Appendix 9. Illustrated core description, Little Bear N-09. Updated from (Kabanov, 2015).

UWID: 300/N-09-6500-12630/0 [NT]

STATUS: Susp (same as O&G Susp)

LAHEE: EXP

SPUD: 2012/01/27

DRILLED BY: Husky Oil Oprtns Ltd [H032]

Core diameter: 9 cm

Interval measured: 1670-1837.4 m

Core 1, 1670.00-1706.00

1.38 m per box, 0.65 m in box # 1 (packing from bottom to top).

CANOL FORMATION

Loon Creek member

1670.00-1674.00 Shale: Brownish black, faintly microlaminar (laminae defined by pyritic streaks) to almost massive (cryptolaminated) where pyritic streaks are not developed. Rare elliptical pyrite nodules (photo). Core relatively hard (7-15 cm thick chunks, with minor conchoid surfaces. Rare vertical formational fractures in upper part, some fractures are lined with brownish microsparitic calcite. Base by gradual increase in fissility.

Figure N-09-1. Siliceous shale with pyrite streaks and upright calcite-lined fracture, 1670.2 m MD

Figure N-09-2. lamination and pyrite nodule, 1672.2 m MD

Mirror Lake member

1674.00-1693.8 Shale: dark gray, fissile, very homogeneous, non-calcareous. Slightly different from the overlying interval by more prominent fissility, lack of conchoid surfaces, and faster absorption of sprayed water indicating greater proportion of expandable clay. Also, pyrite streaks are lacking (or very rare) so the total interval looks less pyritic. Sub-mm sized, poorly preserved organic fragments (plant detritus) and rare pyrobitumen flakes on fissility planes. Abundant pyritized *Tasmanites*. Sponge spicules on fissility planes are rare to common.

Core 1, 1670.00-1706.00

Core 2, 1706.00-1760.25

1693.8-1699.2 Shale to mudrock: Brownish black, fissile, non-calcareous, with minor (<5%) lighter-colored grains (detrital?) of silt to very fine sand size. Most notable difference from the overlying interval is rare lighter-colored silt laminae 0.2-2 mm in thickness. Return to fissile homogeneous shale in lower one-half. Rare siderite(?) nodules producing slickensided impressions in surrounding shale. Sponge spicules rare.

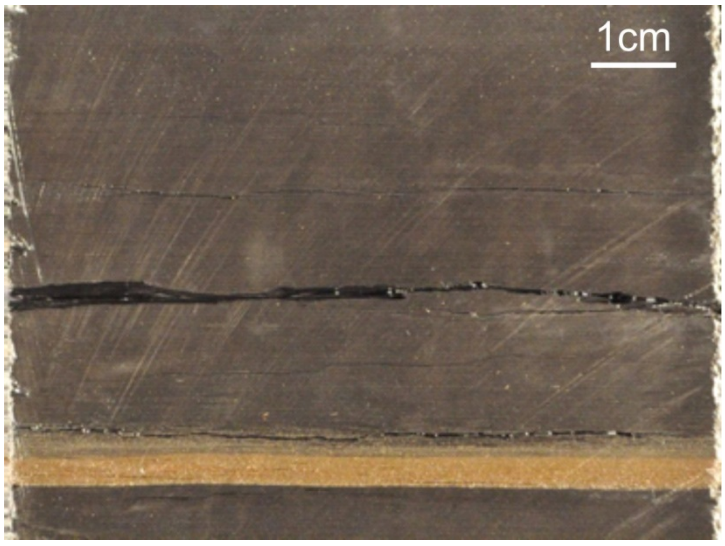

Figure N-09-3. Dark gray fissile shale with pyritized red-shale seam, 1696.0 m MD

Middle Resistant member

1699.2-1713.3 Mudrock: Brownish black, faintly microlaminated shale with laminae defined by pyritic streaks; moderately fissile, slightly harder than the fissile shale above. Thick (5-20 cm) monolithic cylinders of non-expanding siliceous mudrock alternate with more fissile shale. Rare pyritic streaks and small scattered pyrite nodules. Rare thin siltstone laminae including graded laminated beds up to 5 mm in thickness. A horizon of authigenic stellate calcareous aggregates at 1702.8-1702.9 m. Rare subhorizontal conchoid surfaces and rare upright pyrobitumen-lined fractures. At some intervals core looks very homogeneous.

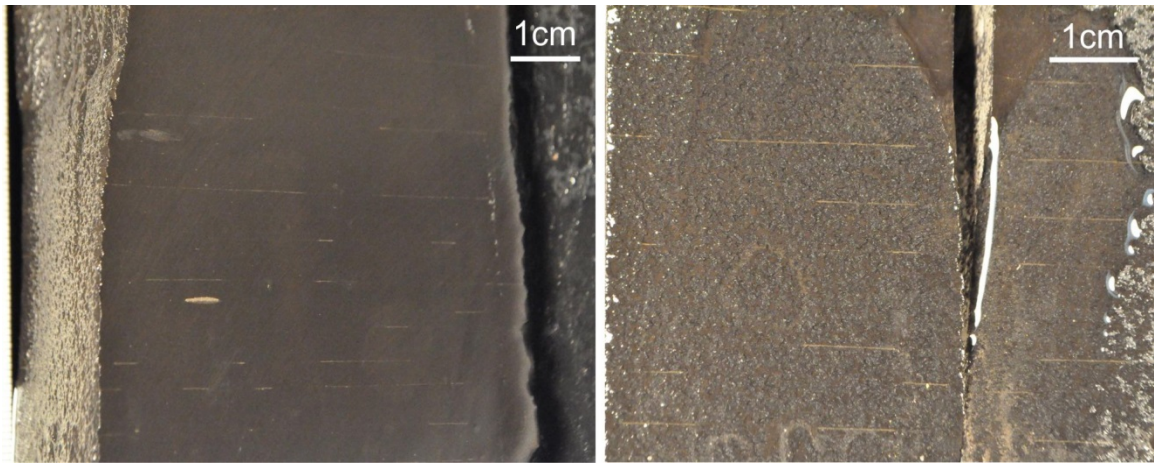

Figure N-09-4. Bitumen-lined fracture, 1712.0 m MD

1713.3-1713.45 Calcareous mudrock: brownish black, hard, non-expanding, microlaminated. Lamination defined by pyritic streaks and calcareous material – authigenic tiny (about 0.1 mm) crystal aggregates, some of them showing stellate shape. No bioclastic calcareous material is preserved.

1713.45-1722.0 Mudrock: Brownish black, faintly microlaminated, relatively hard shale with rare graded laminated beds of siltstone and similarly rare authigenic aggregates of stellate calcite associated with siltstone laminae; these aggregates are the only calcareous material. This interval is very similar to 1699.2-1714.5 m.

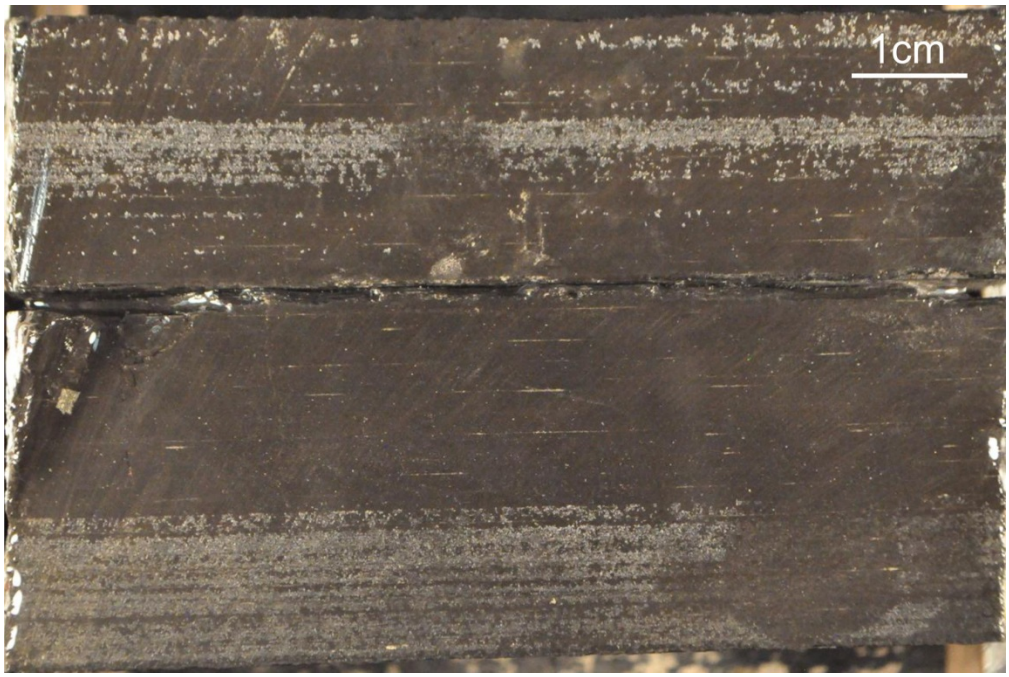

Figure N-09-5. Calcareous shale with lamination emphasized by diagenetic calcite aggregates (“stellate calcite”), 1714.4 m MD

1722.0-1722.3 Calcareous mudrock: very hard, microlaminated, dominated by fine-grained siltstone. The interval is moderately and evenly calcareous, calcite may reside in grains or matrix. Upright fractures with thin skins of light brownish micritic calcite.

1722.3-1724.5 Siliceous shale: brownish black, hard and moderately fissile, non-calcareous, with tiny pyrite streaks highlighting lamination.

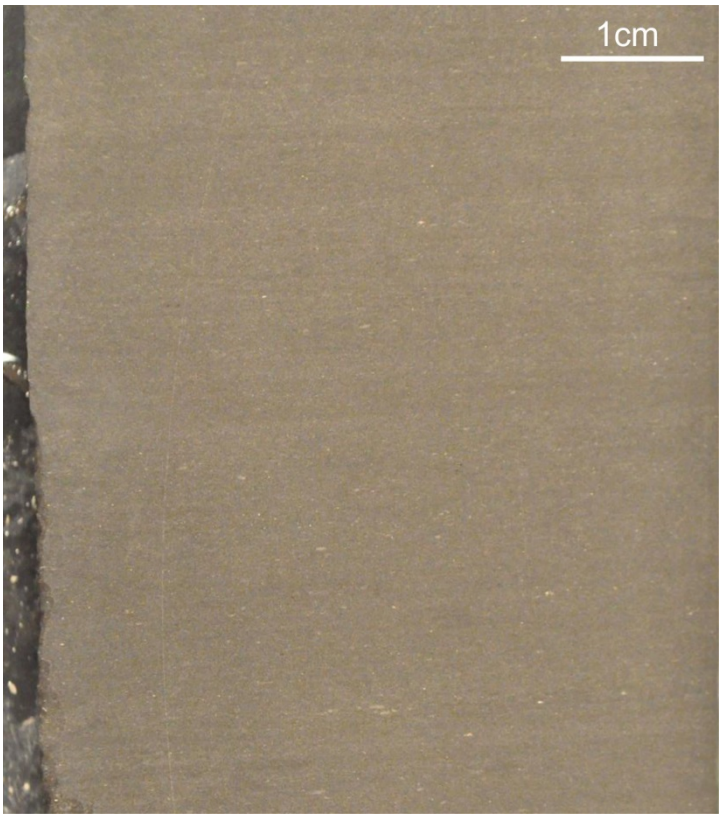

Figure N-09-6. Hard calcareous shale with micritic calcite, 1723.1 m MD

1724.5-1738.2 Mudrock: alternation of hard mudrock similar to 1723.3-1724.5 m and laminated mudrock (silty shale). Laminae enriched in silt – very fine grained sand comprise about 5-10% of the interval. Rare upright bitumen-lined fractures and stylolites associated with boundaries of laminated siltstones and shales (photo). The interval is mostly non-calcareous, with rare horizons containing stellate aggregates of authigenic calcite (photo).

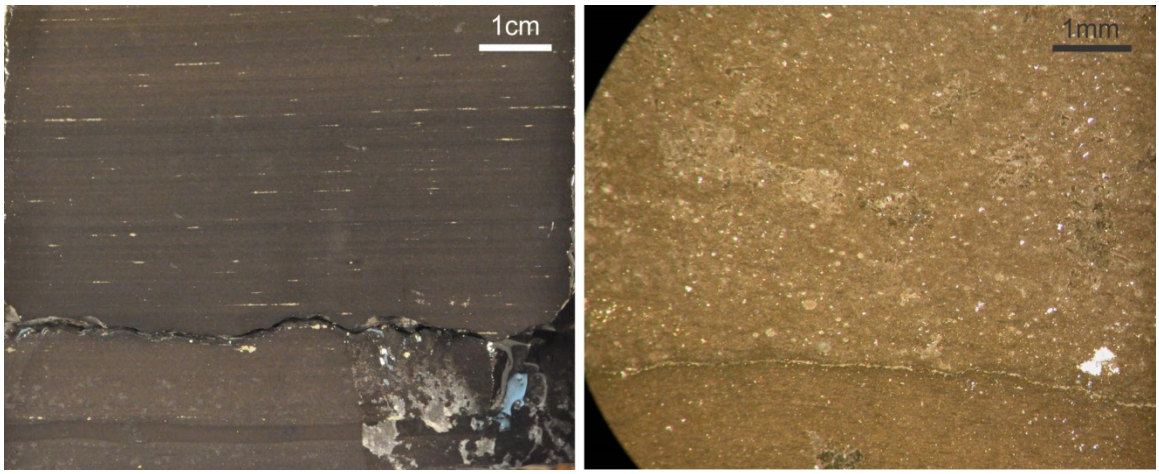

Figure N-09-7. Stylolite (image on left) and stellate calcite aggregates; image on the right is taken under binocular; 1725.9 m MD

1738.2-1738.5 Calcareous shale to limestone: very hard, dark gray (lighter than above and below), distinctly laminated, with poorly preserved conical microfossils (tentaculitids?) in the lower one-half. No microfossils are discernible in the upper half. This interval represents a fining-upward rhythm with very calcareous (calcisiltite) base and weakly calcareous to non-calcareous top. No pyrite streaks/laminae.

Basal Recessive member

1738.5-1746.45 Mudrock: brownish black, siliceous, non-calcareous, laminated (emphasized by pyrite streaks. Very thin (< 1 mm) siltstone seams and lenses rarely occur in basal 3 m. The rock is hard, monolithic to moderately fissile, almost non-expanding, preserves as 1-20 cm long cylinders. Rare large pyrite nodules/lenses and upright bitumen-lined fractures. A 10 cm thick moderately calcareous interval at 1741.6 m. Calcareous material there occurs as micrite encased in a siliceous shaly matrix as indicated by rapid decline of HCl fizzing (indicating that calcareous grains do not form interconnected framework in a matrix). Important feature in lower 3 m: rare large (10-20 cm across) calcareous nodules with diagenetic, probably sparitic-microsparitic, matrix (photo).

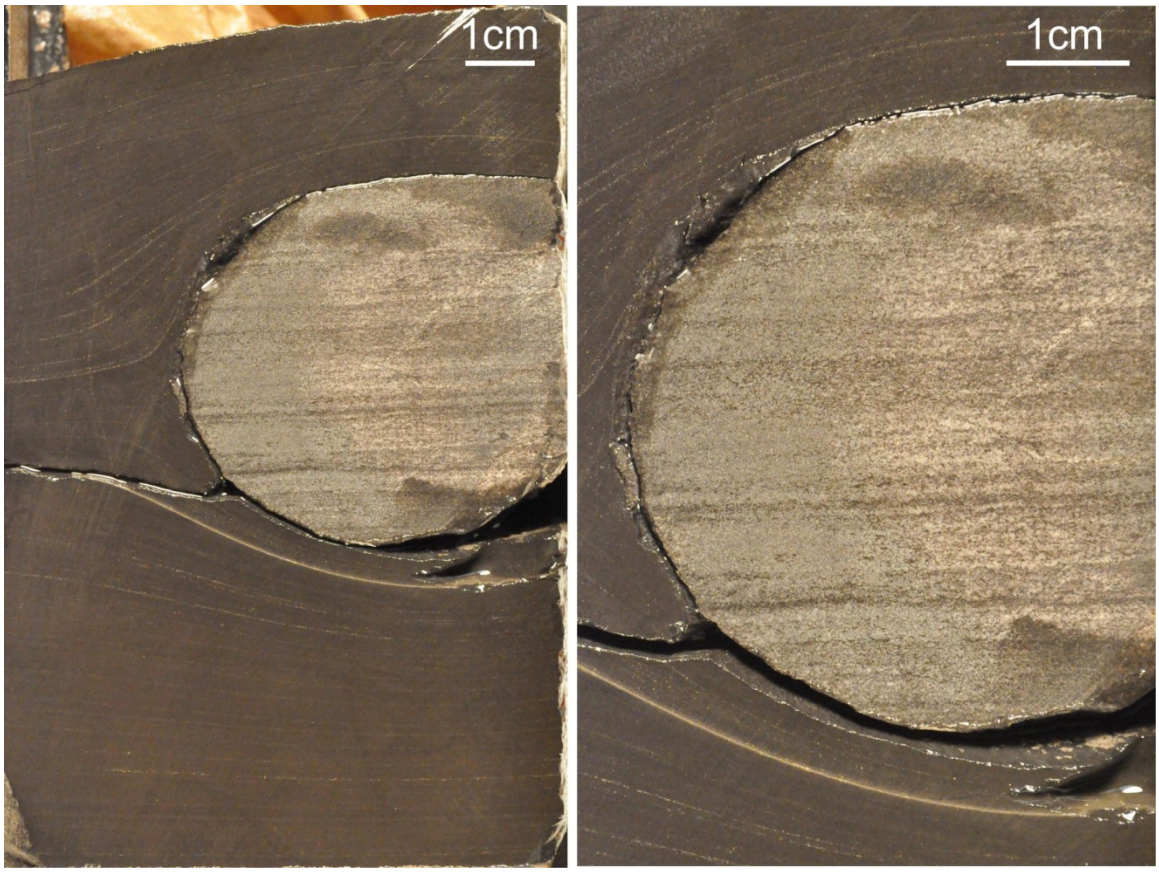

Figure N-09-8. Calcareous nodule in non-calcareous shale, 1744.8 m MD

1746.45-1749.75 Mudrock: black, hard, weakly calcareous to non-calcareous, laminated shale with lamination defined by pyrite streaks. Calcareous intervals (10-30 cm thick) alternate with non-calcareous shales. Calcite occurs in two forms: light gray microsparitic to finely sparitic grains dispersed in matrix of siliceous shale and micrite-sized (invisible) admixture in matrix. Lack of a continuous calcareous network in matrix is indicated by rapid decline of HCl fizzing (especially rapid in intervals with micritic admixture). No fossils preserved. Proportion of calcareous intervals increases downward. The base is defined by a 50-60 cm thick calcareous interval with granular inclusions of calcite. Pyrite in calcareous intervals is less abundant than in non-calcareous. Base and top gradational. Rare pyritized sponge spicules.

Figure N-09-9. Laminated calcareous hard siltstone, 1749.45 m MD

1749.75-1751.2 Mudrock: black siliceous hard non-calcareous very homogeneous shale, minor silty shale. Lamination is poorly visible because of very few pyrite streaks.

1751.2-1755.35 Mudrock: brownish black, weakly to moderately calcareous, with minor non-calcareous intervals, hard, subfissile, very homogeneous (lack of lamination-defining pyrite streaks). The lamination is best expressed in calcareous intervals where it is defined by light-colored calcite inclusions (50-70 μm in size, same as above). Fractured interval at 1755.2 m with oblique fractures at 70° angle to lamination lined by shear striations and thin calcite skin. This interval is calcareous and very hard.

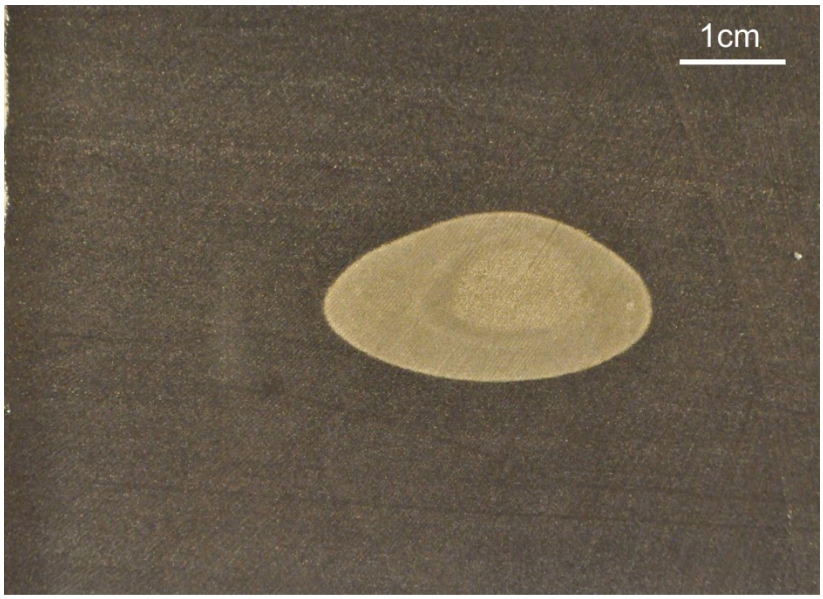

Figure N-09-10. Calcareous shale to limestone with a pyrite nodule, 1753.0 m MD

1755.35-1756.0 Mudrock: brownish black, very homogeneous, non-calcareous, relatively hard and subfissile (slightly more fissile than above), laminated (very poorly seen lamination), Almost no pyrite streaks.

Figure N-09-11. Box view - oblique fractures, 1755.3 m MD

1756.0-1756.6 Mudrock: brownish black, very homogeneous, subfissile, similar to 1755.35-1756.0 m but weakly and evenly calcareous. Like in the interval above, pyrite streaks are absent, which makes sedimentary lamination indiscernible. Calcareous material probably micritic, encased in siliceous shale matrix.

1756.6-1758.4 Mudrock: brownish black very homogeneous subfissile shale; hard, non-expanding, similar to the above but non-calcareous.

1758.4-1758.65 Shale (mudrock): brownish black, very homogeneous, subfissile, hard, non-expanding, similar to the above but weakly and evenly calcareous (identical to 1756.0-1756.6 m). No pyrite streaks or nodules.

1758.65-1759.4 Mudrock: brownish black, hard and less fissile (5-25 cm thick cylinders), siliceous, microlaminated, homogeneous, with tiny (<0.1 mm thick and <1 cm wide) pyrite streaks and isometric inclusions and very rare more continuous pyrite laminae, with rare cm-sized organic fragments (coaly particles?).

1759.4-1759.8 Mudrock: brownish black, weakly calcareous with non-calcareous intercalations. The lower part of the interval contains laminated calcisiltite likely composed of silt-sized carbonate particles (photo).

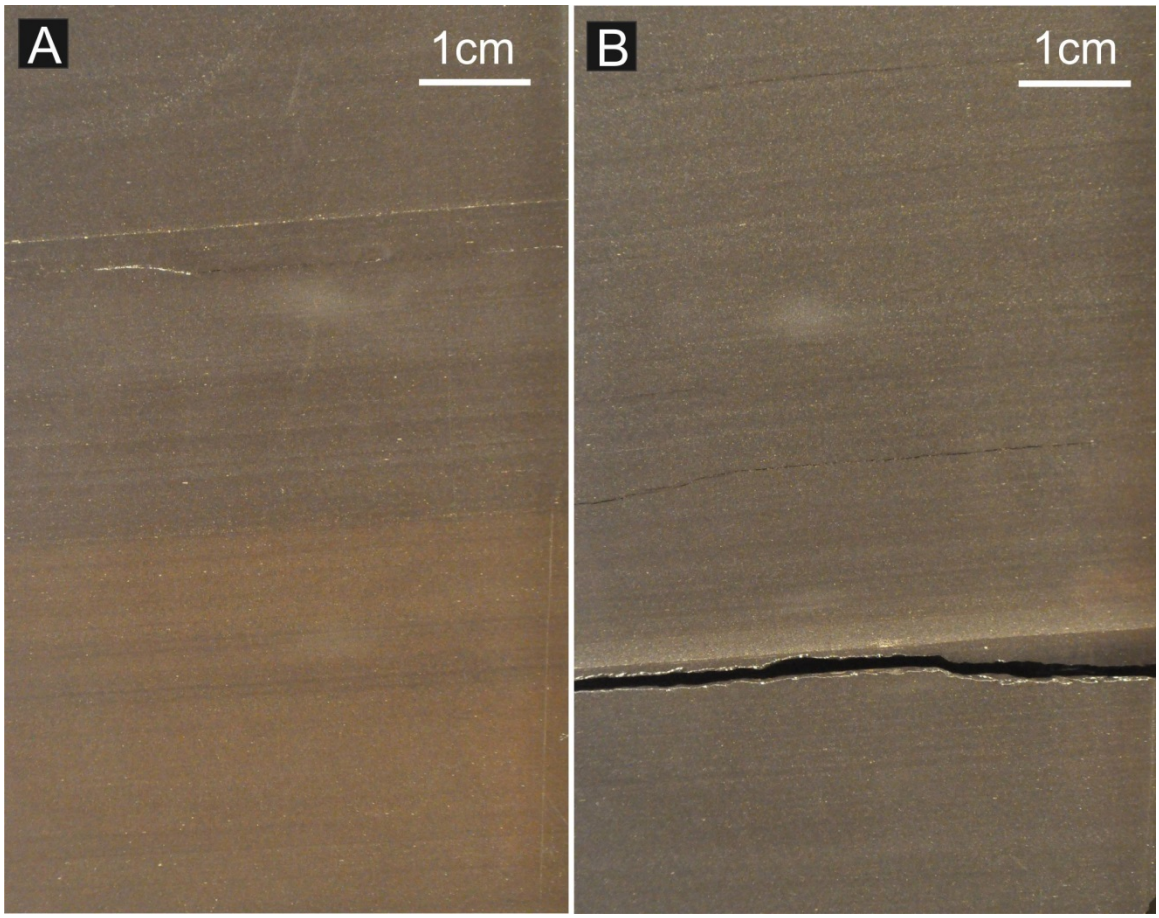

Figure N-09-12. Calcareous laminated shale (polished and treated), 1759.7 m MD

1759.8-1760.25 Mudrock: brownish black, hard and subfissile, non-calcareous, similar to 1758.65-1759.4 m; one weakly calcareous seam at 1760.15 m.

Very few or no conchoid surfaces in 1738-1760 m interval.

Core 3, 1760.25-1814.45

1760.25-1760.9 Mudrock (silty shale to siltstone): black, weakly calcareous with non-calcareous intervals, hard and only weakly fissile (forming 3-25 cm thick cylinders), apparently very siliceous, homogeneous, lamination poorly seen, defined by depositional heterogeneities; no pyrite streaks. Calcareous material as micritic (invisible) components in matrix. A large (5 cm) calcareous-pyritic nodule near the top. The overall content of pyrite is moderate to low.

Figure N-09-13. Pyrite nodule in hard laminar shale, 1760.2 m MD

1760.9-1762.0 Mudrock (silty shale to siltstone): very similar to 1760.25-1760.9 m but non-calcareous, with only very rare calcareous laminae. Infrequent and tiny pyrite streaks.

1762.0-1764.2 Mudrock (silty shale to siltstone): very similar to the above; low-contrast alternation of weakly calcare1ous and non-calcareous 1-25 cm thick intervals. Lamination is generally more distinct in calcareous intervals. Fissility slightly increases to the base.

No more ‘stellate calcites’ are seen downward from 1760.25.

1764.2-1766.4 Calcareous mudrock: similar to the above, different by domination of calcareous intervals with more conspicuous lamination and vertical fractures with finely rugged walls; some intervals fizz vigorously (comply to argillaceous limestones or marls).

1766.4-1770.5 Shale: very homogeneous, black, hard and subfissile (as 1-12 cm thick cylinders), with obscure lamination, dominantly non-calcareous, with minor and thin calcareous

interbeds (no more than 15% of the interval). Rare conchoid fractures and common upright formational fractures. Pyrite occurs as rare large nodules and tiny, relatively infrequent streaks along lamination.

Figure N-09-14. Upright fracture plane in hard shale (mudrock), 1766.8 m MD

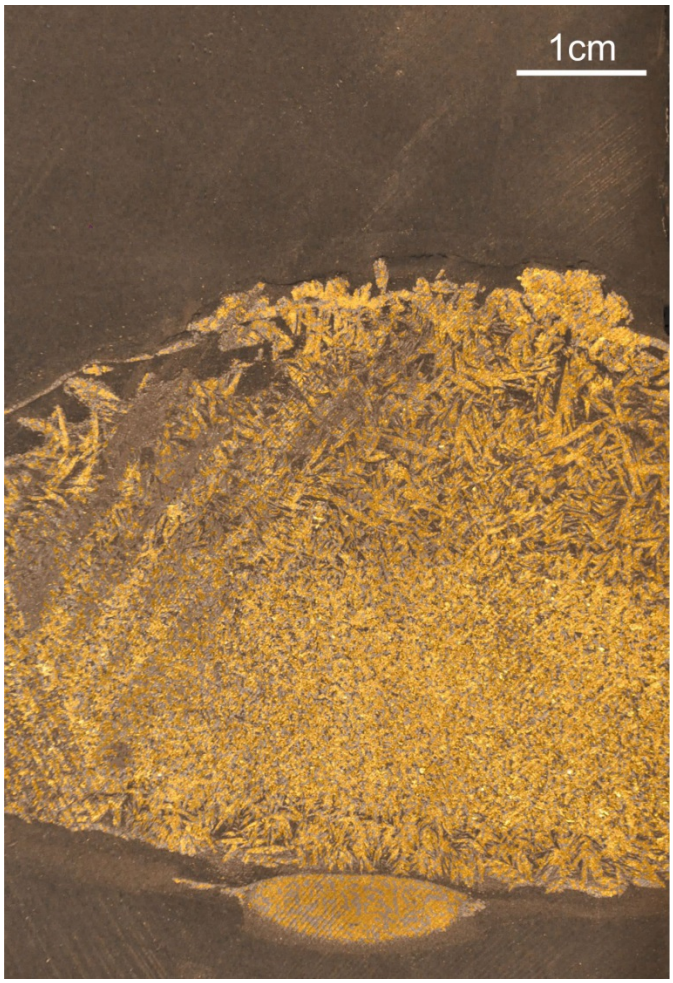

Figure N-09-15. Large calcite-pyrite nodule in bed base, 1770.4 m MD

1770.5-1771.9 Mudrock: black, hard, non-calcareous silty shale to siltstone; very homogeneous, with only faint traces of lamination defined by very weak differences between laminae. Pyrite streaks are notably rare and tiny (up to 1 mm long). Lamination planes very even.

1771.9-1774.25 Mudrock: black, hard, homogeneous, mostly non-calcareous shale with minor weakly calcareous intervals. Calcite resides in micritic matrix. Rare pyritic laminae, tiny streaks, and very rare small elliptical pyrite nodules. Upright formational fractures. Sponge spicules rare.

1774.25-1774.6 Limestone: very argillaceous and silty / finely sandy, very dark gray to black, more distinctly microlaminated due to laminar distribution of calcareous material. Calcite is dispersed in matrix and forms paler-colored laminae as recrystallized matrix and probably very poorly preserved, non-identifiable bioclasts and/or microfossils, all < 0.15 mm in size. Pyrite rare, occurs as tiny (<0.3 mm) aggregates. Smooth, low-amplitude stylolites are common on bedding planes. Black, very fine coaly detritus is present. Top and base very gradational.

1774.6-1778.5 Mudrock: black, hard, faintly laminated to almost homogenous shaly siltstones; weakly calcareous intervals alternate with non-calcareous intervals. As above, calcite occurs in matrix. Infrequent to common, evenly dispersed sand-sized coaly detritus (0.05-0.15 mm in size). Rare pyritic streaks.

1778.5-1782.0 Mudrock: black, hard, faintly laminated to almost homogenous, weakly to strongly calcareous shaly siltstones and silty shales (slightly finer-grained than above). Pyritized

laminae and streaks are infrequent but generally more common than above. Calcareous material micritic and/or microsparitic, resides in matrix and defines lamination. Top and base defined by gradual decline/increase in calcareousness.

1782.0-1782.5 Mudrock to shale: black, mostly non-calcareous, with lamination defined by infrequent pyritic laminae. Upward gradation from mudrock (shaly siltstone) into shale (in upper 10 cm). Shale is distinct from the mudrock in conchoid fracturing surfaces (in difference to planar surfaces in all siltstones) and thick, horizontally stretched calcareous-pyritic nodules. Calcite in these nodules occurs in the form of coalesced stellate aggregates. Top gradational, defined by the top of the uppermost calcareous-pyritic nodule.

1782.5-1784.6 Mudrock: black, homogeneous, predominantly non-calcareous shaly siltstone with thin (0.1-3 cm) calcareous intervals. These intervals make up 3-5% of total thickness. Calcareous material occurs as microlaminae (matrix micrites) and as finely crystalline matrix in flattened nodules intermingled with pyrite. These nodules are similar to nodules in the top of 1782.0-1782.5 m interval, but stellate aggregates are not developed. Some calcareous intervals are laminar and transitional between nodules and primary sedimentary packages. Rare very poorly preserved conical fossils.

1784.6-1786.0 Calcareous mudrock: black, relatively hard; calcareous material resides in matrix and in microlaminae. Lamination locally obscure and in other places defined by pyritic streaks.

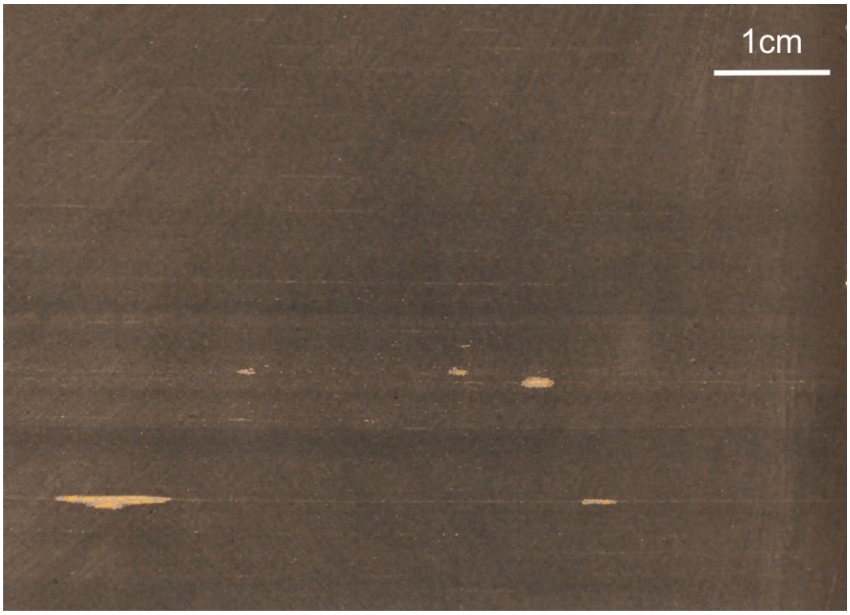

Figure N-09-16. Hard siliceous shale, 1784.8 m MD

Prohibition Creek member

1786.0-1795.4 Mudrock: black, homogeneous shaly siltstone locally with pyrite streaks defining lamination, mostly non-calcareous, with minor (<5% of the interval) and thin (<5 cm thick) weakly calcareous seams. Rare 1-10 mm thick pyritized intervals incorporating several microlaminae. Calcite occurs as matrix admixture and defines lamination. The lower 1.0 m is non-calcareous except of one level of calcareous-pyritic nodules.

1795.4-1799.15 Mudrock: black, homogeneous, variously (mostly weakly) calcareous; laminar distribution of calcareous material and rapid decline of HCl fizzing indicate that calcite is mostly sedimentary and resides in shaly matrix. Common pyritic streaks but no continuous pyritic laminae. Bedding planes are associated with pyritized and crisscrossing straight

filaments, most likely sponge spicules. Lamination is slightly more distinct than above because of regular thicker (3-8 mm) graded laminae enriched in calcareous material. These laminae occasionally preserve tiny ostracods. Fine coaly detritus present.

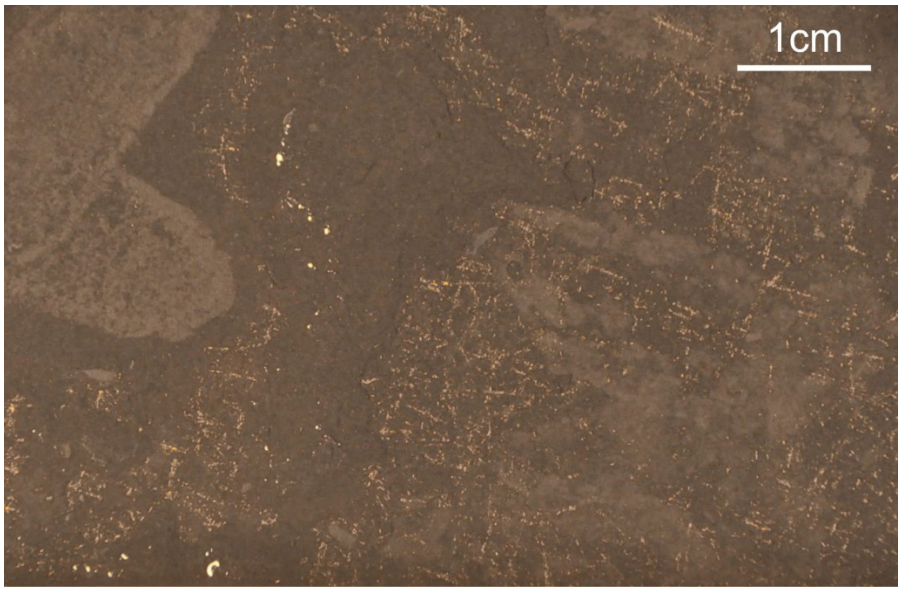

Figure N-09-17. Pyritized sponge spicules on bedding plane, 1796.4 m MD

1799.15-1799.3 Calcareous mudrock to limestone: dark gray, very hard, siliceous, distinctly laminated. Lamination emphasized by white calcareous-siliceous streaks (microphoto) that can represent recrystallized conical microfossils. Because of these calcite streaks the texture looks coarser-grained than above and below. Siliciclastic component is represented by shaly micaceous silt. Top and base are gradational.

1799.3-1803.15 Shale: brownish black, silty, generally more fissile than above (disintegrated into ‘hockey pucks’); low-contrast alternation of non-calcareous and weakly calcareous intervals. Finer-grained (shalier) parts are weakly expanding in water; siltstone (mudrock) interbeds are often calcareous, locally contain same white calcareous streaks as in 1799.15-1799.3 m. Rare to numerous pyrite streaks and pyritized spicules on fissility planes, rare large pyrite nodules.

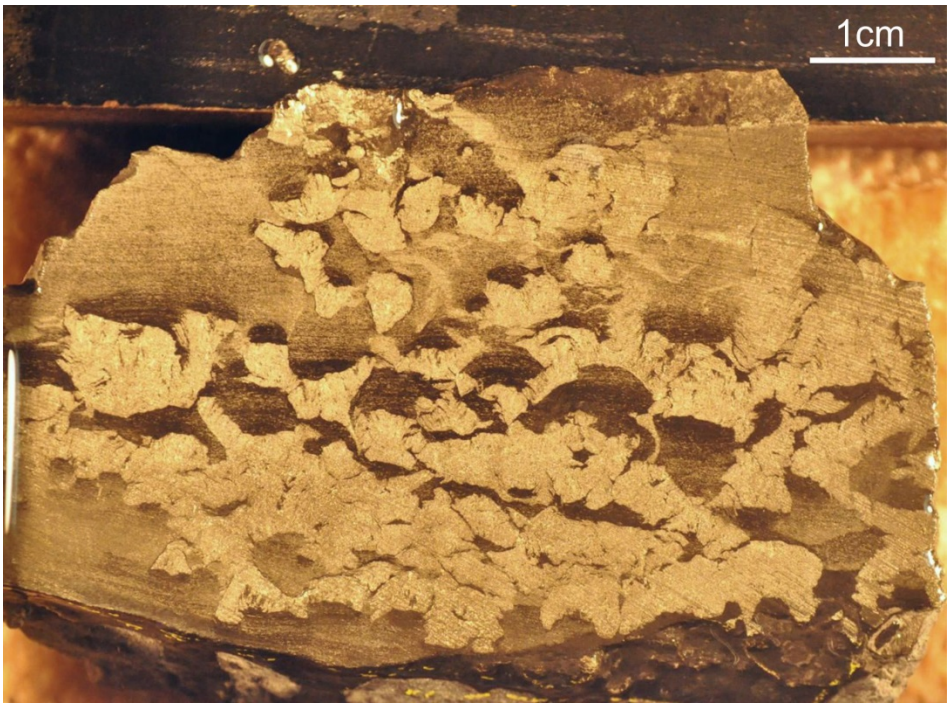

Figure N-09-18. Pyrite nodule with cuspate fabric, 1799.8 m MD

1803.15-1805.7 Shale: brownish black, subfissile to fissile, silty, heavy due to significant amount of pyrites; laminated, non-calcareous, siliceous, almost no expansion in water, producing conchoid surfaces along fissility planes. Infrequent large pyrite nodules, abundant pyrite streaks.

1805.7-1806.0 Shale-chertstone alternation: three beds of hard, weakly calcareous chertstone (cherty mudrock) with white streaks are separated by interbeds of fissile shale; calcareous laminae contain poorly preserved conical microfossils (tentaculitids).

HARE INDIAN FORMATION

Francis Creek member

1806.0-1812.7 Shale: dark gray, fissile, very silty, non-calcareous throughout, very gradually changes downward into a hard siliceous mudrock. Shale is weakly expanding in water. Microlamination is highlighted by slight differences in sedimentary textures/composition, rarely by pyrite streaks and laminae. Rare coarsely crystalline pyrite nodules.

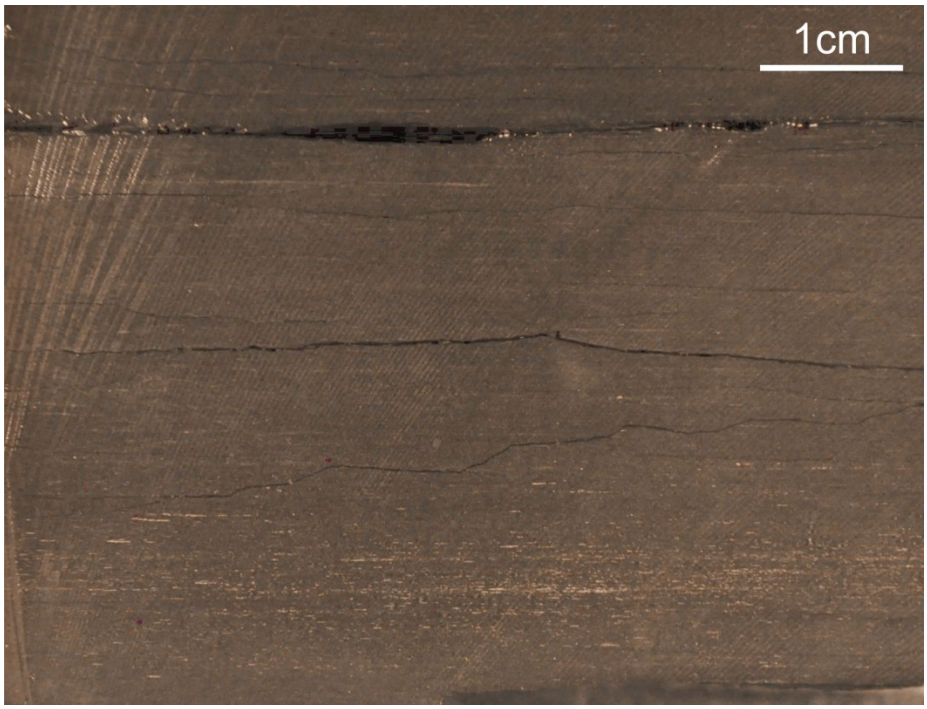

Figure N-09-19. Fissile shale, 1806.65 m MD

Bluefish Member

1812.7-1815.65 Mudrock: black, hard (3-30 cm thick cylinders), siliceous, non-calcareous with several weakly calcareous intervals. Shale-dominated intervals alternate with siltstone-dominated intervals with minor admixture of light-colored very fine sand grains. Lamination is mostly visible, in most homogeneous intervals obscure. Minor pyrite streaks and small nodules. Thin laminae of chertified poorly preserved thin-walled microfossils (<0.2 mm).

1815.65-1816.4 Mudrock: black, hard (3-30 cm thick cylinders), siliceous, variously calcareous. Locally laminae are enriched in thin-walled microfossils including conical forms up to 1 mm in size (photo). These fossiliferous intervals also contain coaly laminae composed of plant litter (photo). Calcite resides as micritic grains in matrix and in tiny microfossils, although the latter are partly chertified and pyritized.

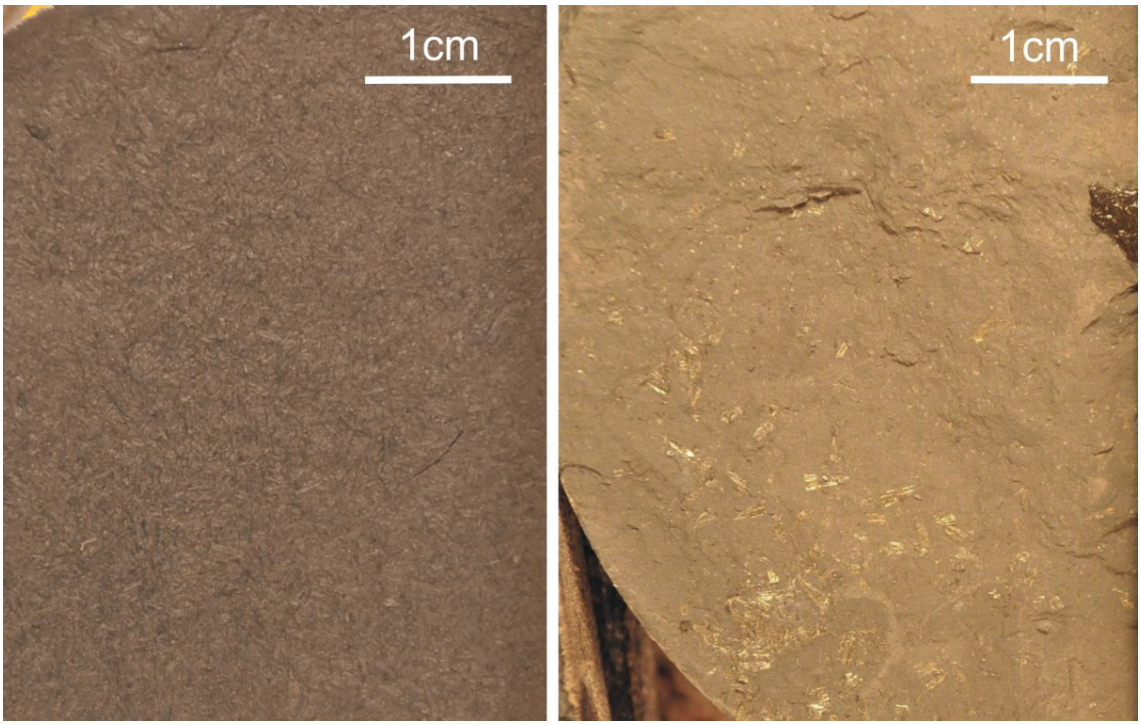

Figure N-09-20. Collapsed tentaculitid cones on bedding plane, 1816.15 m MD

1816.4-1817.7 Mudrock: very similar to 1815.65-1816.4, variously calcareous, locally containing pyritized collapsed ostracods (?) and conical microfossils; infrequent and regularly spaced pyrite streaks.

1817.7-1821.25 Shale: more fissile than above, silty, weakly calcareous to almost non-calcareous, weakly expanding in water. Lamination is mostly defined by slight differences in lithology. Collapsed pyritized tentaculitids seen on bedding planes are common in upper part of the interval and increase to abundant in its lower part. Tentaculitids also retain some calcite (fizzing). Calcite is also dispersed in matrix as invisible (isolated) micritic grains (fizzing rapidly dies on core face).

1821.25-1823.1 Siltstone: black, hard, calcareous shaly siltstone to very fine-grained sandstone. Pyritized collapsed tentaculitids are rare, increase to common in basal part; calcareousness also increases from weak (same as above) in upper half to moderate, longer-fizzing in lower half. Minor and low-contrast finer-grained shaly interbeds. Lamination is poorly seen, frequently obscure. Rare small pyrite nodules. A pyritized and strongly calcareous bed with non-collapsed tentaculitids at 1822.65 m (photo).

N.B.: No more crisscrossing spicules are seen below 1805 m.

1823.1-1824.55 Calcareous shale: black, hard, silty, with very dark gray limestone intercalations, laminated. Limestone seams constitute 10-20% of the interval and consist of 0.1-3 cm thick graded beds of tentaculitid coquinas; micritic calcite is also dispersed in shale matrix. A thick (20 cm) bed of black limestone occurs at 1824.1-2814.3 m. This bed is distinctly graded, with a 4 cm thick basal chaotic mesh of tentaculitids (non-laminated!) lying on sharp shale surface. The tentaculitid mesh grades upward into homogeneous microcrystalline calcite with tiny tentaculitid lenses, practically no pyrite, and very faint lamination. This micrite is capped by an authigenic pyritic horizon (photo). In less calcareous intervals between limestone graded beds lamination is highlighted by pyritic streaks and collapsed, partly pyritized tentaculitids. Top gradational, by downward transition from pyritized to non-pyritized tentaculitids in graded beds. Base on top of a thick

limestone bed that distinctly contain admixture of benthic bioclasts – brachiopod fragments, etc.

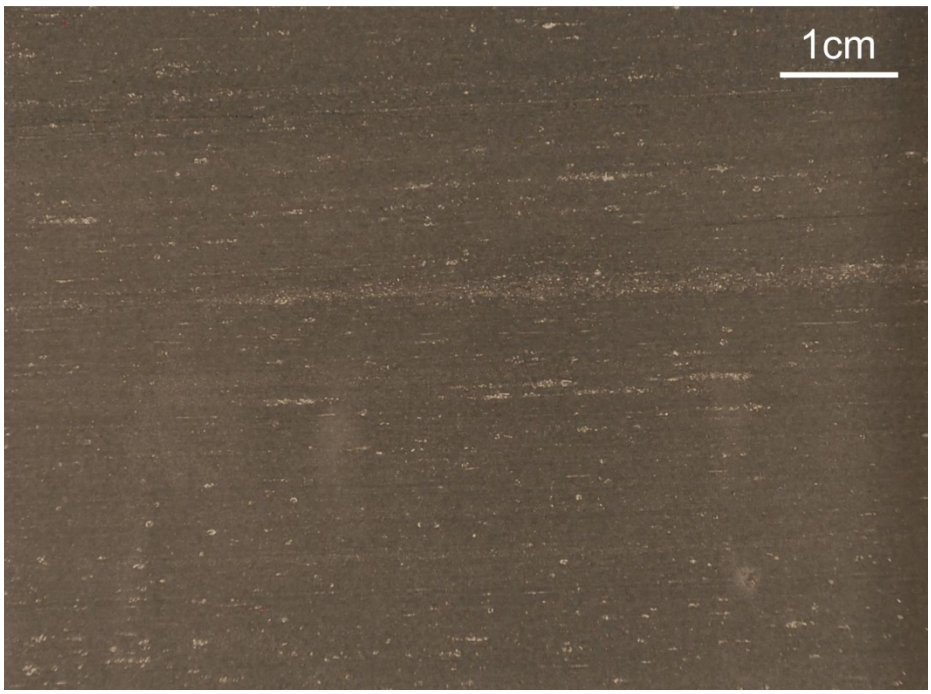

Figure N-09-21. Calcareous shale with tentaculitid limestone laminae. 1823.35 m MD

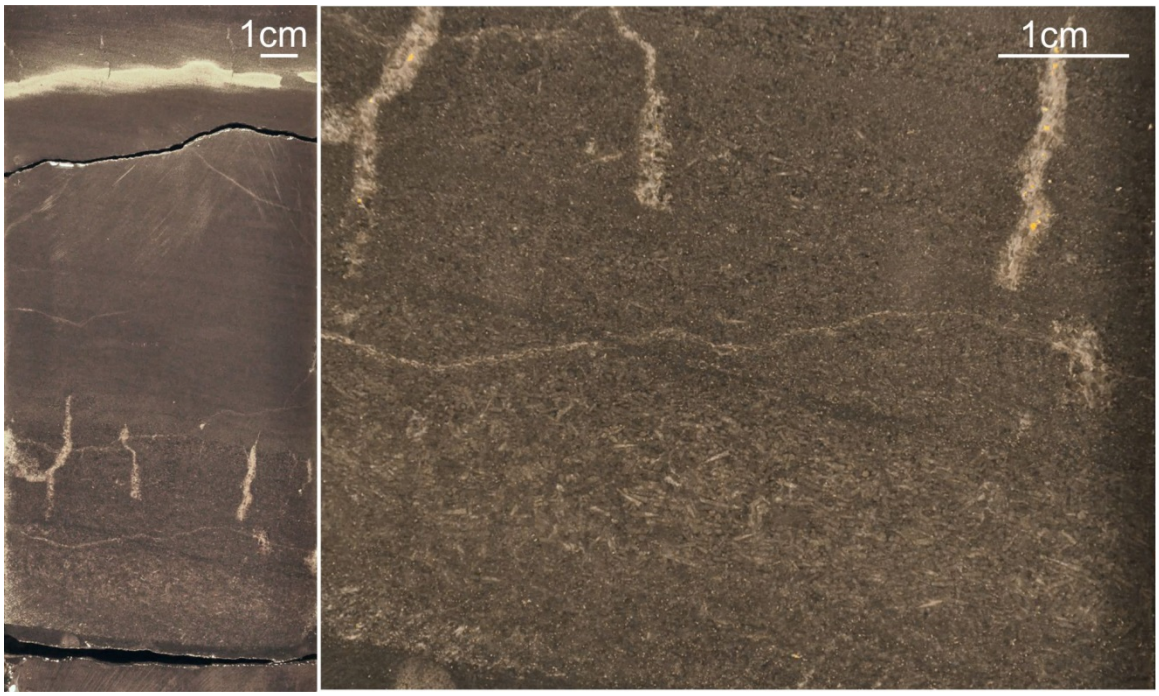

Figure N-09-22. Graded limestone bed with basal mud-lean concentration of tentaculitids (right image is close-up of the left one); 1824.2 m MD

1824.55-1824.8 Limestone: black, argillaceous, silty and cherty, composed of mass tentaculitids and microcrystalline matrix; moderately bioturbated (random to swirly orientation of cones), apparently composed of two or three main churned-up graded beds. Lamination is partly preserved, mostly in top and base. No distinct erosional surfaces. This bed contains infrequent to common fragments of brachiopods, ostracods, maybe bryozoans, and other benthic skeletal forms, but no unbroken valves (transported debris). Defined in base and top by transition to regularly laminated and weakly calcareous shale.

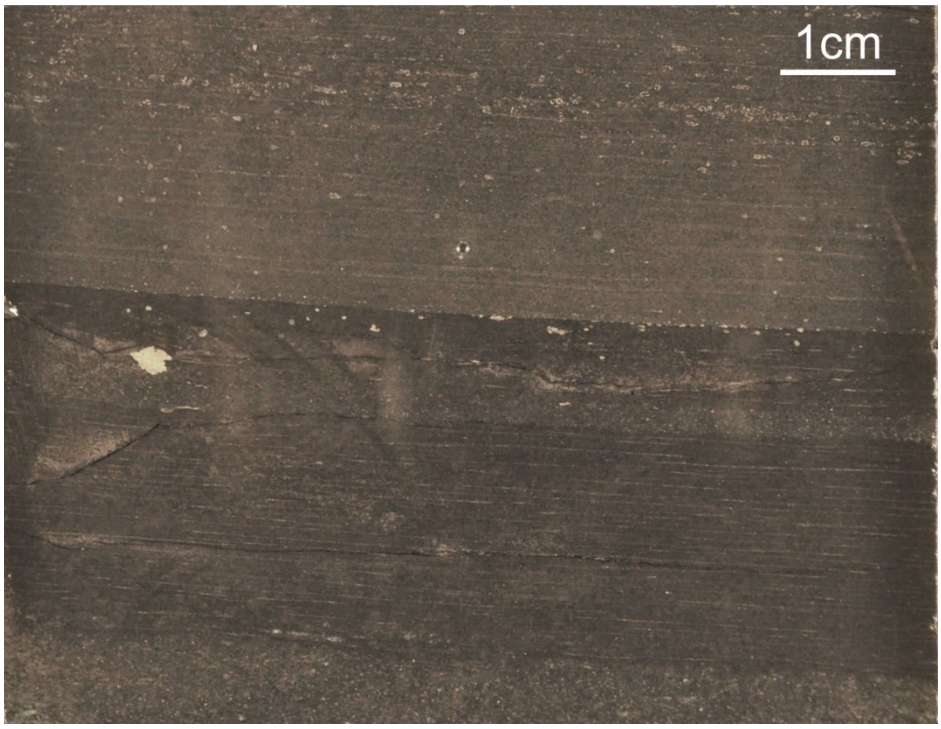

Figure N-09-23. Tentaculitid limestone interbedded with pyritic shale; 1824.5-1824.65 m MD

1824.8-1826.45 Calcareous shale: very dark gray to black, hard, laminated, with alternating intervals of black fissile weakly calcareous shale with collapsed pyritized tentaculitids and strongly calcareous, less pyritic and less distinctly laminated intervals where calcareous material resides in tentaculitid shells and matrix. Basal 15 cm is mostly composed of this latter facies. Rare (in upper half) to common and abundant (in base) fragments of thin-walled bivalves, brachiopods, and possibly other benthic groups. These valves are collapsed and poorly preserved.

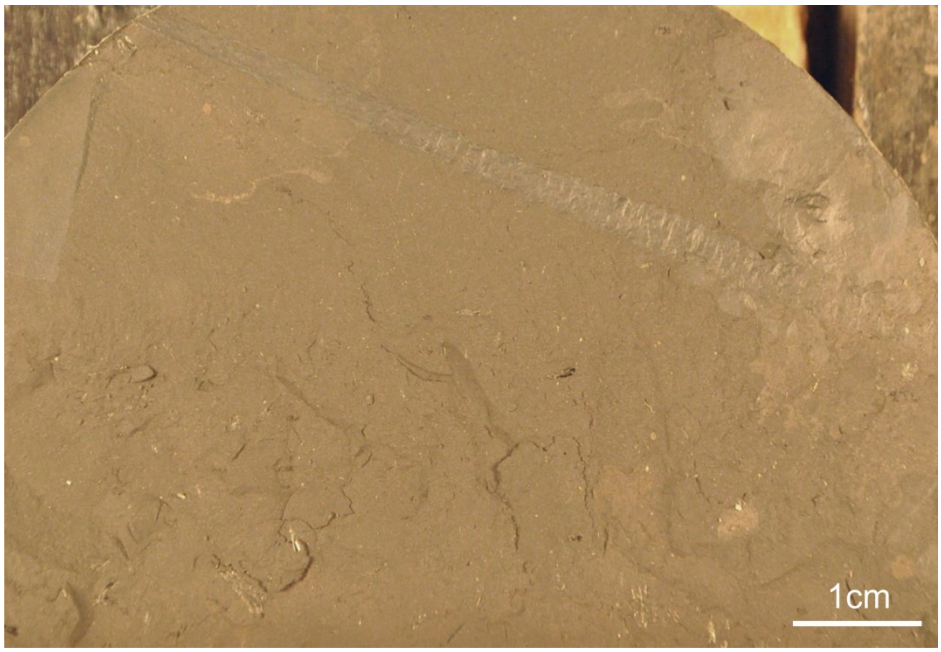

Figure N-09-24. Trace fossil on bedding plane 1824.8 m MD

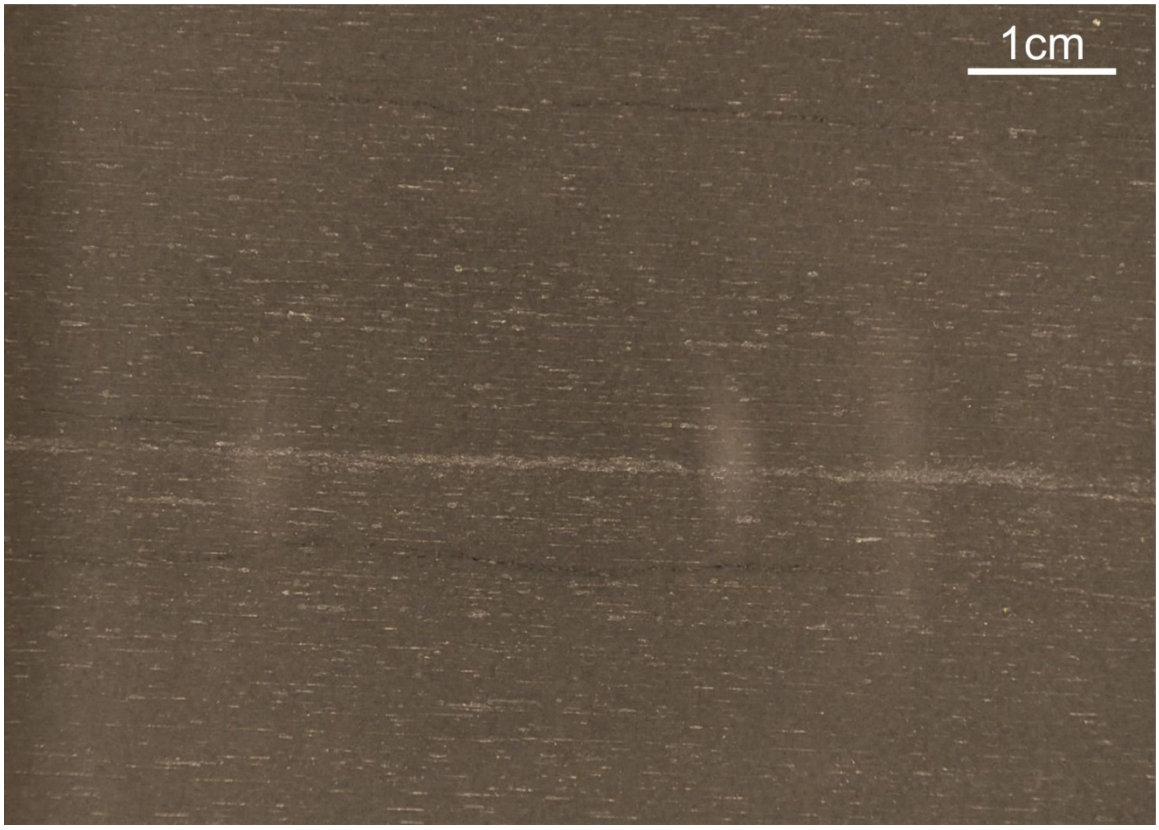

Figure N-09-25. Calcareous shale with tentaculitids 1826.0 m MD

1826.45-1826.9 Argillaceous limestone: unusual dark gray hard rock bearing two levels of cone-in-cone calcite. These levels consist of fan-shaped aggregates of bladed coarsely-

crystalline calcite divided by partitions of laminated shale. Lamination is gently whapping over cone terminations. Aggregates of fans are chevron-patterned (typical cone-in-cone) and in upper layers are suborganized into rough sheets. The upper level is the thickest (10 cm) and most coarsely crystalline (crystals up to 2 cm long in upper layers), occurring in top. The lower level is finer-crystalline (crystals up to 3-4 mm long) and only 2.5 cm thick, occurring in base. Crystals show growth perpendicular to lamination. Both con-in-cone levels have coarsening-upward crystallinity. Between cone-in-cone levels, the rock is a strongly argillaceous finely crystalline (microsparitic?) laminated limestone with common non-compacted tentaculitids grading downward (to the top of the lower cone-in-cone level) into a black laminated calcareous shale with compacted tentaculitids. Rare poorly preserved debris of benthic fossils (Amphipora is the only identified fragment). Tentaculitid cones occur separately and in thin (<1 mm) lenses. These lenses are gently buckled probably during authigenic growth of calcite. Weak pyritization.

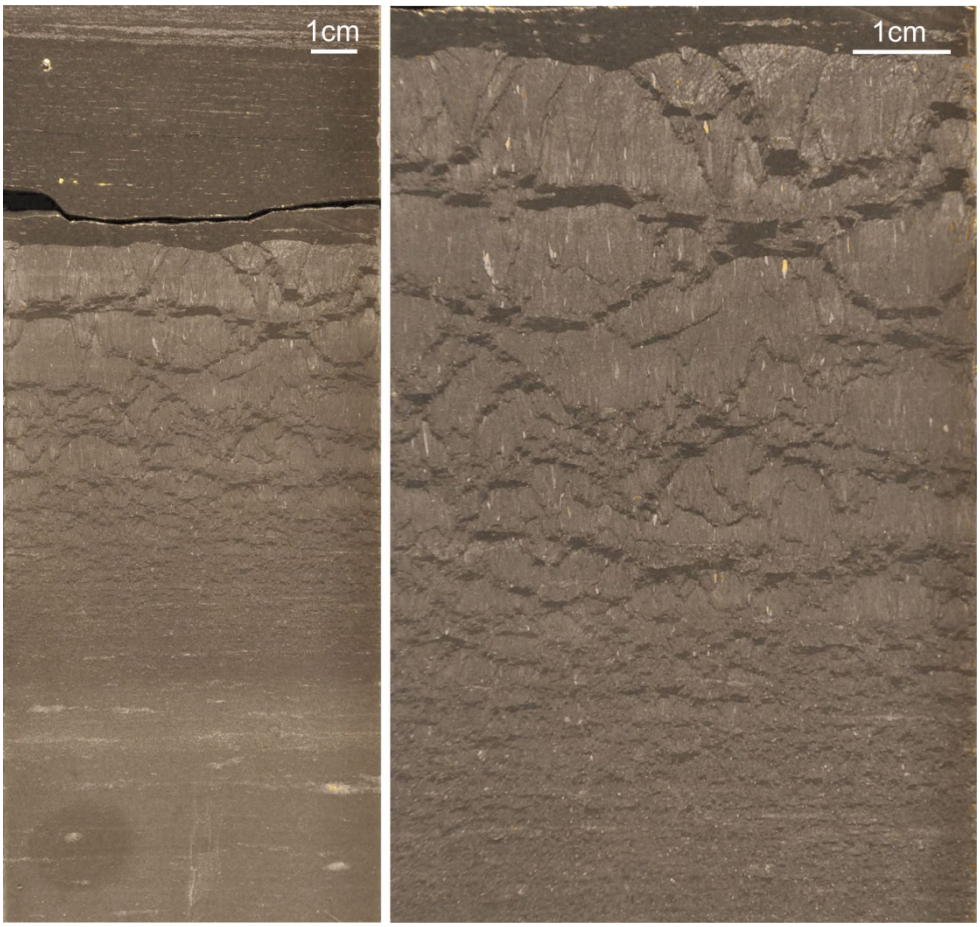

Figure N-09-26. Limestone interval with cone-in-cone layer 1826.3-1826.8 m MD

1826.9-1828.75 Shale with limestone intercalations: black (limestones very dark gray), variously silty and with deviation into siltstone, laminated, hard to subfissile. Lamination is defined by skeletal calcite streaks and thin lenses (mass collapsed tentaculitids) and less abundant pyritic streaks developed on tentaculitid streaks. Sand-sized pyrite grains are regularly dispersed in shale matrix. Minor conchoid fractures. In lower 0.7-0.8 m lamination is angling to horizon with the dip angle gradually building form subhorizontal at 1828.0 m to 20-22° at the base (probably dune overlapping). Limestone intercalations of two types: (1) thin, <1 cm, tentaculitid coquinas and (2) horizons of finely crystalline authigenic calcites up to 10

cm in thickness. These horizons contain non-collapsed tentaculitids, the least amount of pyrite, and less distinct lamination than in stronger pyritic shale.

1828.75-1828.9 Argillaceous limestone: hard, dark gray, crudely cross-laminated; tentaculitid cones mostly occurring in randomly oriented mesh with poorly seen lamination trends. Obvious bioturbation is however lacking. Cones are cemented by pale brownish gray calcite cement – probably a finely crystalline marine cement (need thin section). Cross-lamination is bi- or multidirectional, probably forming mummocks or dunes/large ripples. No obvious benthic fossils. Minor low-amplitude stylolites mostly follow inclined bedding planes Base unconformable.

Figure N-09-27. Tentaculitid limestone with distinct inclined lamination in base of Bluefish Member

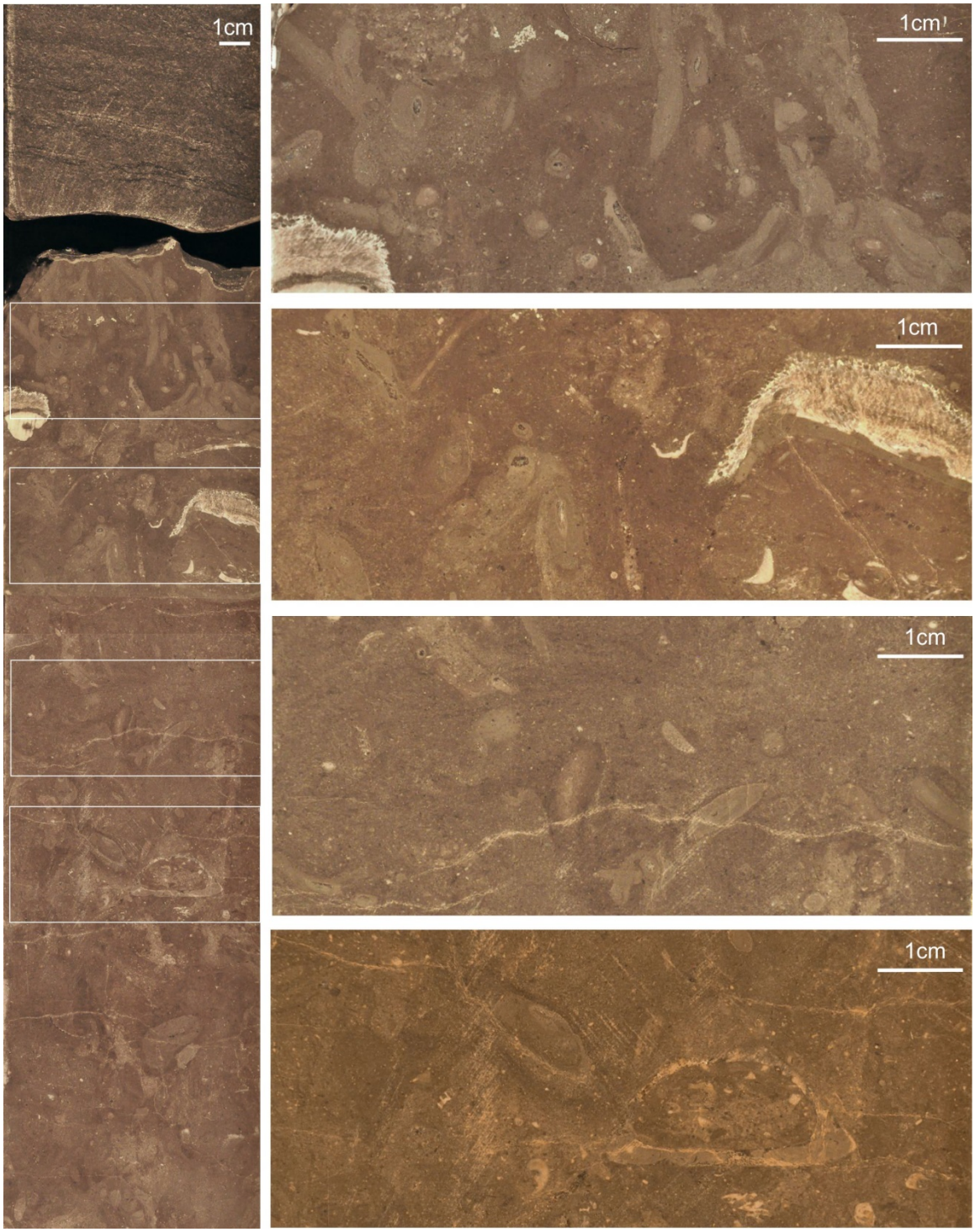

Figure N-09-28. Hume-Bluefish discontinuity with a hard-ground and rugged surface at 1828.6-1829.55 m MD; right column shows close-ups indicated by correspondent rectangles on the left column.

HUME FORMATION

1828.9-1829.4 Limestone: brownish gray, tight, hard, intensely bioturbated. Non-sorted bioclastic wackestones and packstones. Top rugged, presumably moderately phosphatized, penetrated by large (5 mm thick and up to 5 cm deep) curved borings or burrows. These borings/burrows are filled with greenish brown calcimudstone with weak and disappearing backfill patterns (Fig. N-09-28). Sections of such borings also occur below the upper 5 cm. Boturbation includes Scolicia/Asterosoma, ?very poorly preserved Zoophycos, and upright burrows. No signs of soft-sediment compaction. Skeletal assemblage includes (but not restricted to) thick finger-shaped bryozoans, rare pachyporid or alveolitid corals, rare crinoid ossicles, thin-shelled brachiopods and ostracods. Fossils are locally replaced by milky white chert stringers. No tentaculitid cones are detected. Base paraconformable or conformable (on top of synsedimentary breccia). Abundant finely dispersed pyrite grains in 5-7 cm below top.

1829.3–1832.0 Limestone: brownish gray, hard, crudely nodular, bioturbated, nodular (different from 1828.9-1829.4 m by nodularity and presence of infrequent stromatoporoids). Bioclastic packstones with minor rudstones and wackestones. Mass fragments of mollusks locally form churned-up coquinas. Diverse lamellar and bulbous stromatoporoids, bryozoans, alveolinid or pachyporid corals, pelmatozoan ossicles, etc. Nodularity is formed by non-compacted rounded to angular rock fragments separated by dark overcompacted marly partitions. Nodularity is mostly catagenetic but may inherit synsedimentary brecciation. Numerous curved v-shaped and sigmoidal fractures (sheer aspect deformation) cemented by milky white calcite. Top probably conformable, base very gradational.

1832.0-1834.75 Limestone: dark brownish gray, tight, fractured (same style of cemented fractures). Bioturbated bioclastic wackestones and matrix-rich packstones. Macrofossils: large infrequent corals and bryozoans in situ: Favosites, alveolinids, ?pachyporids; only one level with stromatoporoids – thin encrusting lamellar forms on syngenetically lithified surfaces. A bryozoan bafflestone with wackestone matrix occurs in 15 cm above base. Syngenetic lithification and episodic erosion of matrix is evidenced by intraclasts and rare encrusted benches (photo). Base gradational.

Figure N-09-29. Limestone with encrusting stromatoporoids and coral *Favosites*, 1832.7 m MD

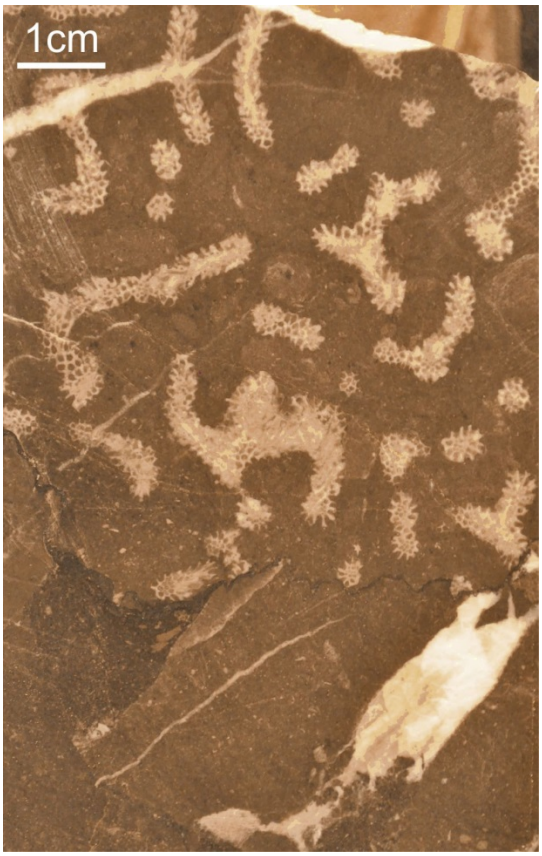

Figure N-09-30. Bryozoan bafflestone, 1833.65 m MD

1833.75-1834.50 Limestone: dark brownish gray, tight, weakly nodular, locally fractured. Coarse to medium grained bioturbated bioclastic packstones. Rare large (4 cm) intraclasts; rare amphiporas.

1834.50-1836.9 Limestone: brownish gray (light gray stromatoporoids and dark gray matrix), nodular and stylolitized. Stromatoporoid boundstones, minor bioclastic packstones in the middle. Bioturbated bioclastic packstones to wackestones as boundstone matrix. Rare mottles of incomplete dolomitization (dolomite < 1% of rock volume). Boundstone texture is indicated by numerous encrusted benches with oblique surfaces and complete lack of matrix compaction inside nodules. Fossil assemblage very diverse: lamellar, oncoidal and large bulbous stromatoporoids, rugose corals, diverse robust bryozoans, pachyporid corals, alveolitids, large amphiporas, tubular skeletal fossils, mollusks, minor brachiopods, ?charophytes. Various stromatoporoids dominate. Rare gravel-size lithoclasts in base. Base disconformable.

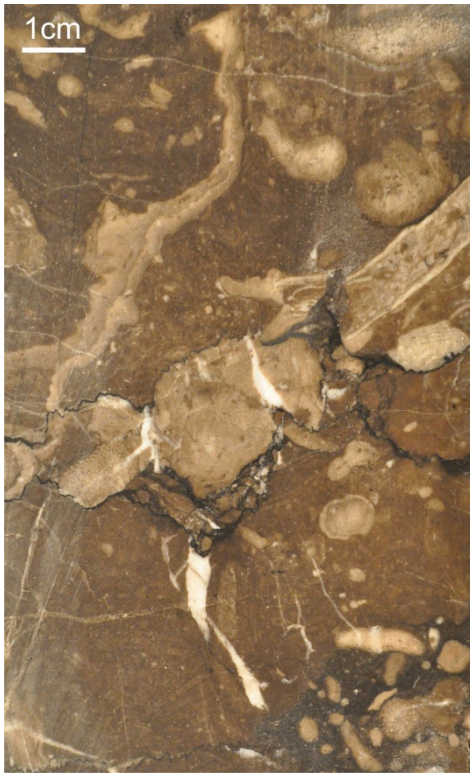

Figure N-09-31. Nodular fossiliferous limestone, 1836.3 m MD

1836.9-1837.4 Limestone: tight, brownish gray, lighter than above. Bioturbated bioclastic calcimudstone to wackestone with amphiporas in life position. Matrix is rich in calcispheres that are very abundant on some intervals. The limestone is karsted from top, stylobrecciated in upper 0.3 m, riddled with solution vugs and channels; the largest (3-5 cm) solution voids are filled with bioturbated bioclastic sediment from the onlapping facies; smaller (mm-scale) cavities are filled with catagenetic clear sparite or contain geopetal sediments. Faint coloration mottling in matrix: weak black staining inside matrix, locally distinctly haloeing around solution holes (‘quasicoatings’). Stylolites bear black insoluble residues. Base conformable.

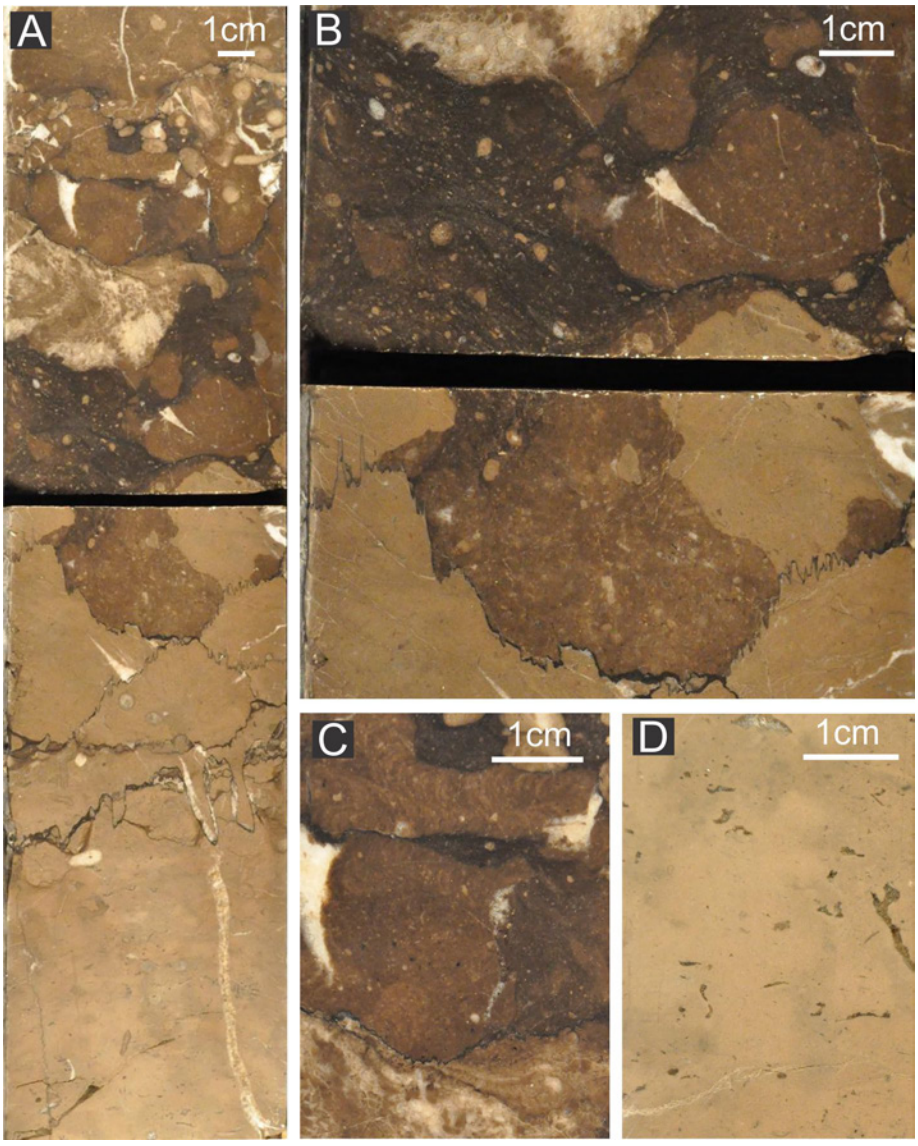

Figure N-09-32. Base of fossiliferous bioturbated limestone on intraformational karstic disconformity, 1836.9 m MD

1837.4-1837.8 Limestone: riddled with solution cavities, very similar to 1836.9-1837.4 m but with gently buckled laminar fenestral fabric in upper 15 cm. Below the lamination grades to bioturbated limestone. Texture: bioclastic wackestone with thick amphiporas and small oncoidal stromatoporoids. Fenestrae are also developed in the lower non-laminated part of the interval.