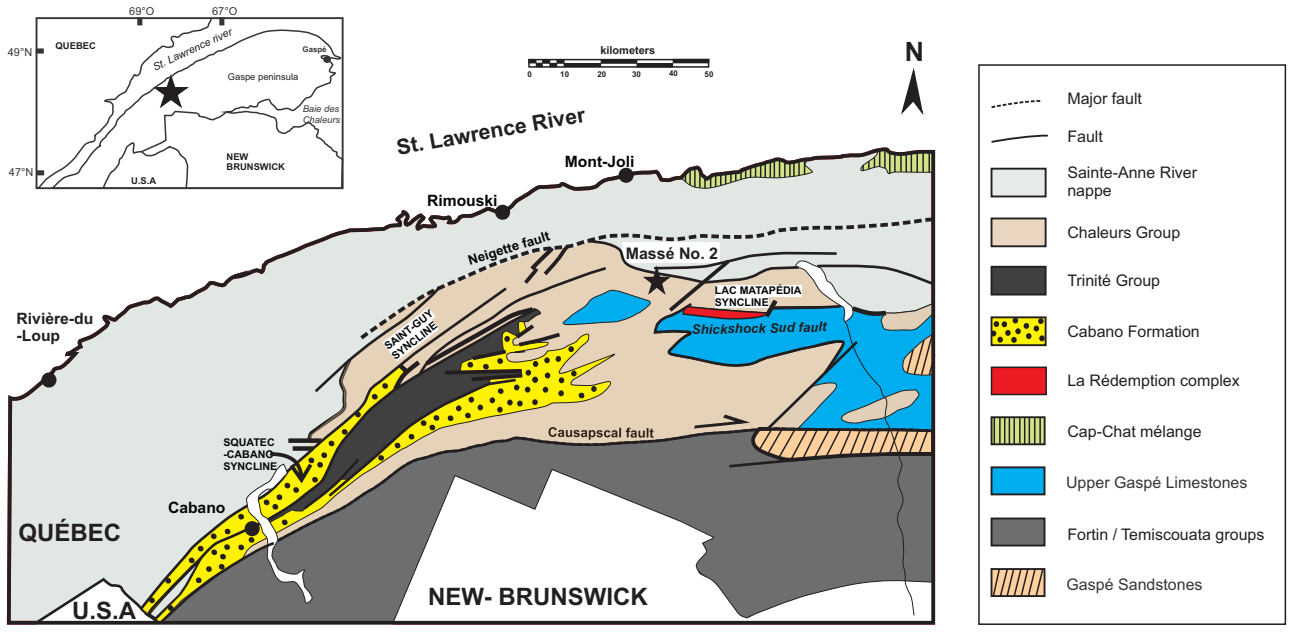
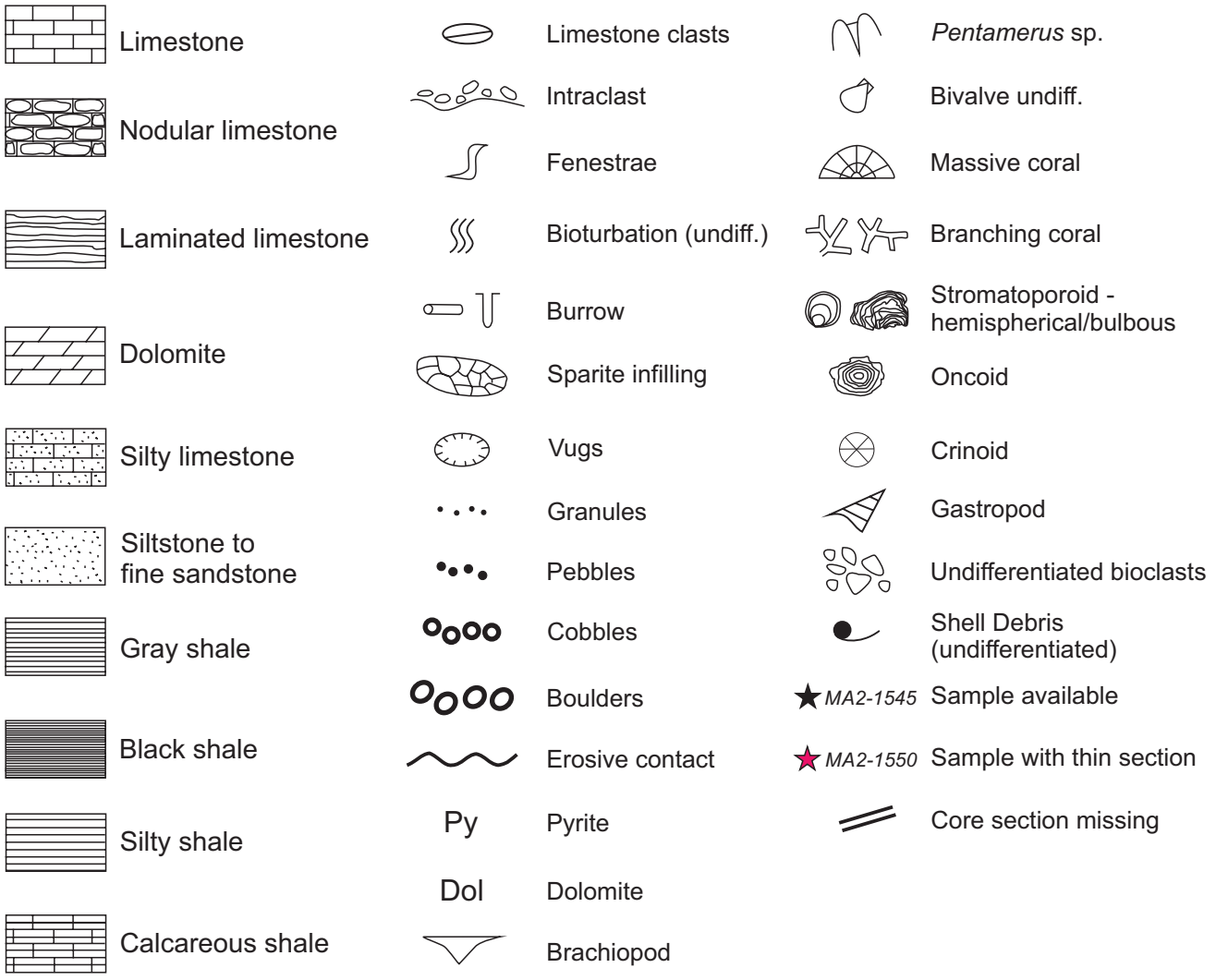


Figure 2: Main sedimentary and paleontological symbols and detailed stratigraphy description of Massé No. 2 drilled well.



Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features	Fracture count
1517,0	BOX 302	Interbedded siltstone/mudstone (Fig. 2a), gray colour, massive to bioturbated. Occurrence of a centimetric layer of green shales (@1520 m) Sparse bioclasts (brachiopods, crinoids, worm tubes), interpreted as Saint-Léon formation.	a	0
1521,4				
1525,8	BOX 304	Wackestone, pseudo-laminated, with stromatopores and occurence of more silty layers, light gray, laminated (Fig. 2b). MA2-1525		0
		3 cm / 2 cm	***Bioturbated siltstone, with distinctive vertical tube (skolithos ichnofacies) (~1523m).***	
1530,2		**Top Sayabec**	b	
	BOX 305	Bioclastic packestone with crinoids, medium to coarse grained. Fragments of crinoids up to 0,8 cm in diameter; irregularly distributed bioturbated intervals.		1
1534,7			***Fine-grained, bioturbated wackstone (~1530m).***	
	BOX 306	Pseudo nodular to nodular limestone with a distinctive zebra aspect. Presence of few millimetric crinoids fragments (1-2 mm in diameter).	c	0
1539				
	BOX 307	Alternance of two facies : - bioturbated mudstone and, - light grey packstone with intraclasts. Nodular limestone. Light gray packstone is bioclastic with bioclasts up to 1cm in length, mainly crinoid fragments (stem fragments) (Fig. 2c). Presence of very thin veins (calcite filled) sub-milimetric to millimetric.	***Fine-grained, bioclastic wackstone with crinoids fragments and intraclasts (width of the picture is 4,5 cm) (~1542m).***	5-6
1543,5				

Fracture count: 0 10 20 30 40 50

Meters **Lithology**

Description
(incl. texture, fossilif content, primary sedimentary fabric and /or structures)

Photos of selected features

Fracture count
0 10 20 30 40 50

1543,3

BOX 308

MA2-1544

Alternance of bioturbated mudstone and crinoidal packstone, coarse grained (with bioclastic fragments averaging 1 mm in size).

MA2-1545

Occurrence of large tabulate coral fragments (1,5 cm thick and 5-6 cm in length)
Few light gray intervals with higher bioclastic content.

1547,7

BOX 309

MA2-1550

Wackestone rich in corals, poorly sorted with coral fragments up to 3 cm in diameter.
Pseudo-nodular aspect.

Angular lithoclasts made of a laminar facies (mud pebbles - see MA2-1550).
One fractured interval @ 1551.5 m depth (10-15 cm thick).

1552

BOX 310

MA2-1553

Wackestone rich in corals, stromatoporoids (Fig. 2d), poorly to very poorly sorted. Bioclasts are large fragments up to 2-3 cm in diameter. Presence of gastropods, bivalves, within a dark gray pseudo-laminated (filamentous) feature (Fig. 2e).

MA2-1554

Interbedded with dark gray, well-sorted, microbioclastic wackestone (Fig. 2f).

2-3 thin veins.

1556,6

BOX 311

MA2-1556

Nodular limestone (Fig. 2g). Nodules made up of fine-grained, laminated sediment. Local presence of fragments of coral colonies (2 cm in diameter) including chain-like corals (*Tabulata*)(Fig. 2f). Local geopetal cavity between corals fronds are present and filled by microbioclastic sediment.

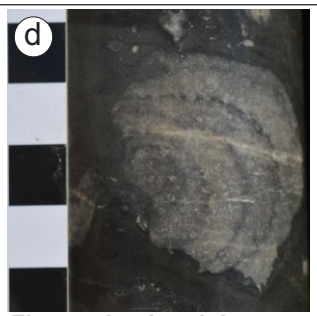
No visible fractures or veins.

1560,9

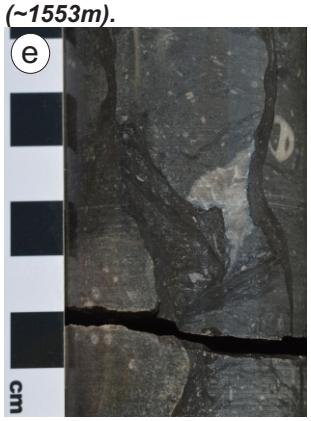
BOX 312

Bioturbated wackestone (zebra like aspect) with important bioclastic content including coral fragments (2-3 cm in diameter), disseminated within wackestone matrix. No visible fractures or veins.

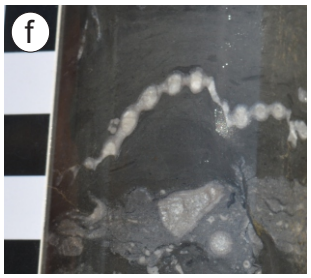
1565,2



Fine-grained nodular limestone, poorly sorted with centimetric fragment of stromatoporoids (~1553m).

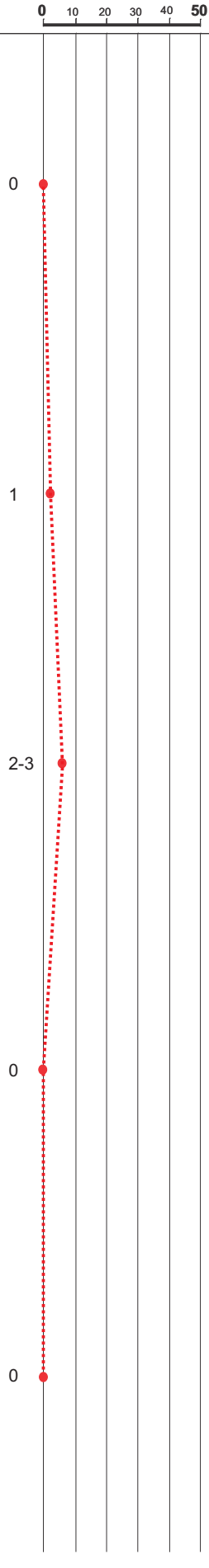


Clay filaments cross-cutting sedimentary matrix and bioclasts (~1553m).

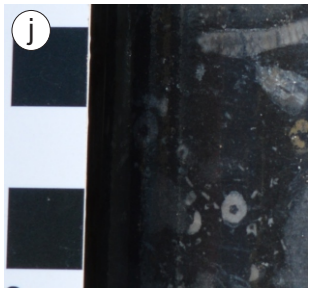


Fine-grained wackstone, with large bioclasts including chain-like coral (~1556m).

Nodular aspect of the Sayabec Formation (1557m).



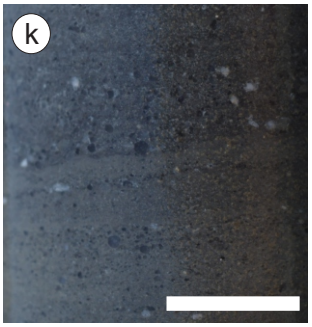
Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features	Fracture count
1565,2				
BOX 313		Nodular limestone with pluricentimetric nodules. Possible evidence of synsedimentary brecciation. Pluricentimetric coral fragments (e.g. tabulate corals). One visible vein, well cemented.	 ***Fine-grained nodular limestone characteristic of the Sayabec Formation (~1575m).***	1
1569,7				
BOX 314		Nodular limestone. Pluricentimetric nodules are interbedded with pluricentimetric fragments of coral colonies. No visible vein or fracture.		0
1574,1				
BOX 315	★ MA2-1577	Nodular limestone with pluricentimetric nodules (Fig. 2h). Presence of crinoids fragments and laminar concentric structures. Nodules are made of medium grained limestone and are interbedded with dark gray microbioclastic wackestone.	 ***Fine-grained wackestone with wavy laminations and small millimetric vugs filled with sparite (~1586m).***	0
1578,4				
BOX 316	★ MA2-1580	Limestone with a zebra-like aspect (possibly due to bioturbation or the presence of microbial structures). Locally dark gray bioclastic sediment organized in horizontal to subhorizontal layers. Several subhorizontal fractures (ca. 10)		10
1582,9				
BOX 317	★ MA2-1585	Poorly sorted bioclastic wackestone with coral fragments up to 2-3 cm in diameter and laminated mudstone/wackestone with low bioclastic content. Occurrence of laminated structures with fenestrae (Fig. 2i). Locally facies look brecciated. Bioclasts consist mainly of corals, crinoids and gastropods (up to 2-3 cm in average). Dark gray, fine grained, argillaceous sediment surrounding bioclasts (Fig. 2j). Some clasts have been fractured before brecciation. Few subhorizontal fractures or veins with locally open veins.	 ***Bioclastic wackestone with large crinoid fragments (~1586m).***	10
1587,3				

Fracture count: 0 10 20 30 40 50

Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

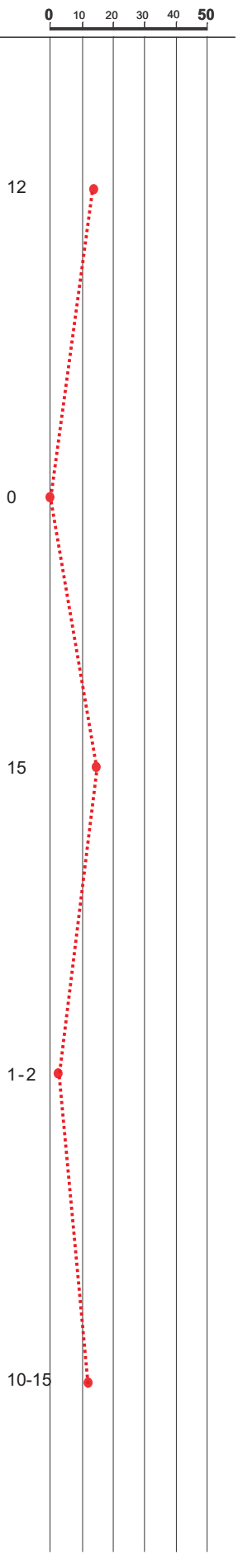
Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features
1587,3	BOX 318	Nodular limestone. Coral-rich wackestone interbedded with microbioclastic mudstone. Nodules appear as light gray facies with coral fragments.	
	★ MA2-1589	Several fractures and veins, mainly subhorizontal.	
1591,1	★ MA2-1595		
	BOX 319	Poorly sorted wackestone with centimetric coral fragments (4-5 cm in diameter) as well as centimetric gastropods (1.5 cm in diameter).	
		Locally sediment is pseudo laminated, likely microbial laminations.Presence of small sparry masses (few millimeter thick and up to 2-3 cm in length).	
1596,1	**Green shales**	Bioclastic wackestone, poorly sorted (Fig. 2k). Presence of large corals fragments as well as lithoclasts. Clasts appear to be fractured and then reworked.	
	BOX 320	Green shale layer, 2 cm thick @ 1596.6 m depth, very friable. From 1599 m, medium to coarse grained laminated packstone.	
	★ MA2-1598	Several thin fractures (0.1 mm in width) and veins. Fractures are colmated by sparry calcite cement.	
	★ MA2-1600		
1600,5	BOX 321	Fine grained, light gray wackestone interbedded with dark gray pseudo laminated wackestone. None or very few bioclasts but few sparry masses (possibly recristallized bioclasts).	
		From 1605 m depth, coarse grained bioclastic facies with clasts up to 3- 4 cm in diameter. Large bioclasts (centimetric) correspond to abundant coral and stromatopore fragments (Fig. 2l), densely packed (framestone texture?). Abundant gastropods (pluricentimetric) and serpulid worm tubes.	
1605,0	★ MA2-1605	Very rare fractures (1-2)	
	Dol ?	Wackestone to lime mudstone facies interbedded with a finely laminated limestone. (Coarse) bioclastic layers (Fig. 2m), 3 cm thick in average defining a fining-upward trend. Lower contact is erosive.	
	BOX 322	Bioclasts are 0.5 cm in diameter in average and correspond mainly to corals and stromatopores. Several oblique and subhorizontal fractures (10-15)	
	★ MA2-1609		
1609,4			



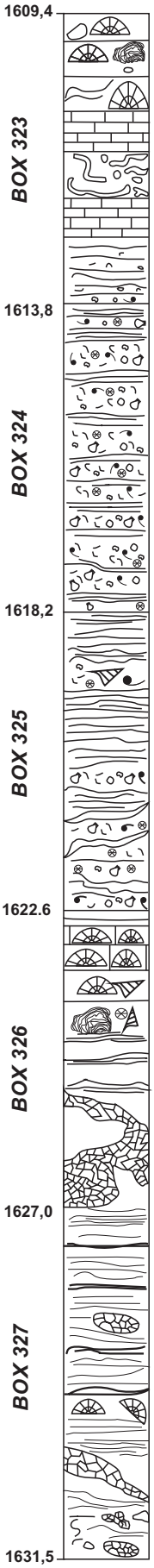
Medium/coarse grained packstone with millimetric laminations. Scale bar is 12 mm (~1599m).

Coral boundstone with densely packed tabulate corals with sutured contacts between colonies. Scale bar is 12 mm (~1605m).

Interbedded fine-grained bioclastic packstones and dark mudstones. Bioclastic beds are 2-3 cm thick (~1608m).



Meters **Lithology** **Description** (incl. texture, fossil content, primary sedimentary fabric and /or structures) **Photos of selected features** **Fracture count**



Reefal facies (boundstone texture?) in a 70-80 cm thick interval or large reefal facies intraclasts.

Boundstone grades into a fine grained wackestone (25 cm thick interval) and into a coarser bioclastic interval. Occurrence of a 20 cm thick layer with abundant bryozoans (Fig. 2n). Lowermost part of the interval corresponds to a pseudolaminated siltstone with few to very few bioclast.

Very few fractures (4-5) colmated by sparry calcite cement.

Fine-grained, pseudo-laminated wackestone and bioclastic wackestone. Both facies are 4-5 cm thick.

Carbonate facies are interbedded with fine-grained clastic facies (dark gray siltstone/ argillaceous siltstone and light gray siltstone). Locally fine-grained clastic facies present an erosive basal contact.

Several fractures (20) colmated by sparry calcite cement.

Bioclastic wackestone interbedded with dark gray/black argillaceous sediment (1 cm thick layers). Limestone facies corresponds to a moderate sorted biolastic wackestone with mainly recristallized bioclasts (undiff. bioclasts) up to 1.5 cm in diameter.

In the lowermost parts of the interval bioclastic layer are moderate to very poorly sorted.

Fractured interval with dolomite.

Bioclastic limestone with large coral fragments (2-3 cm) interbedded with dark gray argillaceous limestone/siltstone sediment. Argillaceous layer are oblique oriented and 4-5 cm width.

★ *MA2-1626*

Dol

Several fractures (with large openings) but no residual porosity. Fractures colmated with multiple generations of sparry calcite and (late) dolomite cements (Fig. 2o).

Bioclastic limestone with large corals fragments (3-4 cm in diameter), gastropods (2-3 cm in transerval section) interbedded with light gray siltstone and dark gray argillaceous layers.

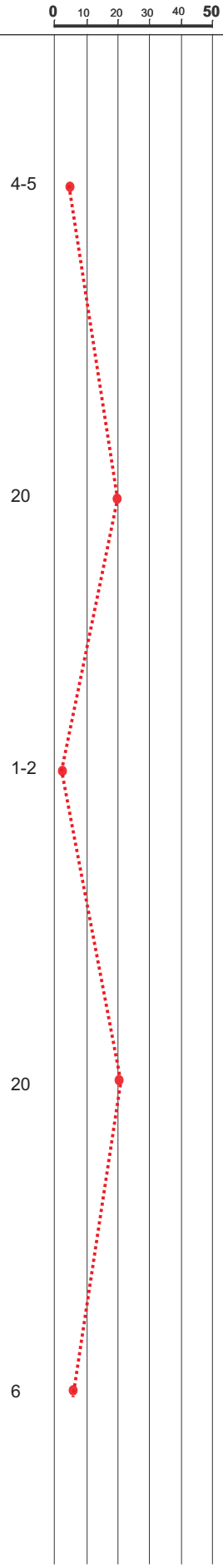
★ *MA2-1630*

Several oblique fractures with two large examples (1-2 cm width) and *en echelon* geometry.

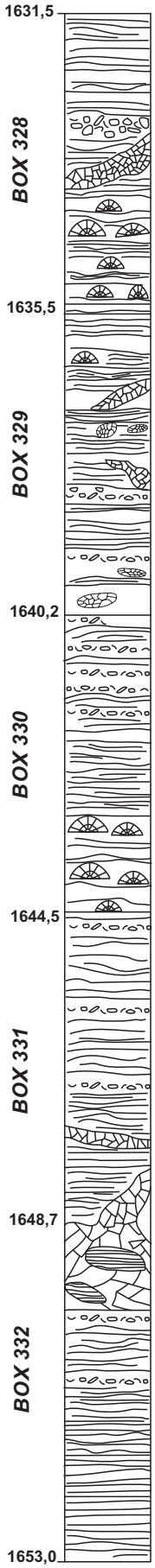
Small sparry masses at the base of the interval, most likely corresponding to recristallized bioclasts.

Bioclastic rich packstone with bryozoans and corals fragments (~1611m).

Fine-grained wackstone affected by oblique fractures, several centimeter in length (~1630m).



Meters | **Lithology** | **Description** (incl. texture, fossil content, primary sedimentary fabric and /or structures) | **Photos of selected features** | **Fracture count**



Fine grained, gray siltstone interbedded with bioclast-rich siltstone layer. Presence of small polychaetes worm tubes (Fig. 2p). Local occurence of coral colonies (Tabulata). Few bioclasts appear fragmented prior to reworking and deposition.

★ *MA2-1633*

Several (30) oblique and subhorizontal fractures, up to 3 cm in width. Insoluble residues associated with fracture infill; possibly calcedony in fracture fill.

Fine grained, light gray siltstone interbedded with argillaceous, darker and irregular layers. Locally presence of small sparry (to microsparitic) masses (possibly former bioclasts recristallized) as well as layer associated with worm tubes (from 1638 m depth). Rare gastropod shells.

Dark gray layer associated with fractures. Several fractures (10) are present.

Fine grained, light gray, siltstone interbedded with argillaceous, darker layers (comparable to Box 329 and 328 above). Layer associated with often linear, regularly spaced cemented cavities @ 1641m depth within a dark gray mudstone/siltstone (Fig. 2q). Coral colonies are pluricentimetric (2-3 cm in diameter) disseminated within matrix. Presence of pluricentimetric gastropod shell fragments and serpulid worm tubes as well.

★ *MA2-1641*

Less than 10 very thin subhorizontal fractures (0,1 mm in width).

★ *MA2-1645*

Laminated siltstone/silty mudstone. Rare to very rare bioclasts. Bioclasts occur as pluricentimetric fragments (2-3 cm max). Several fractures (10) are observed. Fractures (up to 4-5 cm in width) only partially colmated. Blocky calcite is part of fracture fills.

★ *MA2-1648*

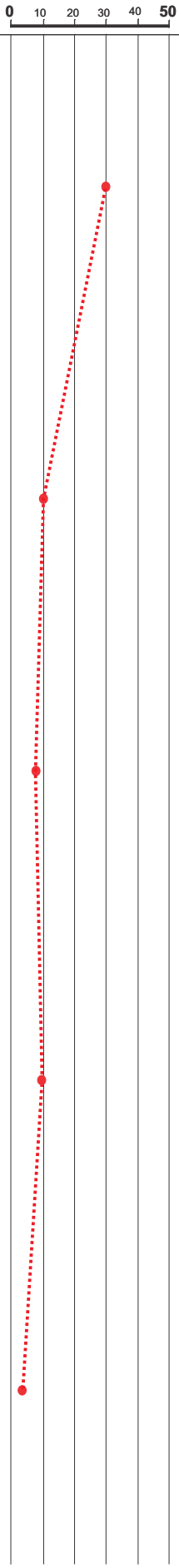
Light gray siltstone, irregularly interbedded with stromatolite locally showing grummelar texture (Fig. 2r). Overall fractured intervals (approx. 50 cm thick). Some core fragments are missing @ 1649 m depth. Few (4-5) mainly oblique fractures. Fractures filled with several generations of cement (calcite and dolomite). Pseudo-brecciation seems associated with fractures locally. Thin layers (2-3 cm thick) associated with horizontal, regularly spaced small sparry masses (undetermined bioclasts, recristallized).

★ *MA2-1652*

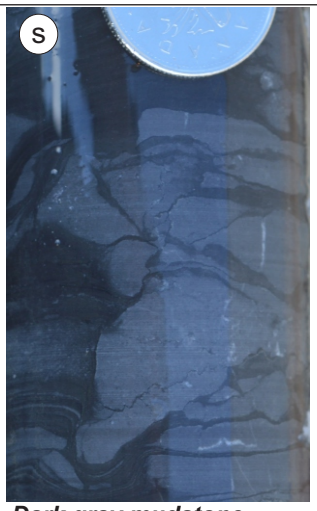
Layers associated with abundant worm tubes (~1632m).

Calcite-filled fenestrae within dark gray mudstone (~1645m).

Light gray mudstone with wavy laminations (possibly of microbial origin) (~1650m).

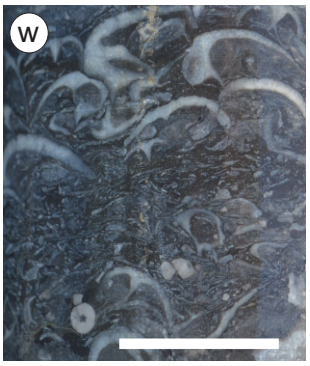


Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features	Fracture count
1653,0	BOX 333	★ MA2-1654 Wackestone with pluricentimetric corals, mainly *Tabulata* with reworking indications (not *in situ*). From 1653 m to 1656 m depth, fine-grained sediment pseudo-laminated with repetitive 1-2cm thick coarse bioclastic layers. Lower part of the interval is dominated by bioclastic grainstone with bioclasts (1 mm in diameter in average). Several fractures, oblique (10) and subhorizontal (over 20). Few thin subhorizontal fractures are only partially colmated.	 ***Dark gray mudstone lithoclasts within light gray siltstone (~1650m).***	10
1657,5	BOX 334	Interbedded light gray siltstone and dark gray mudstone (Fig. 2s). Small pebbles (mud pebbles?) or pseudo-breccia (synsedimentary breccia) within the uppermost 8 cm of the interval. Several very thin subhorizontal fractures (25).		25
1661,9	BOX 335	Interbedded light gray siltstone and dark gray mudstone and bioclastic layers (1 to 4 cm thick). A total of 10 bioclastic rich layers are present within the upper part of the interval. Within the last meter of the interval, pseudo-laminated/bioturbated sediment (Fig. 2t). Veins are rare (5 or 6), very thin and subhorizontal.	 ***Bioclastic intervals within fine-grained laminated mudstone (~1665m).***	5-6
1666,3	BOX 336	Fine-grained limestone with a laminated fabric present down to 1668,5 m depth. Note the presence of a coral rich layer with fragments of 2 cm in diameter in average. No visible fracture or vein.		0
		★ MA2-1668		
1670,8	BOX 337	Bioclastic wackstone, poorly sorted with large (pluricentimetric) coral fragments (*Tabulata*) (Fig. 2u) All colonies appear fragmented. Coral colonies associated with open moldic porosity. Intraskeletal space is filled with calcite and possibly late dolomite cements. Late cement infill crosscuts the colony wall microstructure. Several thin subhorizontal veins (20)	 ***Pluricentimetric tabulate corals (~1672m).***	20
1675,1				

Fracture count: 0 10 20 30 40 50

Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features	Fracture count
1675,1				0 10 20 30 40 50
	BOX 338	Dark gray mudstone to wackestone with coral fragments. Bioclasts are up to few centimeters (2-3 cm) and disseminated within microbioclastic matrix. Overall moderate to poorly sorted facies. Mostly corals, crinoids, gastropods, small shelly fragments (undifferentiated bivalves ?), possible algae and worm tubes (Fig. 2v). Presence of small masses made of microsparite cement (former bioclasts ?). Three oblique fractures including one with 20 cm long extent.	 ***Bioclastic packstone with crinoids and worm tubes (~1682m).***	3
1679,5	BOX 339	Dark gray mudstone/wackestone with coral fragment, moderate to poorly sorted facies. *Pentamerus* (*oblongus*) shells are present. Several occurrences of small dark gray layer (argillaceous rich layers ?). Overall bioclastic to microbioclatic wackestone facies. Several thin subhorizontal fractures (5-6)		5-6
1684,0	BOX 340	★ *MA2-1685* Dark gray mudstone/wackestone with coral fragments, moderate to poorly sorted facies. *Pentamerus* (*oblongus*) shells are present. Several occurrences of small dark gray layer (argillaceous rich layers ?). Overall bioclastic to microbioclatic wackestone facies. Several thin subhorizontal fractures (1-2) ★ *MA2-1686*	 ***Tempestite beds made of Pentamerus shell fragments. Scale bar is 2 cm (~1695m)***	1-2
1688,4	BOX 341	★ *MA2-1688* Bioclastic wackestone, poorly sorted with pluricentimetric coral and/or stromatoporoid fragments. Presence of gastropod shells up to 2-3 cm in diameter and crinoids fragments up to 1 cm in diameter (ossicle) and smal brachiopod shells. Several (1-2) thin subhorizontal veins.	 ***Tabulate coral encrusted by stromatopore (~1695m).***	1-2
1692,7	BOX 342	Bioclastic wackestone, poorly sorted with pluricentimetric coral and/or stromatoporoid fragments and *Pentamerus* occurrence (Fig. 2w). Corals /stromatopores are pluricentimetric in diameter. Locally coral colonies appear encrusted with stromatolithic material (Fig. 2x). Fractures ?		0 ?
1697,0				

Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features	Fracture count
1697,0				0 10 20 30 40 50
BOX 343		Poorly sorted bioclastic limestone with numerous pluricentimetric *Pentamerus* shells, fragmented (not *in-situ*). Presence of crinoids fragments as well. No visible fracture or vein.	 ***Poorly sorted bioclastic wackestone with abundant crinoid fragments and locally centimetric Pentamerus sp. (~1700 m).***	0
1701,4				
BOX 344		Bioclastic wackestone, poorly to well sorted with large *Pentamerus* shells (3-4 cm in diameter) often fragmented (Fig. 2y). Abundance of *Pentamerus* shells decreases with depth. *Pentamerus* shells appear concentrated within 1703-1704 meter depth interval. No fracture or vein.		0
1705,8				
BOX 345	★ MA2-1706	Bioclastic wackestone, poorly sorted, with *Pentamerus* shells interbedded with crinoids rich No bioclasts exceeds 1 cm in diameter within the wackstone facies. No fracture or vein.	 ***Poorly sorted bioclastic packstone with regularly space Pentamerus-rich intervals (~1716m).***	0
1710,2				
BOX 346	***Pentamerus* ++++**	Bioclastic wackestone, poorly to very poorly sorted. *Pentamerus* shells are large (4 cm in diameter in average) and concentrated within 10 cm thick intervals (occuring every 20-30 cm of the core). *Pentamerus* shells density increases with depth from 1714 m depth and poorly sorted bioclastic wackestone is interbedded with fine to medium grained bioclastic wackestone with crinoids (dark gray sediment). No visible fracture or vein.		0
1714,7				
BOX 347	★ MA2-1716	Poorly sorted *Pentamerus* rich wackestone interbedded with well sorted crinoid rich wackestone. The later seems to be largely bioturbated (Fig. 2z). *Pentamerus* rich layers occur every 15 cm. No visible fracture or vein.		0
1719,0				

Detailed stratigraphy

Sayabec Formation, Masse No. 2 well

Meters | **Lithology** | **Description** (incl. texture, fossil content, primary sedimentary fabric and /or structures) | **Photos of selected features** | **Fracture count**

1719,0

BOX 348

Poorly sorted wackestone with *Pentamerus* shells interbedded with well sorted crinoidal wackstone with crinoids (Fig. 2α).

From 1720 m depth, *Pentamerus* density decreases and crinoid-rich wackestone are dominant (diameter of crinoids is about 1 mm).

Small *Pentamerus* rich layers (thickness about 10 cm occuring every 40-50 cm) still occur Gastropod shells (and/or molds) are also present. No fracture or vein.

1723,4

BOX 349

Similar sedimentary facies but the interval is dominated by the wackestone facies with moderate sorting and abundant crinoids fragments. Locally presence of coarser layers with *Pentamerus* shells and poor sorting. *Pentamerus* shells are 2 cm in diametrer in average, with a decrease in shell size with depth. No fracture or vein.

1728,0

BOX 350

Similar sedimentary facies, with fine to medium grained, well sorted bioclastic wackestone.

★ *MA2-1730*

Locally presence of *Pentamerus* shells (2-3 cm in diameter), gastropod shells (recristallized).

★ *MA2-1731*

No fracture or vein.

Poorly to very poorly sorted bioclastic wackestone with centimetric Pentamerus sp. (~1709m).

1732,2

BOX 351

Fine to medium grained, well sorted microbioclastic wackestone with crinoids. *Pentamerus* shells are very rare.

Local presence of nodular layers made of light gray limestone (Fig. 2β). No fracture or vein.

Fine-grained wackestone with low bioclastic content. Nodular aspect (~1734m).

1736,0

BOX 352

Green shale

Green shale layer, 3 cm thick @ 1737 m depth, very friable.

Nodular bioclastic limestone (with «nodules» around 3-4 cm in diameter). No fracture or vein.

★ *MA2-1740*

1740,9

Fracture count

0 10 20 30 40 50

0

0

0

0

Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features	Fracture count
1740,9	BOX 353	Nodular, bioclastic limestone, wackestone, poorly sorted. Rare centimetric bioclasts disseminated within matrix (2-3 cm in diameter). Brachiopod molds (?), unidentified bivalve shells. Alternance with well-sorted bioclastic wackestone. Very few thin oblique fractures (1 or 2)	 ***Poorly sorted bioclastic wackestone (~1746m).***	2
1745,3	BOX 354	Alterning bioclastic wackestone (Fig. 2Y), poorly sorted with centimetric *Pentamerus* shells (1 cm in diameter maximum), crinoïd, bivalve and brachiopod fragments, and bioclastic wackestone, fine to very fine grained. Bioclasts are not adundant (they represent about 10 % of the sedimentary fabric). Nodular aspect only at the top of the internal (approx. 1 meter thick nodular interval). No visible veins or fractures.		0
1749,4	BOX 355	Nodular crinoid-rich wackestone, with other undetermined mm-sized bioclasts.	 ***Green argillaceous layer within a fine-grained bioclastic wackestone (1751m).***	0
	Green shale	Green argillaceous layer, 3-4 cm thick @ 1751.3 m depth (Fig. 2δ).		
1753,8	BOX 356	Nodular bioclastic wackestone to packstone, similar facies but large coral fragments, tabulate corals, most likelly *Syringopora sp.* (up to 4-5 cm large colony). No visible fractures.		2-4
1755,2	BOX 357	Nodular bioclastic wackestone to packstone, similar facies but large coral fragments, tabulate corals, most likelly *Syringopora sp*. (up to 4-5 cm large colony). No visible fractures.		0
	★ *MA2-1759*			
1762,3				

Fracture count: 0 10 20 30 40 50

Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

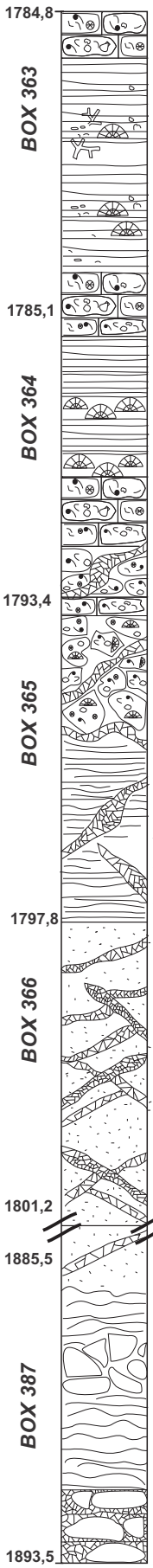
Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features	Fracture count
1762,8				
	BOX 358	Nodular wackestone to locally packstone wih crinoids, rugose corals (diameter around 1 cm), bryozoans, undifferentiated bivalve shells, bioturbation (?). Stromatoporoids encrusting corals (Fig. 2ε).		0
	★ MA2-1766	No visible fractures or veins.		
1767,0				
	BOX 359	Fine-grained, dark gray wackestone with a decreasing bioclastic content. Locally, nodular aspect.		1-2
	★ MA2-1767	Occurrence of fractured intraclasts associated with vertical fractures filled with fine-grained dark material. Locally small crinoids rich layers (Fig. 2ξ) with millimetric crinoids.		
1771,5				
	BOX 360	Microbioclastic wackestone interbedded with mudstone and poorly sorted bioclastic wackestone layers. Bioclastic wackestone is made of mostly brachiopod shells sometimes associated with geopetal features. Presence of bioturbation. Occurences of centimetric framboidal pyrite.		0
	End of the laminated facies			
	★ MA2-1774			
	Py			
	Py			
1775,5				
	BOX 361	Microbioclastic wackestone with mostly crinoids fragments and brachiopod that could reach 1 cm in diameter, interbedded with nodular limestone with corals fragments disseminated within the matrix (diameter 1cm in average). Locally presence of small sparry masses (most likely recristallized bioclasts).		0
		No vein or fracture visible.		
1780,3				
	BOX 362	Nodular limestone interbedded with dark gray massive limestone. Nodular facies corresponds to bioclastic, poorly sorted wackestone with centimetric coral fragments whereas more massive facies correspond to microbioclastic, well sorted wackestone with crinoid fragments (1 mm in diameter in average). Locally occurrence of undifferentiated bivalve shell fragments.		1-2
	★ MA2-1783	Presence of thin, well-sorted, crinoid-rich layers, 1 cm thick in average. One or two oblique fractures are present.		
1784,8				

Coarse grained bioclastic packstone with abundant crinoids and lithoclasts (~1766m).

Millimetric bioclastic layer made of crinoid fragments (1768m).

Fracture count: 0 10 20 30 40 50

Meters | **Lithology** | **Description** (incl. texture, fossil content, primary sedimentary fabric and /or structures) | **Photos of selected features** | **Fracture count**



★ *MA2-1787*

Nodular wackestone that progressively grades into a fine-grained well bedded crinoidal wackestone.

Chain-like corals (*Tabulata*), fragmented, and corned-shape corals (*Rugosa*) (diameter around 1.5-2 cm). Presence of small bioclastic packstone layers, poorly sorted, with mostly crinoids and corals fragments.

From 1788 m depth, 2 cm thick layers are interbedded with bioturbated wackstone. Few oblique fractures throughout the interval.

Nodular microbioclastic wackestone interbedded with coarse bioclastic layers, (bioclast diameter around 1 cm), well sorted, dominated by rugosa corals fragments.

Lowermost 80 cm are fractured. Five oblique fractures throughout the interval.

Fractured interval within nodular limestone facies (~1793m).

★ *MA2-1793*

Carbonate Breccia

Dol

★ *MA2-1794*

★ *MA2-1796*

★ *MA2-1797*

Si

Si

Si

Silicified carbonate breccia, possibly related to (late) diagenetic fluids circulation. Interval is densely fractured (over 20)(Fig. 2η).

Brecciated facies corresponds to the finely laminated/bioturbated carbonate facies, Tabulate corals fragments.

- - - - - - - *Base Sayabec* - - - - - - -

Quartzite. Contact with the Val-Brillant Formation (Fig. 2θ).

★ *MA2-1799*

Interval is densely fractured (over 30 fractures for the interval).

Sandstone interval at the transition between Sayabec Fm and Val-Brillant Fm (~1806m).

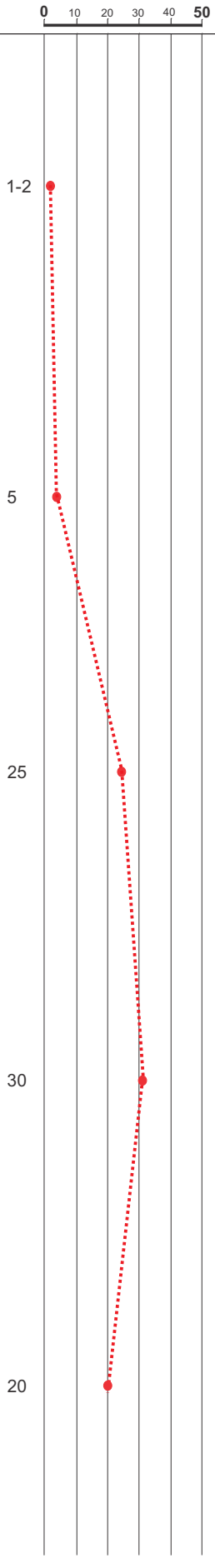
★ *MA2-1893*

Damaged core interval

Dark gray limestone facies, finely laminated/bioturbated, fine to very fine grained.

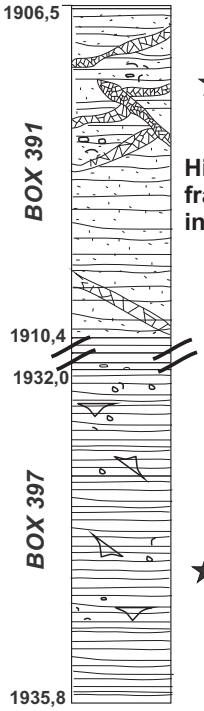
Presence of thin vertical fractures at several depths and few horizontal veins. Total of at least 20 fractures and/or veins.

Late brecciation at the base of the interval.



Detailed stratigraphy — **Sayabec Formation, Massé No. 2 well**

Meters	Lithology	Description (incl. texture, fossil content, primary sedimentary fabric and /or structures)	Photos of selected features	Fracture count



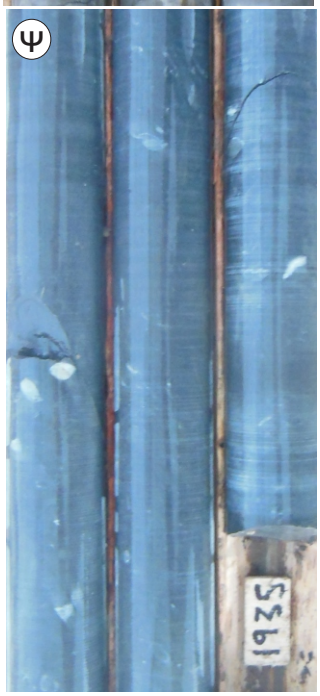
Fine to medium grained sandstone (quartzite; Fig. 2Σ) with (rare) occurrence of bioclastic rich layers (recristallized bioclasts, millimetric in size).

Locally greenish colour associated with fractures.

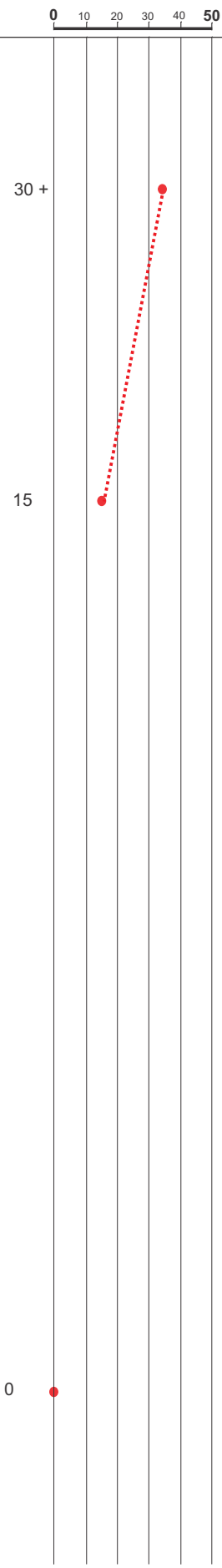
Highly fissile interval due to argillaceous content.

Dark grey calcareous siltstone, presence of bioclasts (centimetric in size), disseminated within fine-grained matrix (Fig. 2Ψ). Bioclastic intervals are poorly sorted and mainly composed of brachiopod shells. Locally geopetal features.

Typical quartzite from the Val-Brillant Fm (~1906m).



Bioclastic siltstone (~1933 m).



DISCUSSION

In the adjacent Lac Matapédia syncline to the east of the study area, the Sayabec Formation thickness ranges between 250 to 350 m where its four internal members are developed (Lavoie et al., 1992). These four members are:

- Member A: sharp contact with the underlying quartzite of the Val-Brillant Formation. The member is 25 m thick and consists of well bedded peritidal to shallow subtidal carbonates with locally high siliciclastic content.
- Member B: the member is between 30 and 100 m thick. It consists of below fairweather wave base fine-grained, muddy to nodular limestone with locally abundant open marine fauna, with the distinctive abundance of the brachiopod *Pentamerus oblongus*.
- Member C: the member is between 30 and 170 m thick. It consists of an assemblage of shallow subtidal carbonate facies including well sorted packstone to grainstone calcarenite, metazoan (coral, stromatopore, algae) bioherms and biostromes and some intertidal laminites.
- Member D: the member is between 10 and 30 m and is dominated by below fairweather muddy to nodular limestone although to the contrary of member B, it is largely devoid of fossils.

In Massé No. 2 well, the Sayabec Formation is 267.6 m thick (1797.8 – 1530.2 m); the four members recognized in the Lac Matapédia Syncline are recognized, from bottom to top:

- The first member, at the contact with the quartzite of the Val-Brillant is 29.8 m thick (1768 – 1797.8 m), it consists of well-bedded limestone facies with locally pseudo-nodular fine-grained mudstone.
- The second member is 88.5 m thick (1679.5 – 1768 m), it is dominated by nodular lime mudstone to packstone, rich in marine fauna including locally abundant *Pentamerus sp*.
- The third member is 101.1 m thick (1578.4 – 1679.5 m), the member consists of diverse well-bedded carbonate lithologies, from wackstone to packstone. Fauna is abundant in particular corals and stromatopores. Even with the limited size of the core, metazoan bioherms are suggested. Interpreted intertidal facies (cryptalgal laminites, laminated mudstone and siltstone) are locally abundant.
- The fourth member, at the top of the formation is overlain by the green siltstone of the Saint-Léon Formation. The member is 48.2 m thick (1530.2 – 1578.4 m) and is represented by muddy to nodular lime mudstone and wackestone with locally abundant corals and crinoids.

The detailed facies association found in the four members as well as their environmental interpretation and comparison with the Sayabec Formation in the Lac Matapédia Syncline are covered in a peer-reviewed publication.

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