

Appendix 6. Illustrated core description, Loon Creek O-06.

UWID: 300/O-06-6510-12700/0 [NT]

STATUS: Susp (same as O&G Susp)

LAHEE: EXP

SPUD: 2013/01/26

DRILLED BY: ConocoPhillips Cda Rsrcs [C149]

Measurements in meters

Measured depth corrected to recovered core thickness

Core # 1 packed in 20 boxes: 0.71 m in Box 1, per 1.35-1.45 m in boxes 2-20. Box intervals as pre-marked on box bottoms.

IMPERIAL FORMATION

Canyon Creek Member

1622.0-1625.2 Mudrock: very dark gray to black, non to very weakly calcareous, subfissile silty shale with intercalated with distinctly laminated siltstone-shale intervals. These intervals show heterolithic lamination with flaser laminae of paler gray siltstone. Low visual pyrite content (rare small nodules and few "pyrite dust" The thickest (25 cm) heterolithic interval occurs at 1623.0-1623.25 m. rare elliptical calcite-enriched nodules; coaly plant detritus, including collapsed cm-sized plant fragments. A fine-grained sandstone lamina with thick sideritic (?) cement at 1622.3 m.

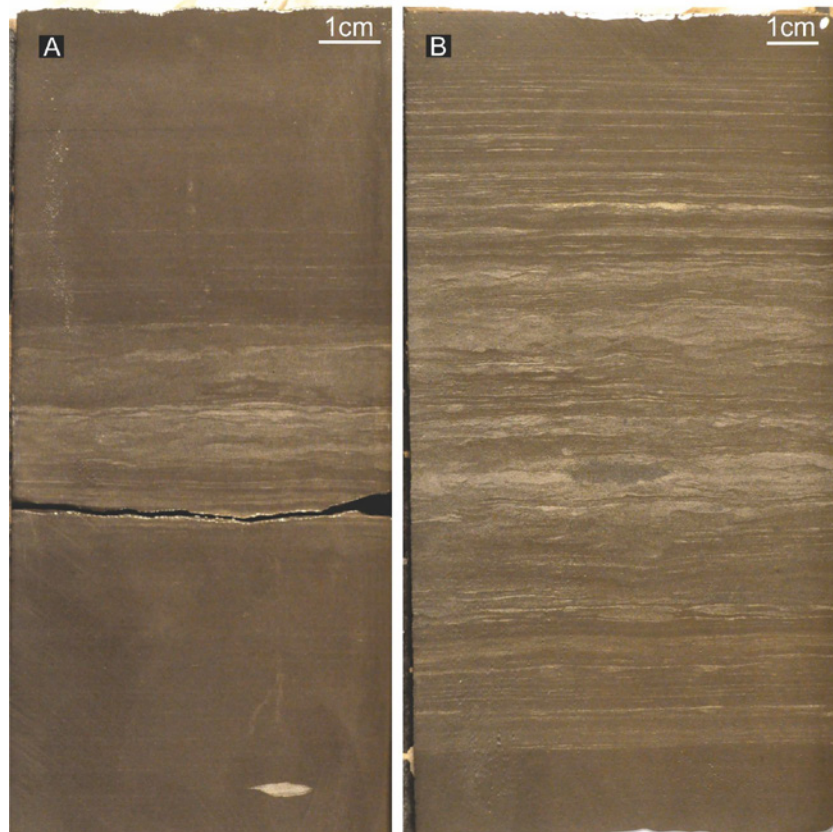


Figure O-06-1. Heterolithic lamination, (A) 1623.05 m MD, (B) 1624.5 m MD.

CANOL FORMATION

“Loon Creek member”

1625.2-1626.9 Mudrock: black, hard, non-calcareous, homogeneous silty shale, subfissile, with planar fissility planes; distinct from mudrocks above and below by elevated pyrite content (evenly dispersed “pyrite dust” and locally developed pyritic streaks). Small (< 1 cm) pyritic nodules are also present. Pyritic streaks define lamination. Straight pyritic filaments (pyritized sponge spicules?) are locally seen on bedding planes. A collapsed siliceous body (sponge?) at 1626.73 m.

1626.9-1627.46 Siltstone to mudrock: thin (0.5-2 mm) laminar “heterolithic” alternation of black shale and gray siltstone with important flaser features. Thin (1-2 mm) series of asymmetric ripples are common. Some thicker siltstone laminae in the middle of the interval seem to be bioturbated (shallow bioturbation, probably surficial crawling traces; BI 1-2). None to some calcareous material.

1627.46-1628.62 Mudrock: dark gray subfissile to fissile laminated silty shale with minor seams of laminated siltstone. The mudrock is enriched in well-preserved triaxonic and monaxonic siliceous spicules (photo). The unsorted siliciclastic material includes a

mixture of very fine whitish sand grains. The rock is relatively light-weighted and notably less pyritic than otherwise similar mudrock at 1625.2-1626.9 m. infrequent coaly detritus.

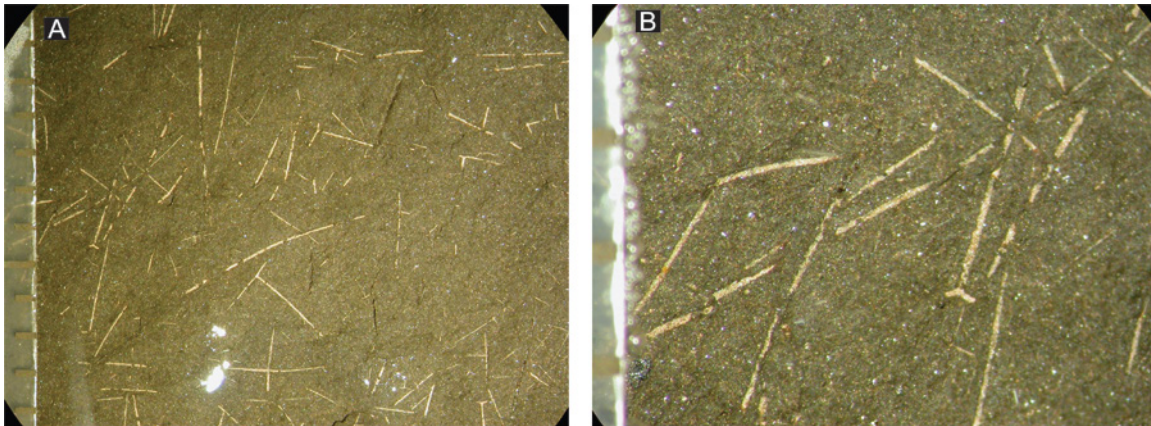


Figure O-06-2. Silicisponge spicules on bedding planes, 1627.9 m MD. Scale ruler on the left in mm.

1628.62-1629.05 Siltstone: dark gray, laminated (parallel to gently wavy to locally flaser lamination). Very similar to 1626.9-1627.46 m. Rare collapsed siliceous cm-sized bodies interpreted as sponges. Top and base are very gradational.



Figure O-06-3. Heterolithic lamination at 1628.9 m MD.

1629.05-1632.0 Mudrock: subfissile to fissile silty shale, homogeneous, laminated, slightly more fissile and more water absorbing than at 1627.46-1628.62 m, in lower half

slightly hardening and slightly less water absorbing. Very rare and small (1-3 cm) pyritic nodules. Silicisponge spicules are common in upper one-half and rare in the lower one-half. Infrequent coaly detritus.

1632.0-1633.1 Mudrock: very similar to 1629.05-1632.0 m but contains large ovoid early diagenetic calcareous nodules composed of microsparitic material. Fizzing of calcareous nodules is slow, indicating major admixture of cherty, dolomitic or sideritic material in the cementing matrix. Top and base by uppermost and lowermost nodule levels correspondingly. Some nodules contain pyritic concentric layers and late-phase upright stylolites (lateral pressure). The nodules make up 5-7% of the interval. Rare sponge spicules and very fine rounded sand-sized grains in mudrock matrix. ED-XRF data and spectra on this interval can be found in appendices 13 and 14.

1633.10-1639.93 Mudrock: very dark gray silty shale to shaly siltstone with admixture of very fine sand grains (pale gray and yellowish color subrounded grains), similar to the above but without calcareous nodules. Small (up to 2 cm) pyritic nodules and slightly harder, heavier-weighted rock at 1635.50-1636.30 m. Rare to common mm-sized coaly detritus on fissility planes, more common fine (<100 µm) black shiny particles, presumably coaly, in the mudrock matrix. Rare and small silicisponge spicules on fissility planes. The rock is notably homogeneous, fissile with deviations to subfissile, moderately water-absorbing, very evenly laminated (slight grain-size contrast between sub-mm thick laminae). An ovoid calcareous nodule at 1639.3 m.

1639.93-1639.96 Sandstone to shale: normally graded bed with erosional base, 1 cm thick basal sandstone-like seam grading upward into a 2 cm thick brick-red flaky, water-expanding and Al-rich shale. The latter has sharp geochemical (oxidation-front) top and overlain by dark gray shale with paler –colored laminae containing whitish grains. The grains in “basal sandstone” and in upper laminated shale are up to 0.7 mm in length, whitish and soft, can be sulphate crystals rather than detrital grains.

1639.96-1642.5 Mudrock: very dark gray, non-sorted (mud with admixture of very fine sand), subfissile (slightly harder than at 1633.10-1639.93 m), very homogeneous and slightly more monolithic (less fissile) than above. Microlamination is indiscernible (massive intervals) to very poorly seen. Rare to abundant silicisponge spicules, rare to common mm-size coaly fragments on bedding/fissility planes. Moderate to slow water adsorption. Rare and small pyrite nodules and stringers.

1642.5-1644.25 Mudrock: dark gray, similar to the above but more monolithic and more distinctly laminated due to thin (0.1 mm) pale gray siltstone laminae and lenses; several 5-15 cm thick intervals of siltstone-mudrock micro-alternation; two distinct brownish sandstone seams at 1642.7 m (2 cm thick, heavily pyritized) and at 1643.95 (1 cm thick, non-pyritized). Spicule meshes are occasionally preserved on fissility planes. Base at the base of the lowermost 15 cm thick interval of siltstone-mudrock micro-alternation. ED-XRF data and spectra across the sandstone seam can be found in appendices 13 and 14.

1644.25-1646.15 Mudrock: Similar to 1639.96-1642.5, homogeneous, evenly and faintly laminated, relatively hard and subfissile, with spicule meshes on some fissility planes, slow water adsorption, with rare small pyrite nodules.

1646.15-1646.37 Siltstone: hard, horizontally laminated, moderately calcareous to non-calcareous, dark gray with whitish laminae rich in calcareous material. Poorly preserved styliolinids in calcareous laminae; rare low-amplitude stylolites. No visual pyrites. Top and base are conformable and gradational.

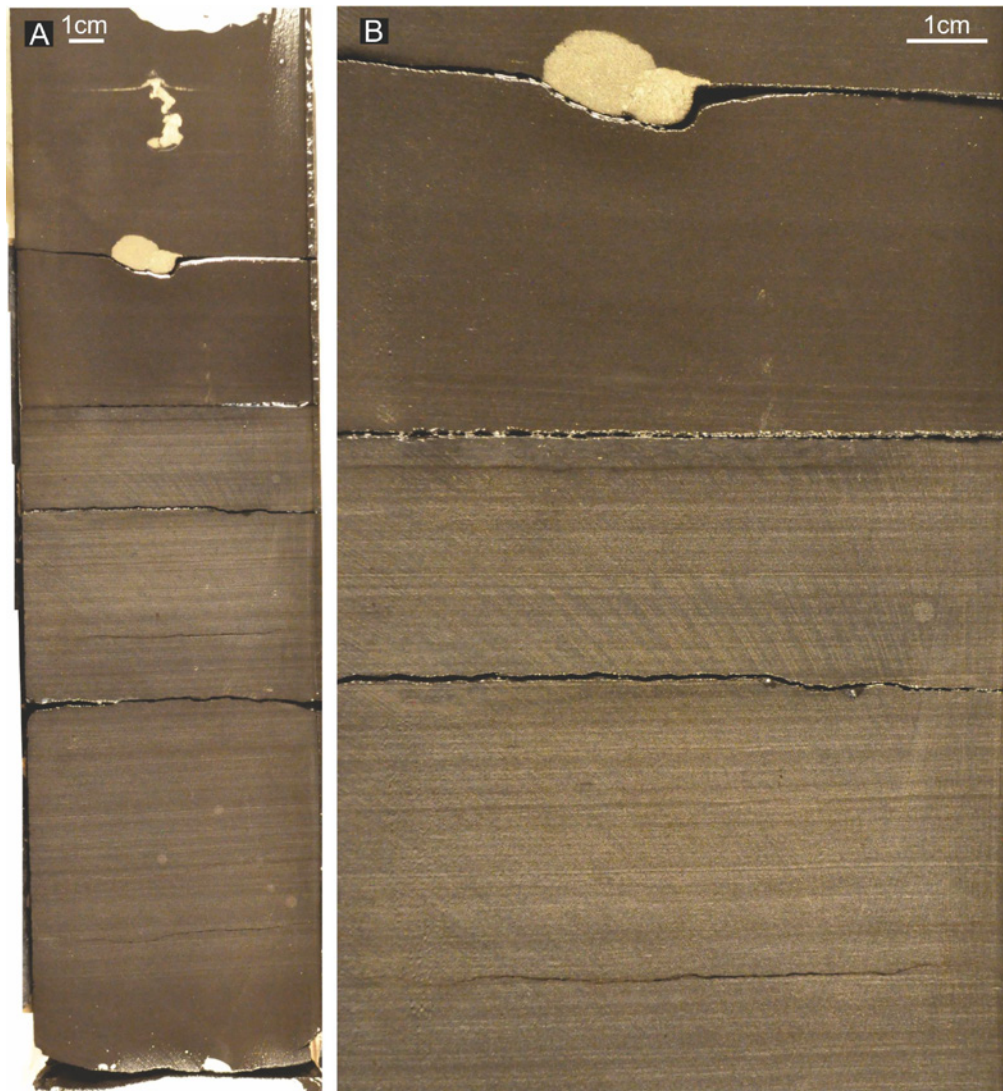


Figure O-06-4. Microlaminar siltstone overlain by dark mudrock with pyrite nodule (right image is the close-up of left image), 1646.37 m MD

1646.37-1647.75 Mudrock: hard, very dark gray to black silty shale; subfissile to monolithic, weakly to moderately pyritic (“pyrite dust” and tiny nodules), a 10 cm thick weakly calcareous laminated siltstone at 1647.0 m (facies very similar to 1646.15-1646.37 m). Silicisponge spicules on bedding planes are abundant in upper part and

decrease in number to rare to common in the base. Common cm-sized flat coaly fragments on fissility plane.

1647.75-1649.33 Mudrock: black, hard, homogeneous, non-calcareous, slightly heavier and more pyritic than above. Pyrite in the form of evenly dispersed “pyrite dust”, laminar streaks, rarely continuous laminae, and rare small nodules. The streaks and laminae appear as laminar concentrations of “pyrite dust”. Some fissility/bedding planes obtain conchoidal aspect (which is absent in the section above). Very slow water adsorption, no expanding clay shows. Rare to common silicisponge spicules. No more than ½ of all available bedding planes do not contain spicules at all. A 10 cm thick weakly calcareous laminated siltstone in the middle of the interval.

1649.33-1649.8 Siltstone: dark gray, moderately calcareous, less pyritic than above and below. Distinctly microlaminated due to whitish calcareous and siliceous particles; rare elongated particles can belong to poorly preserved styliolinids. Top and base are gradational.

1649.8-1651.67 Mudrock: black, homogeneous silty shale (with meager admixture of very fine sand), hard, monolithic and with many curved and upright trending conchoid fracture surfaces; relatively light-weighted; regular laminar pyrite streaks.

1651.67-1651.80 Argillaceous sandstone to sandy mudrock: very fine-grained, black, non-sorted, with sand-sized grains making the framework in top and base of the interval and the slightly muddier middle part. Lamination is very weakly expressed. Many sand grain are conspicuous by their pale whitish color. Base sharp and even but lacks obvious current-scour features. Pyrite content is visually low.

1651.80-1652.0 Mudrock: black, hard, sandy and silty subfissile shale to argillaceous siltstone, very homogeneous, with faint lamination, relatively light-weighted; relatively low pyrite content in the form of “pyrite dust”. Silicisponge spicules are extremely rare and pyritized.

1652.0-1652.6 Mudrock: black, hard, non-calcareous to weakly calcareous silty and sandy shale with increased bedding-denying conchoid fracturing; lamination is mostly faint but persistent, defined by paler-colored (cherty?) silt-sized particles and locally with pyritic streaks. Spicules are present in large number on few bedding planes; all spicules are pyritized.

1652.6-1653.25 Mudrock: very dark gray silty and sandy shale, subfissile (slightly more fissile than at 1652.0-1652.6 m), laminated, with lamination partly emphasized by pyritic streaks; no spicules are spotted on bedding planes; no conchoid-fracture features; small (< 1 cm) pyritic nodules. Top and base are very gradational.

“Mirror Lake member”

1653.25-1655.2 Mudrock: dark gray silty faintly laminated shale; lighter-colored than above, subfissile with minor fissile intervals, rich in water expandable clays, mostly non-pyritic (only with few pyrite blebs on fissility planes; rare to common coaly detritus; non-

calcareous with minor very weakly calcareous intervals; no sponge spicules. Top and base are gradational.

1655.2-1655.45 Mudrock: gray, relatively light-weighted silty shale, subfissile, slightly harder than above and with bedding-denying conchoid fracturing (more SiO₂ in rock matrix)

1655.45-1655.84 Sandy mudrock: gray, fissile, non-calcareous very fine-grained argillaceous sandstone grading into very sandy and silty shale; faintly laminated to almost massive, relatively light-weighted, water adsorbing; no pyrite other than rare and small (< 5 mm) pyrite nodules. No sponge spicules. Rare coaly detritus. Base gradational.

1655.84-1658.2 Mudrock: gray silty shale to argillaceous siltstone, fissile, rich in expanding clays (water adsorbing and dirty), faintly laminated; many fissility planes bear small (<1 mm) rounded finely crystalline pyritic “tablets” (macrophoto).

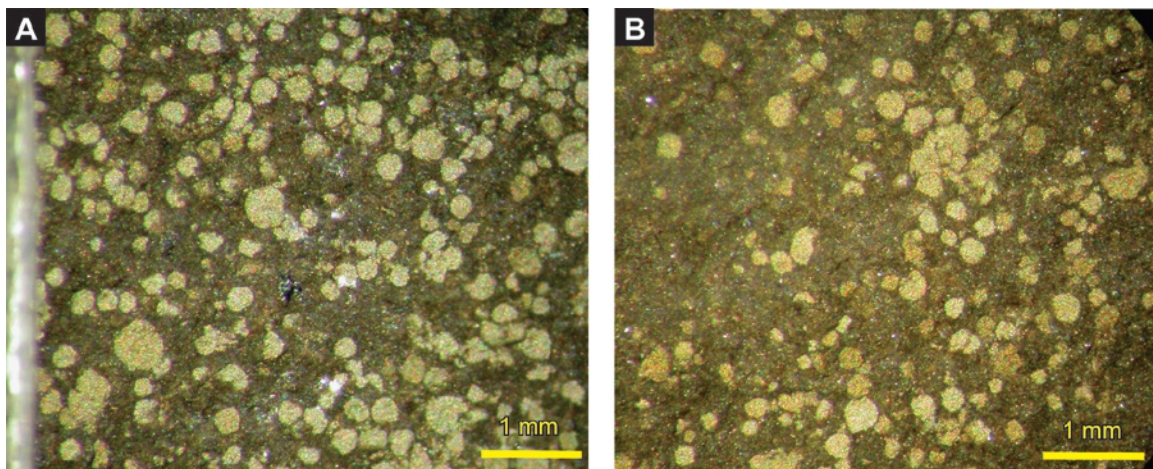


Figure O-06-5. Photomicrographs of fissility planes with pyritic tablets interpreted as pyritized *Tasmanites* s.l.: (A) 1656.85 m MD, (B) 1658.15 m MD

1658.2-1664.8 Mudrock: very similar to 1655.84-1658.2 m but without finely crystalline pyritic tablets on fissility planes. A normally graded fining-upward interval at 1659.00-1659.45 m (from shaly very fine-grained sandstone to silty and sandy shale). Minor deviations to argillaceous sandstone throughout the interval. Rare mm-sized flattened coaly particles; very rare small pyritic nodules. Rare pyrobitumen films on fissility planes.

1664.8-1665.0 Mudrock: dark gray fissile to subfissile silty shale to non-sorted argillaceous siltstone, similar to the above but with small pyritized sponge spicules on some fissility planes.

1665.0-1665.75 Mudrock: dark gray, subfissile to fissile; silty shale to siltstone with thin very fine-grained sandstone intervals; low pyritization, infrequent to common coaly detritus; very similar to 1658.2-1664.8 m.

1665.75-1667.0 Mudrock (siltstone): dark gray hard subfissile siltstone-dominated interval; slightly less water adsorbing than above; rare small (< 1 cm) pyrite nodules of different shape, but matrix visually contains no pyrite; fissility planes very even, planar; no sponge spicules; basal 30-40 cm are dominated in non-sorted very-fine-grained argillaceous sandstone. Base is gradational.

1667.0-1970.47 Mudrock: dark gray hard subfissile non-calcareous silty shale with minor argillaceous and sandy siltstones; faintly and evenly laminated, with smooth parallel fissility planes; no sponge spicules; pyritization is visually weak – rare streaks, small nodules, and cubic mm-sized crystals. Large coaly fragments retaining plant tissue morphology on bedding planes. No sponge spicules. Two completely pyritized 1 cm thick sandstone beds at 1667.75 m and 1670.1 m.

1670.47-1674.2 Mudrock: very dark gray hard subfissile silty shale to pure shale; alternation of pyrite-lean and pyrite-rich beds; the former make 2/3 of the interval, very similar to the facies at 1667.0-1970.47 m. The pyrite-rich intervals show pyrite “dust”, streaks and laminae and poorly formed pre-compactional pyritic nodules. Proportion of pyrite-rich intervals increases to base. Rare 0.5-1.0 cm thick pyritized graded siltstone beds; fissility planes somewhat rougher than at 1667.0-1970.47 m, with flattened conchoidal aspect; upright conchoid fractures are absent; no sponge spicules. Poorly preserved mm-sized flattened coaly detritus.

“Middle Resistant unit”

1674.2-1674.75 Mudrock: very hard, black, monolithic and homogeneous, with minor subfissile intervals; distinct by presence of pale gray tiny (0.01-0.15 mm) “stellate crystals” composed of non-calcareous material (dolomite? ED-XRF log available in appendices 13 and 14). Rough bedding planes; pyrite evenly dispersed as “pyrite dust”. Base by disappearance of “stellate crystals”.

1674.75-1675.0 Mudrock: very hard, homogeneous, very similar to 1674.2-1674.75 m except for absent “stellate crystals”.

1675.0-1676.0 Mudrock: very dark gray, hard, subfissile to fissile silty shale to argillaceous siltstone; moderate pyritization seen as “pyrite dust”; lamination mostly faint, a relatively monolithic interval in the middle looks almost massive due to its homogeneity. Rare, 0.5-2 mm in size, coaly detritus; rare small pyrite nodules. No sponge spicules.

1676.0-1676.95 Mudrock: black, hard, very homogeneous, non-calcareous monolithic silty shale with minor subfissile intervals; significant pyrite content (“pyrite dust”, minor streaks and rare intervals with pyrite nodules and laminae). Rough, sometimes flattened conchoidal bedding planes.

1676.95-1677.45 Mudrock (siltstone): very dark gray to black hard argillaceous poorly sorted siltstone; homogeneous, non- to weakly calcareous, monolithic to subfissile (splits into “hockey pucks”); evenly pyritized with abundant “pyrite dust” and pyritic laminar streaks; very poorly preserved styliolinids. Top and base are gradational.

1677.45-1678.05 Mudrock: hard monolithic non-calcareous shale very similar to 1676.0-1676.95 m.

1678.05-1678.25 Mudrock: brownish black, hard, calcareous monolithic shale; calcite resides in the forms of tiny (0.1-0.2 mm) stellate crystal aggregates bundled in coalescent laminae; visually less pyrite than above and below; poorly preserved styliolinids cones. This interval also has a low-amplitude upright stylolite.

1678.25-1681.0 Mudrock: black, monolithic to subfissile, with significant pyrite content as “pyrite dust” and streaks, with rare pyrite nodules and laminae, very similar to 1676.0-1676.95 m and 1677.45-1678.05 m. Very rare poorly preserved coaly fragments and streaks of pyrobitumen; are stellate calcite aggregates.

1681.0-1681.21 Mudrock: black, hard, moderately pyritized, alternation of calcareous and non-calcareous intervals. Calcite in calcareous intervals resides in laminar concentrations of “stellate aggregates”. Base at the distinct, 1 mm thick lamina of the bright brown silty shale (or siltstone) rich in expandable clay, this lamina has sharp even base and shows normal gradation (photo).

NB: Hard mudrocks below 1665.0 do not contain sponge spicules.

1681.21-1682.65 Mudrock: brownish black, hard, non-calcareous subfissile (“hockey pucks”), very homogeneous silty shale with minor argillaceous siltstone; lamination poorly seen, emphasized by pyrite streaks; evenly dispersed “pyrite dust” and whitish very fine siliceous grains (radiolaria?). the interval is dissected with characteristic upright fractures with rough walls.

1682.65-1686.8 Mudrock: brownish black, hard, non-calcareous, subfissile silty shale with minor siltstone intervals. Different from the mudrock at 1681.21-1682.65 m by lack of upright fractures and visually higher pyrite content in the form of regular pyritic streaks and locally continuous laminae. Fissility planes even, sometimes as flattened conchoid fractures. Rare upright fracture re-enter below 1684.8 m. Thin (1 mm) clay-rich brown siltstone laminae at 1685.1 m and 1686.9 m.

1686.8-1687.55 Mudrock: brownish black, hard, with frequent intercalations of weakly calcareous siltstones and fine-grained sandstones (graded beds); a 3 cm thick very calcareous interval with rich in authigenic stellate calcite aggregates in the middle. The mudrock shows pyritic streaks and is similar to the above (1682.65-1686.8 m); sandstone and siltstone interbeds contain large plant fragments (photo) and at least one fragment of the recrystallized calcareous shale, probably a brachiopod (photo).

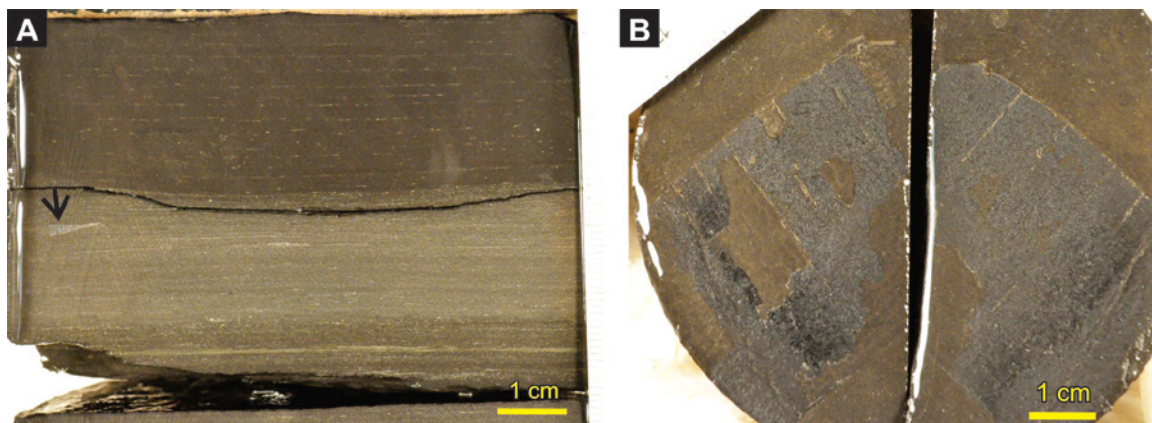


Figure O-06-6. Siltstone bed with an arrowed macrofossil fragment (A) and large plant fragment on bedding plane (B); 1686.93 m MD

1687.55-1692.4 Mudrock: hard, brownish black, subfissile, pyritic, with infrequent upright fractures in monolithic blocks, with rare and thin (1-3 mm) graded beds of very fine-grained variously calcareous sandstone; some levels enriched in radiolaria (photo). Pyrite forms regularly spaced (2 mm) laminae and streaks emphasizing lamination. Rare small pyritic nodules. The calcareous siltstones and sandstones are often stylolitized.

1692.4-1692.78 Siltstone: dark gray, distinctly laminated, very hard and monolithic, grading to very fine-grained sandstone. Collapsed pale-colored elongated fragments in the lower part – probably styliolinids; less pyritic than above and below 9only as evenly dispersed “pyrite dust”). Base is gradational.

1692.78-1698.2 Mudrock: hard brownish black silty shale intercalated by 0.1-2.0 cm thick chertstone laminae (radiolarites). Bases and tops of radiolarite laminate are stylolitized, rarely lined with stellate aggregates of authigenic calcite. The mudrock makes up 75-80% of the interval and varies from homogeneous to pyritic laminated (regularly spaced pyritic streaks and laminae). The radiolarite chertstone laminae make up about 20% of the interval; they are mostly massive inside, with grainy fabric, locally show weak normally graded structure. Rare thin (up to 1 cm) laminae of brown silty (micaceous) shale enriched in expandable clay (water adsorption) make less than 1% of the interval. Common upright fractures, some of them lined with thin (<0.1 mm) white calcite cement.

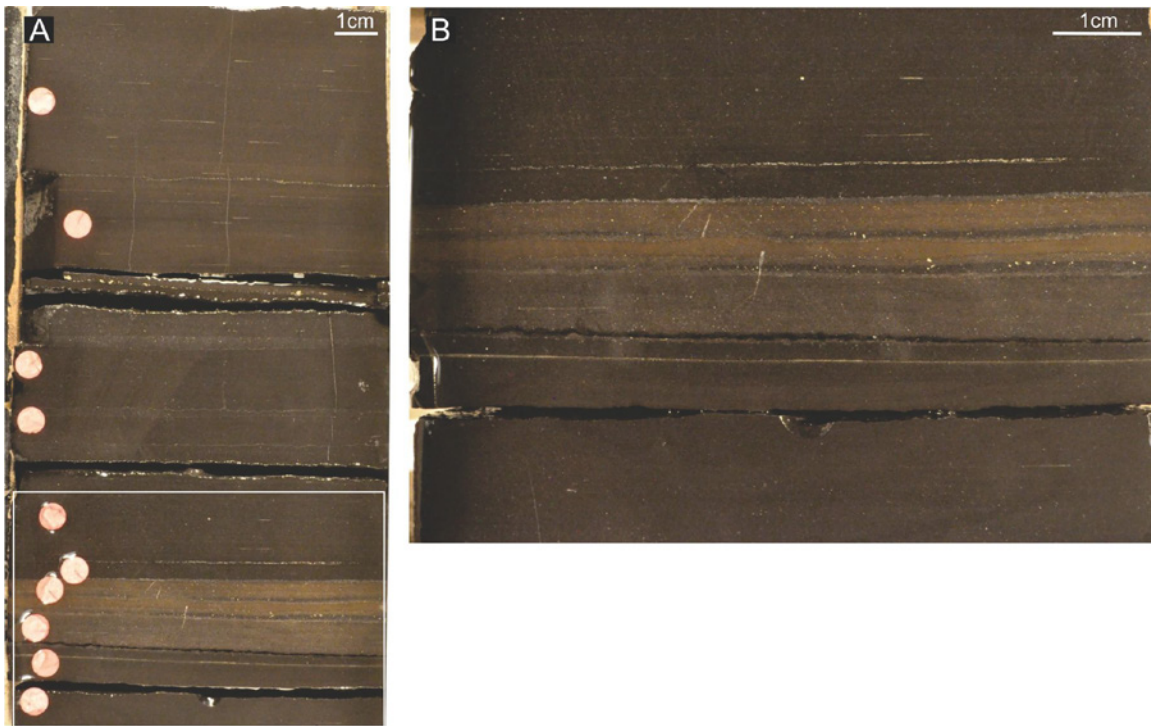


Figure O-06-7. Mudrock-chertstone alternation and a brown shale lamina, 1694.58 m MD. Sticky rounds on (A) are ED-XRF reading points.

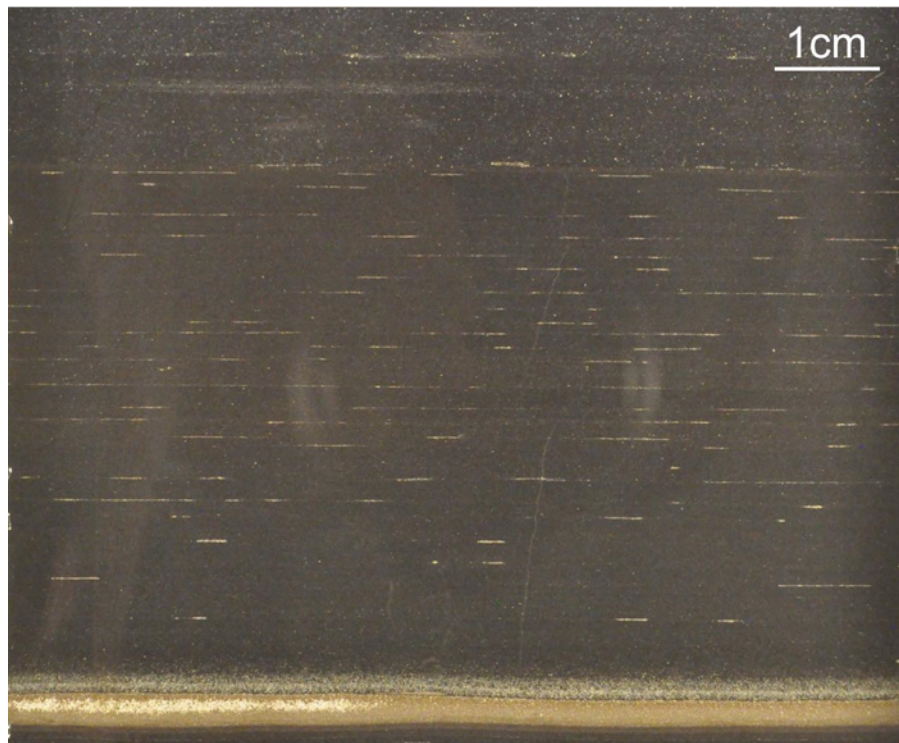


Figure O-06-8. Brown shale, pyritic mudrock and radiolarian chert laminae, 1695.23 m MD

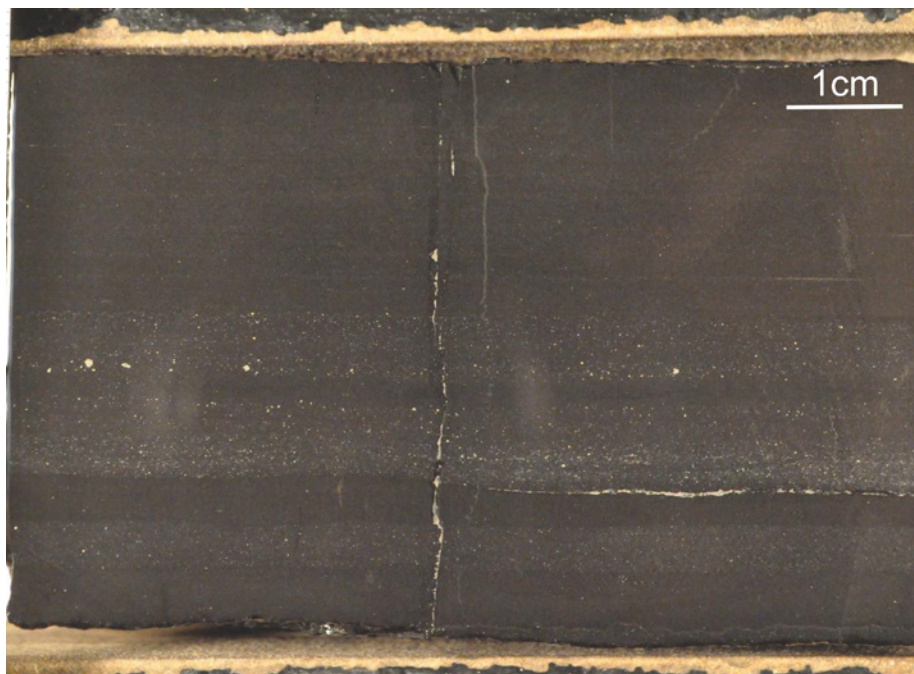


Figure O-06-9. Mudrock with radiolarite laminae and upright fracture, 1696.65 m MD

1698.2-1700.75 Mudrock: brownish black subfissile (“hockey pucks”) silty shale; mostly very homogenous, pyritic (steaks and “dust”), locally very homogenous and with obscure lamination; very rare and thin radiolarite chertstone laminae. A 3 cm thick horizon enriched in tiny stellate calcite aggregates in base.

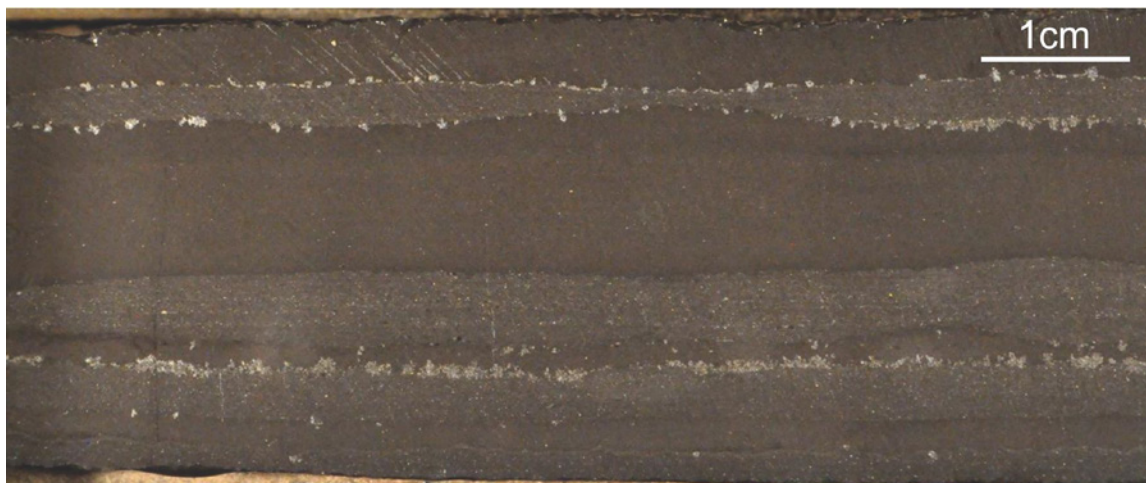


Figure O-06-10. Stylolitized radiolarian laminae lined by radial calcite aggregates; 1698.2 m MD

1700.75-1701.65 Siltstone: black, hard, subfissile, argillaceous and grading to mudrock (silty shale); fissility planes show rare small completely pyritized sponge spicules and poorly preserved plant detritus.

1701.65-1701.9 Mudrock: hard, brownish gray, monolithic and heavy (pyritic), with regularly spaced pyritic laminae.

1701.9-1706.9 Mudrock to chertstone: black, hard, brittle, non-calcareous, with variously developed upright and conchoid fractures, broken into shards at some intervals; distinctly lighter weighted than the mudrock at 1701.65-1701.9 m; some bedding planes are weakly stylolitized. Lamination emphasized by pyritic streaks. Radiolarite siltstone/chertstone laminae very rare in main part of the interval and become thicker and more frequent (up to 20%) in basal 0.7 m.

1706.9-1711.35 Mudrock-chertstone alternation: brownish black (mudrocks) to pigeon dark gray (chertstones); distinct from the above by less fracturation and subfissile (“hockey-puck”) jointing. Three types of rocks: (1) pyritic mudrock (silty shale to siltstone) with regularly spaced pyritic streaks and laminae, ca. 50% of the interval; (2) homogeneous lighter-weighted pelitomorphic mudrock to chertstone with occasional conchoid fracturing, 25-30%; and (4) radiolarite chertstone laminae, up to 2 cm in thickness, making 15-20% of the interval. Proportion of pyritic mudrock increases downward at expense of pelitomorphic mudrock to chertstone. Many bedding planes show low-amplitude pressure solution sculpture. All facies are non-calcareous. No sponge spicules.

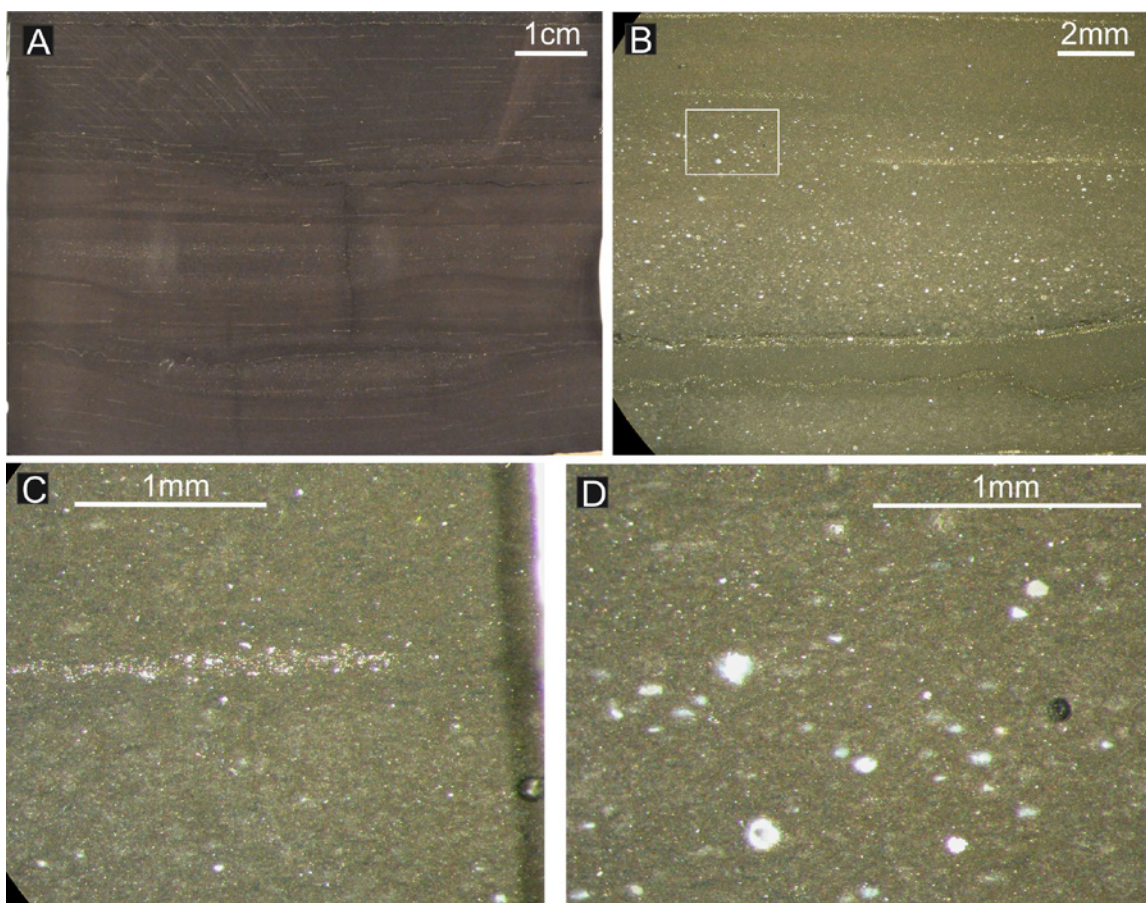


Figure O-06-11. (A) Alternation of mudrock and radiolarian chertstone; (B, C and D) close-up microphotos under binocular: (C) a pyritic streak, (D) radiolaria; 1709.4 m MD

1711.35-1711.5 Siltstone: dark gray, hard and monolithic, very weakly calcareous, enriched in paler colored grains (< 0.06 mm in diameter), grading to very fine-grained sandstone, microlaminated; top and base gradational; very similar to 1692.4-1692.78 m.

1711.5-1716.2 Mudrock: brownish black, very homogeneous, hard, subfissile to monolithic silty shale interbedded by thick (0.5-2 cm) laminae of radiolarite (chertstone with very fine sand-grade fabric). Pyrite content moderate to low, with only minor horizons of pyritic laminae and streaks. Light-weighted black monolithic cherty mudrock with conchoid fractures and numerous upright fractures occurs in minor quantity (10-15%) and mostly in the upper 2.0 m. Regular horizontal stylolitization throughout. A 7 cm thick very fine poorly sorted sandstone at 1714.7 m.

1716.2-1718.45 Mudrock: similar to 1711.5-1716.2 m except for disappearance of radiolarite chertstones, presence thin (1-2 mm) graded siltstone laminae, and less stylolitization. Extremely rare 1 mm thick laminae of brownish clay-rich shales. Top and base conformable.

1718.45-1718.65 Calcareous siltstone: gray, hard, monolithic, grading to argillaceous and silty limestone; laminated, less pyritic than above and below; top and base conformable.

1718.65-1720.43 Mudrock: brownish gray, subfissile, faintly laminated homogeneous silty shale; alternation of weakly calcareous and non-calcareous beds, the latter containing pyritic streaks. Rare radiolarite laminae and light-weighted cherty mudrocks with conchoid fracturing. The calcite resides in pale-colored silt-sized grains and also probably in matrix.

1720.43-1721.1 Mudrock to limestone: dark gray hard monolithic cherty and moderately calcareous mudrock in the upper half grading downward into muddy styliolinid limestone (fine laminar alternation and micritic marls and styliolinid coquinas). In basal 10 cm the styliolinid laminae are rare; base by the lowermost styliolinid lens. The styliolinids are not collapsed. Rare non-calcareous and cherty (conchoid-fractured) intervals and scattered pyritic laminae in the upper one-half. Lamination in upper part is emphasized by thin (0.1 mm) pale-colored laminae of calcareous siltstone and in the middle by styliolinid laminae. Possible bioturbation: some styliolinid laminae in the middle-lower part show light convolute disturbance – possible burrowing?

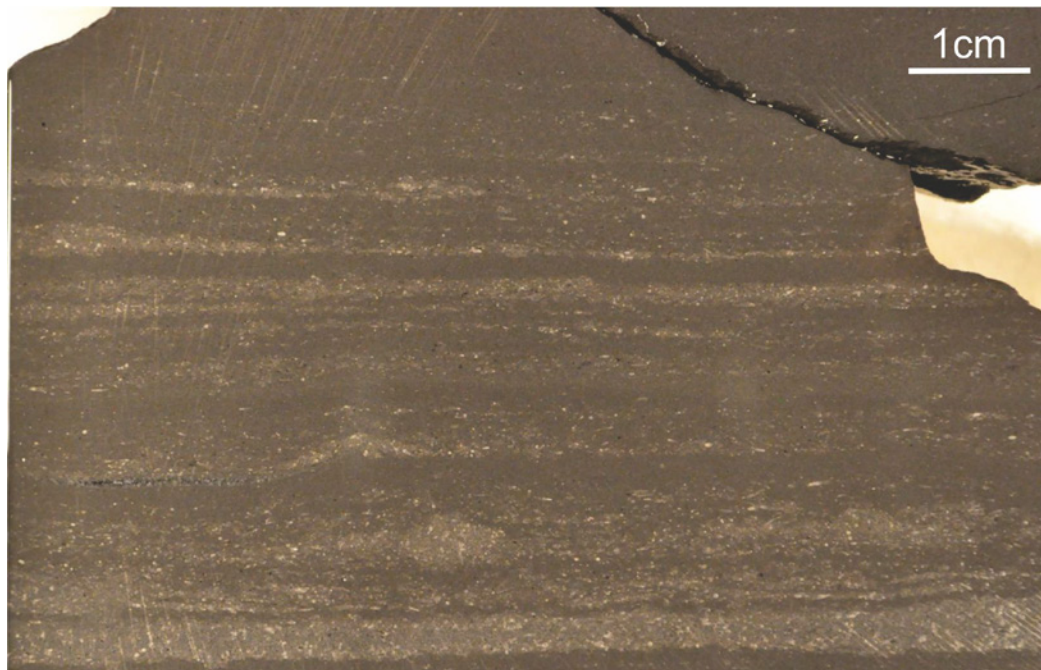


Figure O-06-12. Tentaculitid limestone grading to mudrock, 1721.1-1720.43 m MD

“Basal Recessive member”

1721.1-1724.73 Calcareous mudrock: very hard, monolithic, microlaminated and pyritic silty shale; lamination is emphasized by pale-colored calcisiltite laminae and pyritic streaks. Evenly dispersed “pyrite dust” throughout. Pelitomorphic matrix also contains minor calcite. Lenticular pre-compactional calcite microsparitic nodules in upper 30 cm and in basal 10 cm. Thin, oblique calcite-filled shear fractures associated with calcareous nodules.

1724.73-1725.00 Mudrock: hard, brownish black, non-calcareous, homogeneous, monolithic, pyritic (rare laminae, more frequent streaks and “pyrite dust”).

1725.00-1727.24 Calcareous mudrock: black, hard, monolithic to subfissile, laminated, weakly to strongly calcareous; calcite resides in pale gray calcisiltite laminae; less calcite resides in mudrock matrix. Rare large lenticular pyrite nodules. Rare pyrite streaks and very rare laminae.

1727.24-1727.29 Brown shale: a prominently thick seam of brown strongly pyritized shale disintegrated into shards with conchoid surfaces; fine-grained, with small (<0.15 mm) occasionally preserved crystal clasts, the basal part replaced by pyrite to form large lenticular nodule (m/photo).

1727.29-1731.30 Mudrock: silty shale with minor argillaceous siltstones; similar to 1725.00-1727.24 m. Very rare seams (1-2 mm thick) of brown to blue (gleyified) water-adsorbing shale. Contains graded rare upright fractures.

1731.30-1732.40 Calcareous siltstone to sandstone: very dark gray to black, weakly to strongly calcareous, microlaminated, very hard, monolithic to sub-fissile, in upper half containing pre-compactional lenticular calcareous nodules and split by upright open fractures. The upper half is an alternation of muddy siltstones and silty shales with very even bedding planes; lamination locally shows normally graded pattern. The lower half is more monolithic, dominated by similarly evenly laminated very fine-grained sandstone. Lamination is highlighted by distribution of whitish silt-size calcareous material. Rare pyrite streaks in upper half, no pyrite streaks in lower half. NB: no sponge spicules on bedding planes. Base is conformable.

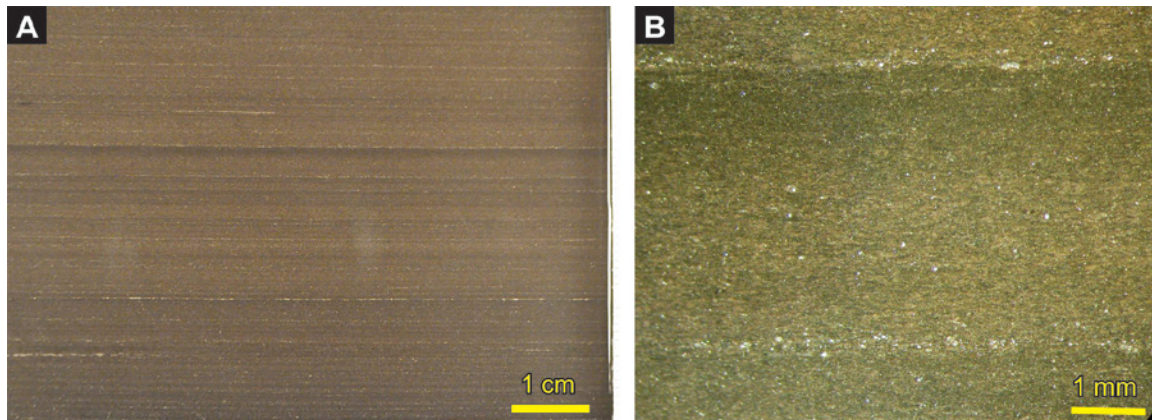


Figure O-06-13. Mudrock with micro-rhythms; (A) macro-image, (B) close-up of a micro-rhythm under binocular, 1731.42 m MD

1732.40-1736.05 Calcareous mudrock to siltstone: black, similar to the upper half of 1731.30-1732.40 m but with only rare upright fractures. Finer-grained weakly calcareous silty shale in uppermost 20 cm. Rare lenticular calcareous-pyritic nodules. Lamination is mostly defined by calcisiltite streaks and laminae. Evenly dispersed “pyrite dust” and rare streaks. Minor very poorly preserved small styliolinids. Base is very gradational.

1736.05-1737.60 Calcareous mudrock: brownish gray, subfissile, very homogeneous silty shale. Calcite resides mostly in matrix, fizzing dies out fast. Faintly laminated intervals (thin calcisiltite and pyritic streaks) alternate with very homogeneous intervals with obscure lamination. Evenly dispersed pyrite dust.

1737.60-1739.65 Very calcareous mudrock: hard, monolithic very dark gray silty shale to siltstone; moderately calcareous in top and grading downward into laminated argillaceous calcisiltite. Long upright fractures across the entire interval; some fractures filled with thin calcite sheaths.

1739.65-1740.60 Calcareous siltstone to limestone: dark gray to black, hard, monolithic to subfissile alternation of very calcareous siltstones, silty shales, and muddy calcisiltites. More distinct lamination than above due to more calcareous silt-size material. No upright fractures. No spicules spotted.

1740.60-1743.9 Calcareous mudrock: brownish black, homogeneous, faintly laminated, subfissile silty shale with two slightly more fissile 15 cm thick intervals at 1741.8 m and 1742.80 m where shale is disintegrated along rough conchoid surfaces. Pyrite only as evenly dispersed “dust” and small nodules. A large plant fragment at 1741.5 m. Pre-compactional pyritic-calcareous nodules in basal 20 cm.

1743.9-1744.2 Argillaceous silty limestone: very dark gray, grading in upper half into very calcareous silty shale; lamination defined by distribution of calcareous silt. Base and top gradational.

1744.2-1747.00 Mudrock: black, hard, subfissile silty shale to minor muddy siltstone; almost non-calcareous in upper 20 cm and weakly-moderately calcareous below; calcite resides in thin (0,1 mm) calcisiltite laminae and probably minor calcite in matrix. Rare lenticular pyritic-calcareous nodules. Pyrite mostly as evenly dispersed “pyrite dust”. Infrequent upright stylolites. Base is gradational.

1747.00-1747.3 Limestone to mudrock: very dark gray, very hard argillaceous microlaminated calcisiltite (laminar alternation of calcareous mudstone and limestone). Different from 1744.2-1747.00 m only by higher calcite content.

1747.3-1747.9 Calcareous mudrock: black, hard, subfissile, moderately calcareous, very homogeneous and cryptolaminated. Some bedding planes show low-amplitude stylolitization.

1747.9-1748.15 Limestone to mudrock: hard subfissile to monolithic microlaminated muddy calcisiltite similar to 1743.9-1744.2m. Elongated fragments included in calcisiltite laminae may represent styliolinids. Bedding plane cement is stylolitized.

1748.15-1757.75 Calcareous mudrock: brownish black, hard, microlaminated, subfissile silty shale to muddy siltstone, with minor deviations into muddy limestone (calcisiltite). The rock is slightly thinner-bedded (more fissile) than above. Lamination is emphasized by distribution of paler-colored calcisiltite and some collapsed styliolinids. Rare poorly formed pre-compactional calcareous nodules. Thin calcite-filled sigmoidal fractures and low-amplitude upright stylolites. Rare very thin (1 mm) laminae of pyritized brown shale. Pyrite occurs as evenly dispersed “dust”, scattered streaks and laminae. Numerous upright stylolites. Poorly formed pre-compactional pyritic-calcareous nodules (swellings) and one large (core diameter) nodule in the lower half of the interval. Styliolinids become more numerous to the base, and some bedding planes bear memes of collapsed styliolinids. Base is gradational.

NB: upright fractures with etched walls in overlying part of section are stylolites unless they are lined with white calcite cement.

1757.75-1758.05 Limestone: dark gray, hard and monolithic, distinctly laminated, argillaceous; the matrix is micritic or microsparitic; the interval stands out by presence of pinching laminae of non-compacted styliolinid cones reaching 2 mm in length. Top and base are gradational.

1758.05-1760.75 Calcareous mudrock: black, subfissile to locally fissile silty shale; generally more fissile and more calcareous than at 1748.15-1757.75 m. Calcite forms a continuous framework in a rock (HCl fizzing is not dying after 3 treatments). Common collapsed styliolinids, rare and poorly preserved collapsed coaly particles. Base is very gradational.

1760.75-1761.70 Limestone: dark gray, argillaceous, monolithic in upper part and subfissile in basal 30 cm; calcisiltite with admixture of styliolinid calcarenite. Few laminae are composed entirely of styliolinids. Different from the above by development of low-amplitude stylolites. Low pyrite content. A sharp (scour?) surface at 1661.43 underlain by darker, slightly more argillaceous and slightly more fissile marl/limestone. The lamination is gently inclined at 2-3° at 1760.85-1761.05 m indicating possible high-lambda hummocky cross-stratification. Base is gradational.

1761.70-1765.00 Mudrock: brownish black, hard, pyritic subfissile to monolithic silty shale; weakly calcareous (weak and rapidly dying HCl fizzing), with frequent large pre-compactional pyritic-calcareous nodules. Calcisiltite laminae with styliolinids are mostly rare, more frequent in the middle. Pyrite as regularly spaced (1-4 mm) streaks defining lamination and the lowermost pyritic-calcareous nodule. Straight upright stylolites are common; local presence of thin calcite-filled shear fractures. Base by decline of regular pyritic streaks.

“Prohibition Creek member”

1765.00-1778.7 Mudrock: brownish black, hard, very homogeneous, subfissile to monolithic shale, silty shale, and minor fine siltstone; weakly calcareous (same slow fizzing as above), with rare very calcareous laminae; different from 1761.70-1764.97 m by lack of regularly spaced pyritic streaks and no pyritic-calcareous nodules. Pyritic-calcareous nodules are rare and only in upper 2 m. Long upright stylolites as above. A hard very homogeneous monolithic calcareous shale (more calcite than above and below) at 1771.35-1771.70 m. Pyrite as evenly dispersed “dust” and small (<2 cm) nodules. Lamination indicated only by horizontally oriented calcareous particles (collapsed styliolinids?), otherwise the rock is very homogeneous and almost massive. Infrequent upright stylolites. Base indicated by a thick (3.5 cm) graded calcareous bed on plain scouring surface. Very rare pyritized sponge spicules in lower part of the interval. The bed is composed of very fine sand sized calcareous material (mostly non-styliolinids) with admixture of radiolaria.

1778.7-1786.45 Mudrock: very similar to 1764.97-1778.7 m; the upper half is very homogeneous and very weakly calcareous; the lower 4.5 m (1782.0-1786.45 m) is slightly more calcareous and contains very rare small pyritized sponge spicules and large pyritic-calcareous nodules. Large (3 cm) post-compactional dendritic pyritic nodules in basal 2.0 m (photo).

1786.45-1787.32 Limestone-mudrock alternation: dark gray muddy limestones (graded beds of calcisiltites-calcarenites) interbed with very calcareous black thinly subfissile shale. Three main thick (5-10 cm) limestone beds in top, at 1786.65-1786.75 m, and in

base. Calcite resides both in matrix and grains. The latter are mostly collapsed styliolinids, with admixture of non-identified very fine isodiametric grains, tiny pelmatozoan ossicles, and very rare thin-shelled ostracods. Graded calcarenite beds are also enriched in sand-sized mudrock intraclasts indicating erosion. Base is weakly erosional.

1787.32-1788.5 Mudrock: brownish black fissile to subfissile calcareous muddy micaceous siltstones to shales with slow water adsorption. A conodont found on fissility plane. Pyritization in the form of regular pyritic streaks, “dust”, and very rare cm-sized dendritic post-compactional nodules. Calcareous material resides in matrix and laminae-forming particles (collapsed styliolinids and unidentifiable calcareous silt). Base is gradational.

“Francis Creek member”

1788.5-1788.80 Sandstone: gray, hard, very fine-grained, monolithic, moderately calcareous, faintly laminated, in the middle almost massive. Top and base are conformable.

1788.80-1789.52 Mudrock: similar to 1787.32-1788.47 m but less calcareous to non-calcareous. Rare fish teeth and poorly preserved coaly impressions on fissility planes. A large pre-compactional elliptical to post-compactional dendritic pyrite nodule at 1789.30 m.

1789.52-1790.30 Shale: gray, notably fissile, soft, expanding in water and smelling clay, mostly laminated but with rare horizons of collapsed trace fossils, most likely *Chondrites* (photo); BI = 1. Texture on fissility planes characteristically flaky (photo). Rare poorly preserved styliolinid impressions. A 5 cm thick, hard monolithic graded bed of very fine-grained sandstone at 1790.05 m. A distinct 2 cm thick pyritic interval in top here pyrite resides in abundant (rock-forming) collapsed tablets 0.5-1.0 mm in diameter – these are most likely pyrite-replaced *Tasmanites*. Another horizon with pyritized tablets (including elongated ones) occurs at 1790.12 m. Rare poorly preserved coaly detritus.

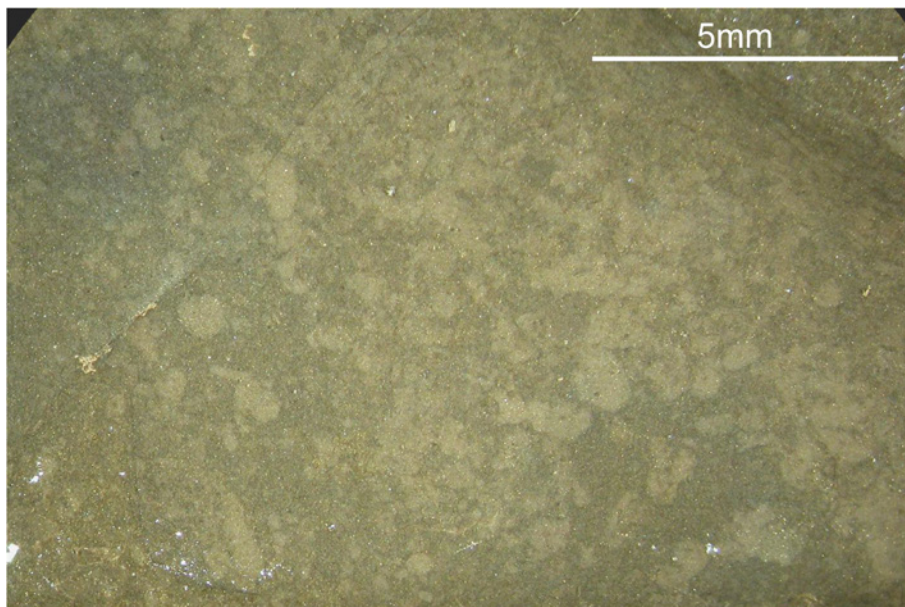


Figure O-06-14. Fissile shale with floccular fabric, 1789.6 m MD, scale in mm

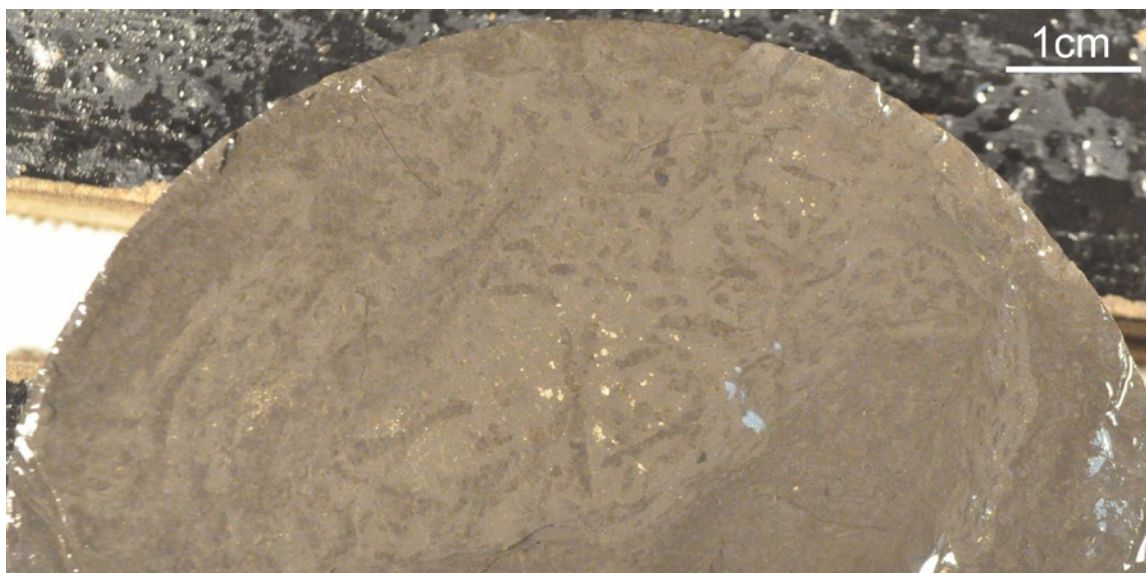


Figure O-06-15. Chondrites traces, 1789.7 m MD.

1790.30-1790.90 Sandstone: hard, monolithic, gray, very fine-grained, weakly calcareous, argillaceous (water expanding clays). Lamination discontinuous, defined on vertical surface by thin paler-colored lenticular structures (lenses); along bedding planes these structures appear irregular and flaky (possible interpretation: collapsed burrowing pattern). The lamination is more regular and continuous in upper 20 cm. A paler-colored 2 cm thick sandstone with weakly bioturbated top on planar scour surface at 1790.65 m. Poorly preserved coaly detritus. Increased clay content and gradation to muddy siltstone in base.

1790.90-1792.00 Shale: very dark gray, subfissile, non-calcareous, harder and darker colored than at 1789.52-1790.30 m; contains water-expanding clays. Lamination more distinct, defined by thin paler-colored clayey streaks. No clear signs of bioturbation. Characteristic feature: many fissility planes expose abundant small (0.2-0.3 mm) black tablets (*Tasmanites*). Coaly detritus may be present as well. Two paler-colored silt enriched levels in upper part. Base is very gradational.

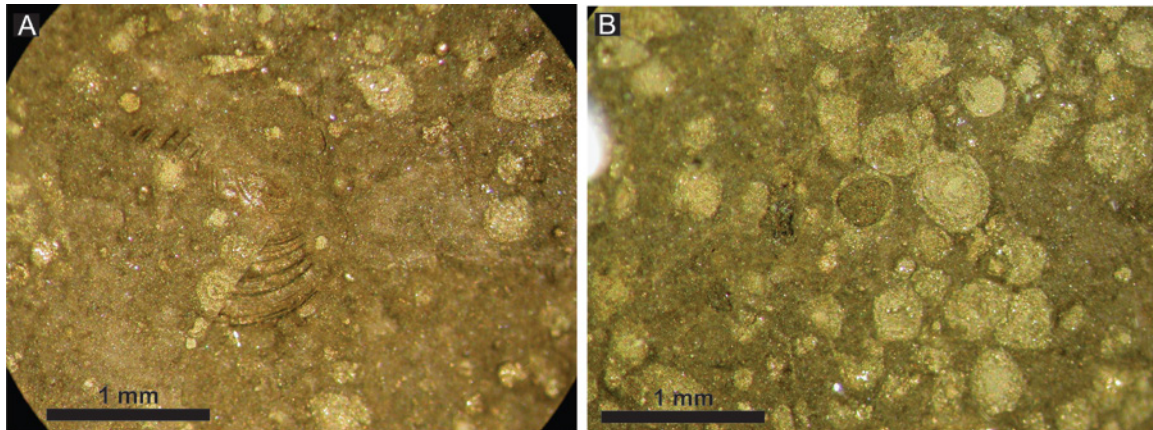


Figure O-06-16. An inarticulate brachiopod (A) and pyritized acritarchs *Tasmanites* s.l. (A and B) under binocular, 1790.0 m MD

Bluefish Member

1792.00-1794.15 Mudrock: black, hard, weakly to non-calcareous, subfissile to monolithic, locally moderately pyritized (streaks and “dust”). The lamination is defined by paler-colored streaks. Mass *Tasmanites* and occasional tiny pyritized sponge spicules on bedding planes. Top and base are gradational.

1794.15-1795.75 Mudrock: very dark gray non-calcareous to weakly calcareous silty shale to minor muddy siltstone; hard subfissile in top and base and more fissile in the middle. Different from 1792.00-1794.15 m by paler color, more pronounced water adsorption and better fissility. Fissility planes contain *Tasmanites* pavements, some also collapsed styliolinid meshes. Rare calcareous laminae associated with styliolinid pavements. Pyritic streaks are locally developed. Base is gradational, by decline of HCl fizzing.

1795.75-1796.00 Siltstone: calcareous, very hard, monolithic, homogeneous, fossiliferous (styliolinid pavements, in lower half common valves of small (< 1 cm) articulate brachiopods. All fossils are strongly pyritized. Rarely styliolinids occur in upturned position indication rudimentary bioturbation (BI=1). Base is conformable.

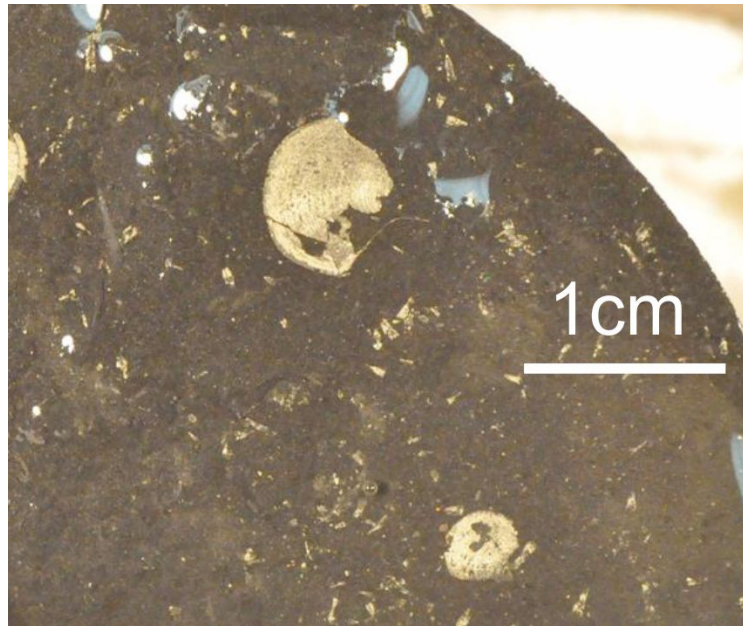


Figure O-06-17. Pyritized brachiopods, 1795.95 m MD

1796.00-1797.80 Mudrock: black hard subfissile weakly to strongly calcareous laminated silty shale with moderate content of water-expanding clay. Characterized by mass styliolinids forming pavements on most fissility surfaces (preserved as impressions, less frequently as collapsed shells). The lower one-half contains fewer styliolinid pavements and more *Tasmanites*. Small (1-3 cm) pre-compactional elliptical and post-compactional dendritic pyrite nodules. Rare large (0.5-2.0 cm) coaly fragments.

1797.80-1798.5 Sandstone: dark gray to almost black, hard, monolithic, calcareous, very fine-grained and grading to siltstone in upper 20 cm, fine-grained in the lower one-half. Non-collapsed styliolinids. Common to abundant *Tasmanites*. Lamination is poorly seen. No indications of bioturbation. Base indicated by rapid although gradational (1-2 cm) change in granulometry with no erosion surface.

1798.5-1799.9 Mudrock: hard brownish black subfissile to monolithic weakly calcareous silty shale to muddy siltstone; enhanced pyrite content in the form of regularly spaced (1-2 mm) thin (0.1 mm) pyritic laminae. Rare pyritized and calcareous styliolinid pavements; very rare pyritized *Tasmanites* pavements. No sponge spicules. Base is gradational.

1799.9-1800.0 Sandstone: very fine-grained, identical to 1797.80-1798.5 m. Pyrobitumen streaks and styliolinid pavements; *Tasmanites* rarely preserved.

1800.0-1803.25 Mudrock: black calcareous subfissile silty shale with pale gray calcareous laminae; frequent intercalations of 1-7 cm thick styliolinid limestones; rare thin (2-4 cm) beds of very fine-grained calcareous sandstone. Styliolinids are less compacted to non-compacted. Thicker styliolinid limestones show graded structure with chaotically piled cones in basal parts. Some limestone seams contain relatively large (up

to 1 cm long) cones with well-preserved internal structure. A limestone bed in 3.0 cm above base contains common admixture of crinoid ossicles and thin-shelled brachiopods.

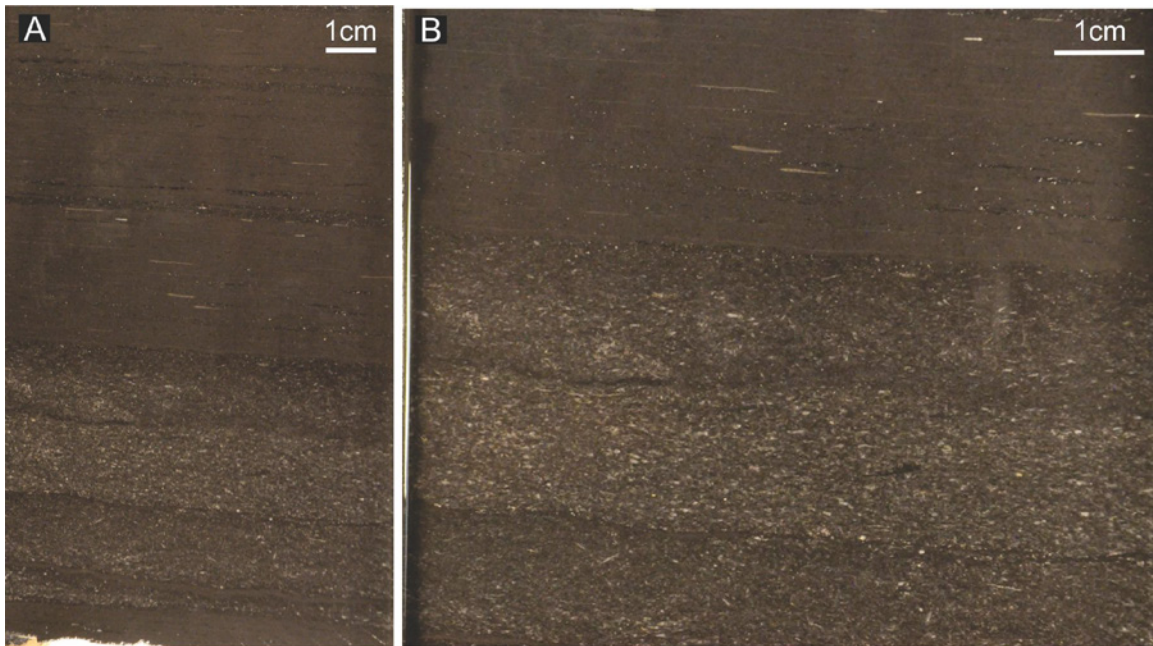


Figure O-06-18. Graded tentaculitid bed and thinner seams in laminated shale, Bluefish Mb., 1800.05 m MD. (B) is a close-up of (A).

1803.25-1803.45 Cone-in-cone limestone: dark gray, with thick vertically radiating crystal fans in top and base and with finer crystalline pattern in the middle. Authigenic origin indicated by displacive growth pattern in the most mudrock.

1803.45-1806.00 Calcareous mudrock : black, hard, weakly to strongly calcareous silty shale with frequent gray limestone interbeds. Abundant styliolinids; alternating beds with collapsed styliolinids (mudrocks) and non-collapsed styliolinids (marls to limestones with micritic matrix). Rare large (> core diameter) plant fragments. The styliolinid seams are most frequent and the thickest (0.5-2 cm) in lower half (1805.30-1806.00) m. No signs of bioturbation.

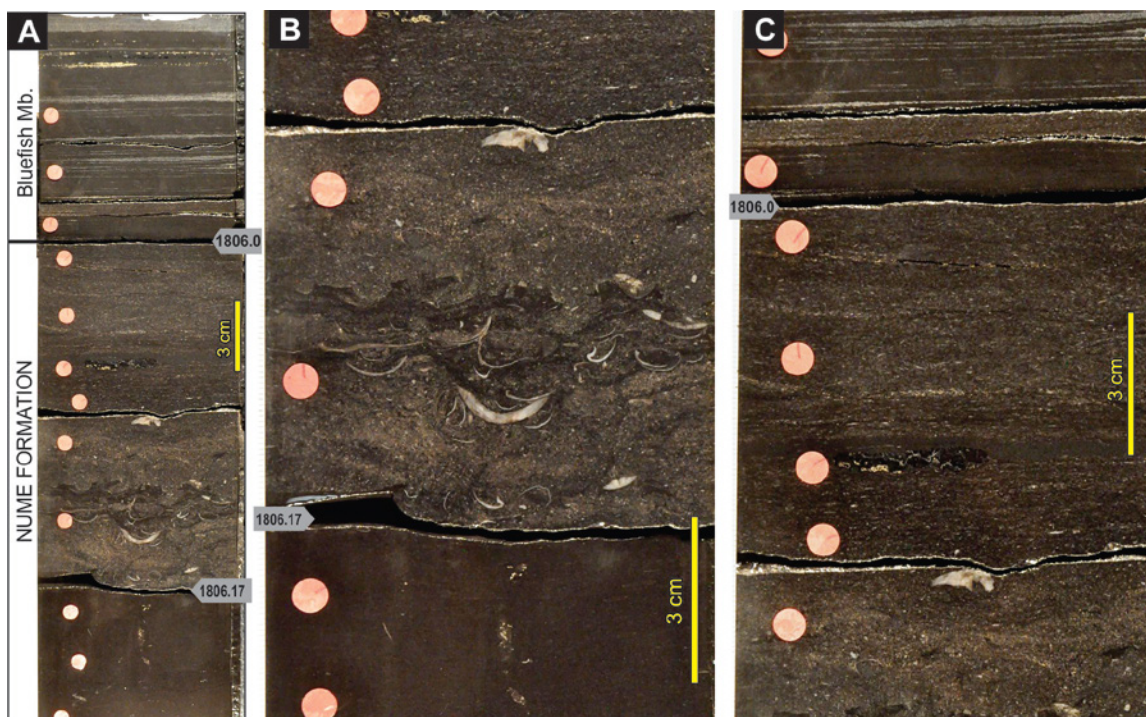


Figure O-06-19. Hume-Bluefish contact, 1806 m MD. Red circles are ED-XRF reading points (Appendix 13). (B and C) are close-ups of (A).

HUME FORMATION

1806.00-1806.17 Limestone: dark gray, hard, argillaceous, with stringers of dark shale; bioclastic matrix-poor packstone; the facies changes gradually from top to base: laminated fine-grained styliolinid packstone with rare brachiopod and crinoid fragments in upper half to predominantly benthic (brachiopod-pelmatozoan) medium-grained (0.2-0.3 mm) packstone in lower half. Styliolinids are predominantly horizontally oriented in upper 5 cm and chaotically piled below; BI increases from 2 in top to 3-4 in base. The basal 5 cm show brachiopod coquina (rudstone) with bivalve and disarticulated convex-up brachiopods. Base is sharp, undulating, probably erosional.

1806.17-1806.47 Limestone: dark brownish gray, moderately argillaceous calcimudstone, in upper one-half pyritic (dispersed “pyrite dust” and pyritized thin-shelled bioclasts). Facies gradually changes from top to base: upper 5 m is darker colored, with bioclast component dominated by styliolinids showing horizontal orientation (preserved lamination, BI=2). Below facies changes to bioturbated calcimudstone with very few thin-shelled fragments of benthic fossils (ostracods and/or brachiopods) and only solitary in-situ brachiopod (small form) and a disarticulated brachiopod valve. The lower 15 cm is prominently bioturbated with deep burrowing pattern but contain almost no bioclasts. Base is conformable.

1806.47-1806.70 Limestone: dark brownish gray, moderately argillaceous and weakly pyritic (dispersed “dust” and partly pyritized shells), hard, mostly non-compacted, bioturbated with deep superimposed burrows; brachiopod floatstone with some in situ

brachiopods. Other fossils: Lingula (and possibly other phosphatic inarticulates), fish sclerites, rare thick ramiform bryozoans and trilobites. Matrix composed of tight homogeneous micrite.

1806.70-1807.18 Argillaceous limestone: dark, similar to 1806.47-1807.70 m but fissile throughout and with more fossils. Numerous phosphatic brachiopods. Base is likely conformable.

1807.18-1807.60 Limestone: brownish gray, hard, monolithic, vigorously bioturbated (BI=6), bioclastic calcimudstone in top and grading to packstone-wackestone to base. Diverse macrofossils including brachiopods, trilobites, crinoid ossicles, bryozoans.

1807.60-1809.65 Limestone: mottled brownish gray, partly nodular due to differential compaction; bioclastic packstone with stromatoporan-pachyporid bafflestone patches. Very diverse fossil assemblage including cm-sized encrusting pachyporid corals and stromatoporoids, bryozoans, large massive calcisponges, brachiopods, trilobites, pelmatozoan fragments. Base situated at the fractured zone.

End of description.