

Appendix 7. Illustrated core description, Mirror Lake N-20.

UWID: 300/N-20-6500-12645/0 [NT]

STATUS: Susp (same as O&G Susp)

LAHEE: OTH

SPUD: 2013/02/25

DRILLED BY: ConocoPhillips Cda Rsres [C149]

IMPERIAL FORMATION

Measurements in meters

Measured depth corrected to recovered core thickness

1891.5-1899.43 Shale: gray, fissile, expanding in water, with minor silty and sandy intervals; lamination (as defined by lithological contrasts) is mostly lacking, but no obvious trace fossils. Fossils: mm-sized petal-like, fingerprint-looking fish scales (rare to common); rare small bivalves; rare possible fragments of brachiopods and collapsed orthocone cephalopods; one probable tentaculitid cone. Rare to common coaly detritus including cm-sized fragments. Shells are preserved as impressions stripped of CaCO_3 , covered by thin water-repellent films. Rare paler-colored 2-3 cm thick seams of muddy fine-grained sandstones (e.g., at 1896.54 m). Pyrite is rare, mostly as sub-mm sized grains and crusts. The color moderately darkens downward. Lower one-half contains more tentaculitid cones. Base is gradational.

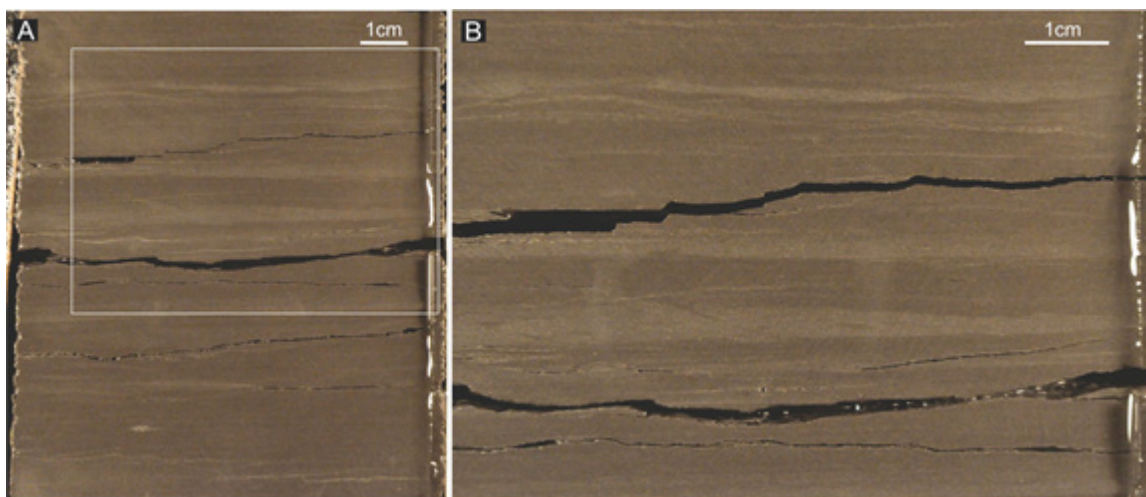


Figure N-20-1. Fissile homogeneous shale with lightly disturbed lamination, 1896.35 m MD; (B) is a close-up of the rectangular area in (A).

1899.43-1899.6 Mudrock: dark gray, subfissile, with admixture of very fine sand (or radiolaria?), calcareous in top and weakly calcareous, less sandy in base; the 4 cm interval in top is harder and prominently calcareous; lamination is obscure, betrayed locally by horizontal orientation of elongated shells. Pavements of “fingerprint microfossils”, collapsed tentaculite cones, and coaly particles on fissility planes. Base indicated by disappearance of sand admixture and decline of calcareous streaks.

1899.6-1902.0 Shale: gray to dark gray, fissile, with or obscure lamination, similar to 1891.5-1899.43 m and with same fossil assemblage. Rare small (1-2 cm) lenticular pre-compactional calcareous nodules. Few levels with large collapsed coaly plant fragments.

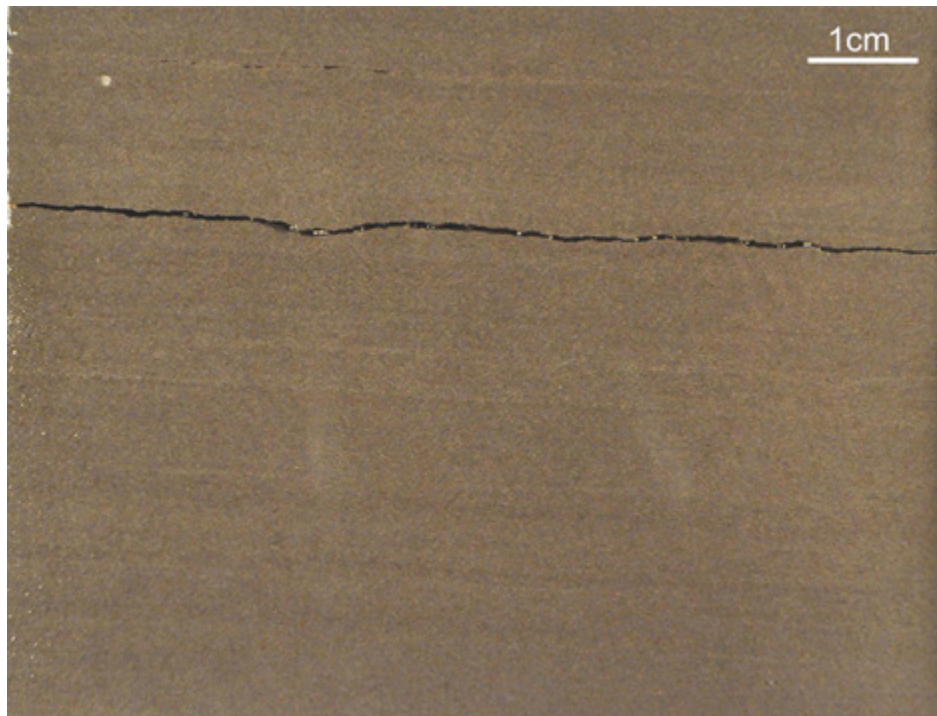


Figure N-20-2. Fissile silty shale, 1901.1 m MD

1902.0-1902.15 Mudrock: harder than shale above, very similar to 1899.43-1899.6 m and similarly moderately calcareous. Horizontal lamination is more distinct than in the shale above. Top and base are gradational.

1902.15-1904.9 Shale: dark gray, fissile to subfissile, mostly non-calcareous, slightly harder than above; partly shows more distinct lamination due to weak lithological contrasts (paler and darker shale). Minor 5-7 cm thick weakly calcareous intervals. Fewer bedding planes with fish scales; fossils preserved as collapsed casts/impressions: very

rare bivalves; ostracods (occasionally numerous); common large plant fragments; small goniatites and orthocone cephalopods; probably tentaculitids. Base contains more of the harder weakly calcareous intervals marking transition to the underlying Canyon Member.

Canyon Creek Member

1904.9-1905.9 Mudrock: dark gray, hard, subfissile (“hockey-pucks”) with minor monolithic intervals, weakly calcareous; cryptolaminated silty shale and minor argillaceous siltstone; contains significantly less expanding shale than above. HCl fizzing dies rapidly indicating isolated calcite grains in non-calcareous (siliceous?) matrix. Fissility/bedding plains are planar, locally with low-amplitude solution sculpture; large plant fragments; infrequent surfaces with paved with ostracods; rare fish scales. Low pyrite content as small (mm-sized) pyrite nodules. A 25 cm thick laminated monolithic very fine-grained muddy sandstone in base; upward this sandstone grades into silty mudstones and siltstones. The base is conformable.

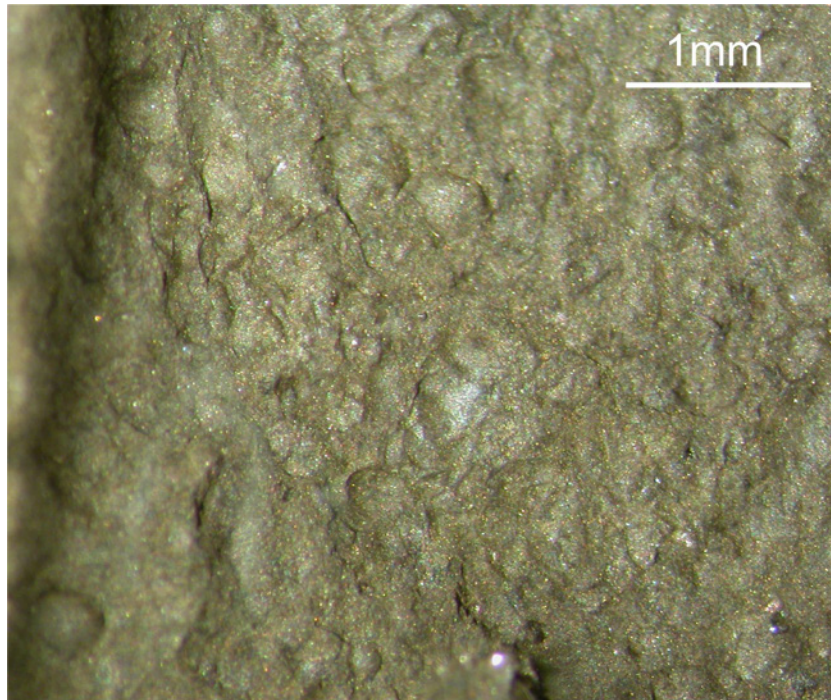


Figure N-20-3. Ostracod pavement on bedding plane, binocular microphoto, 1905.16 m MD; scale ruler on left in millimeters.

1905.9-1907.1 Mudrock: very dark gray (almost black), thinner subfissile to fissile, non-calcareous, silty shale with fish scales, plant fragments, and several levels with pavement-forming ostracods. Same proportion of pyrite. Gradation to muddy siltstone in base.

1907.1-1907.87 Mudrock-siltstone alternation: hard, subfissile, weakly to non-calcareous, gray to dark gray, distinct by heterolithic lamination (paler-colored siltstone laminae in dark mudrock). Vertical core surface shows common lenticular cuts of distributary channels. No sponge spicules.

1907.87-1908.37 Mudrock: gray silty and sandy laminated fissile shale; more homogeneous and with fewer pale gray siltstone laminae than at 1907.1-1907.87 m.

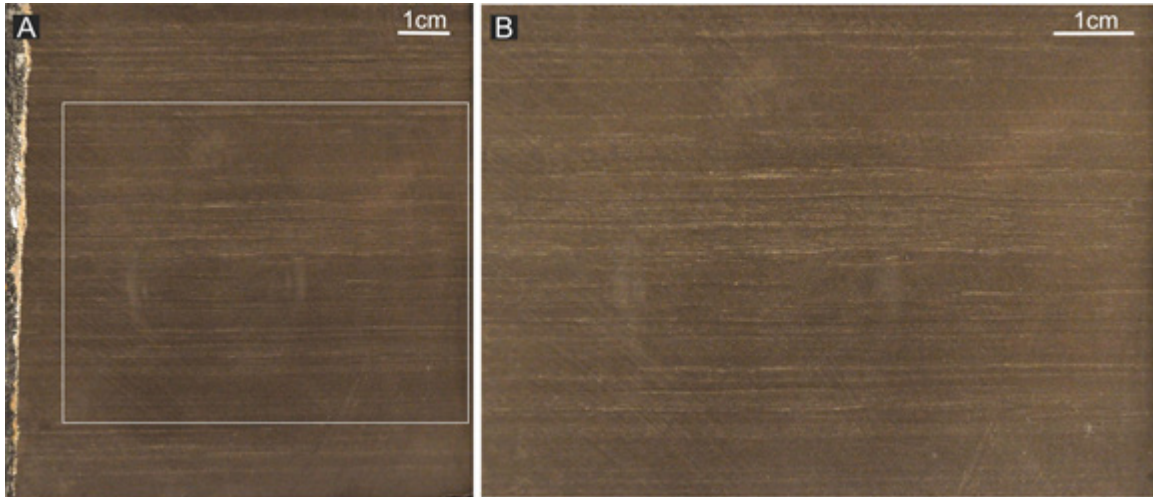


Figure N-20-4. Muddy siltstone, 1908.35 m MD

1908.37-1910.40 Mudrock-siltstone alternation: hard, subfissile, very similar to 1907.1-1907.87 m. A lenticular pale gray carbonate nodule at 1910.15. Rare small post-compactional (thick-dendritic) pyrite nodules. Rare mm-sized coaly detritus; very rare small sponge spicules.

CANOL FORMATION

Loon Creek Member

1910.40-1910.75 Mudrock: hard subfissile to monolithic dark gray silty and sandy shale with minor pale gray siltstone laminae; distinct by presence of lenticular (tablet-shaped) sparitic carbonate nodules. These nodules have slow fizzing (some layers are not fizzing) and XRF tracer readings with CaO around 12%, Fe₂O₃ 7-8%, S 3%, and negligible Mg.

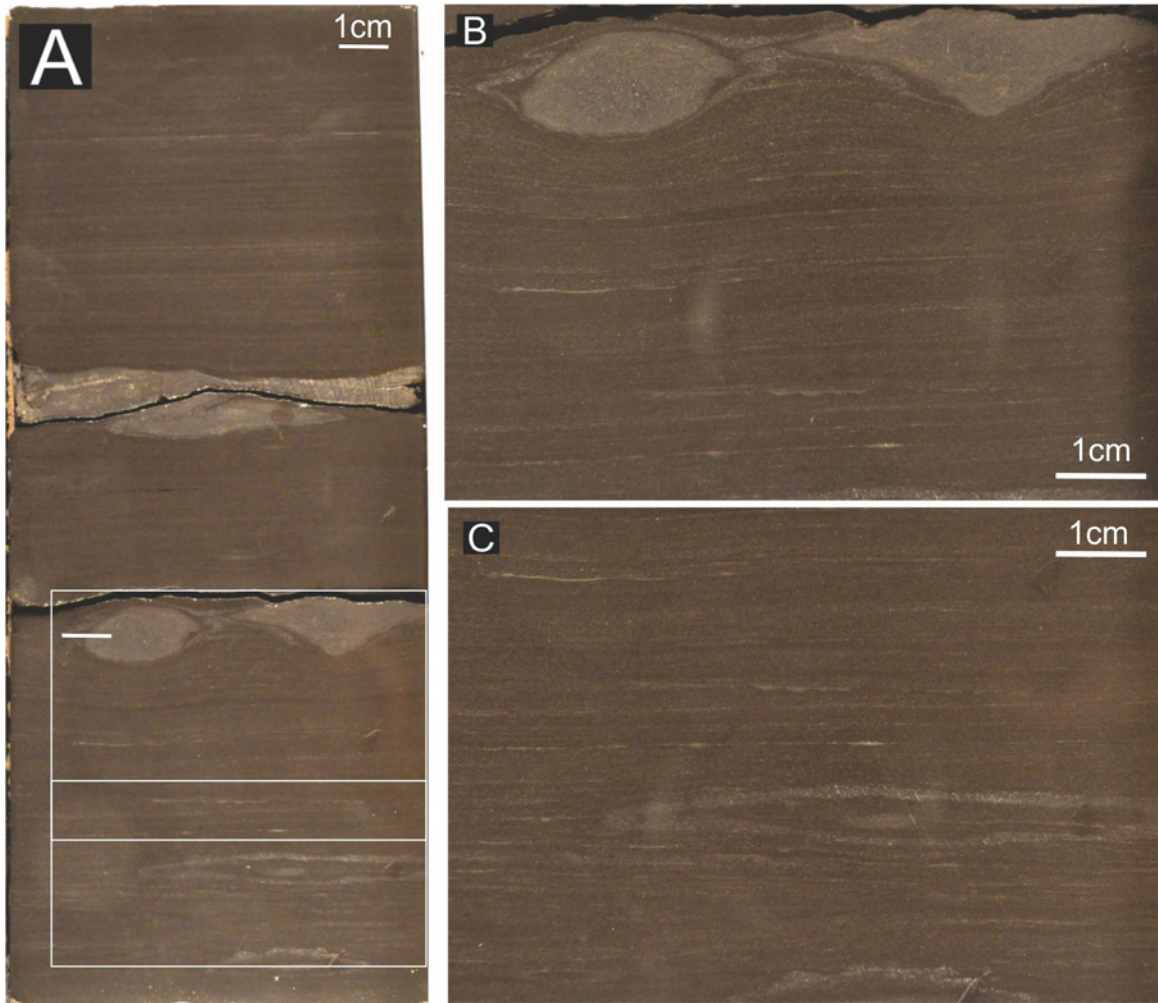


Figure N-20-5. Mudrock with carbonate nodules, 1910.5-1910.7 m MD

1910.75-1912.60 Siltstone: hard, dark gray, subfissile, poorly sorted muddy and grading to mudrock. Very thin (0.1-0.2 mm) lamination defined by paler colored siltstone laminae and lenses. Minor intervals where these laminae concentrate into heterolithic pattern. The interval distinct by mass silicisponge spicules on some fissility planes. Common sub-mm sized coaly detritus. Pyrite low, as “pyrite dust” and very rare small post-compactional nodules.

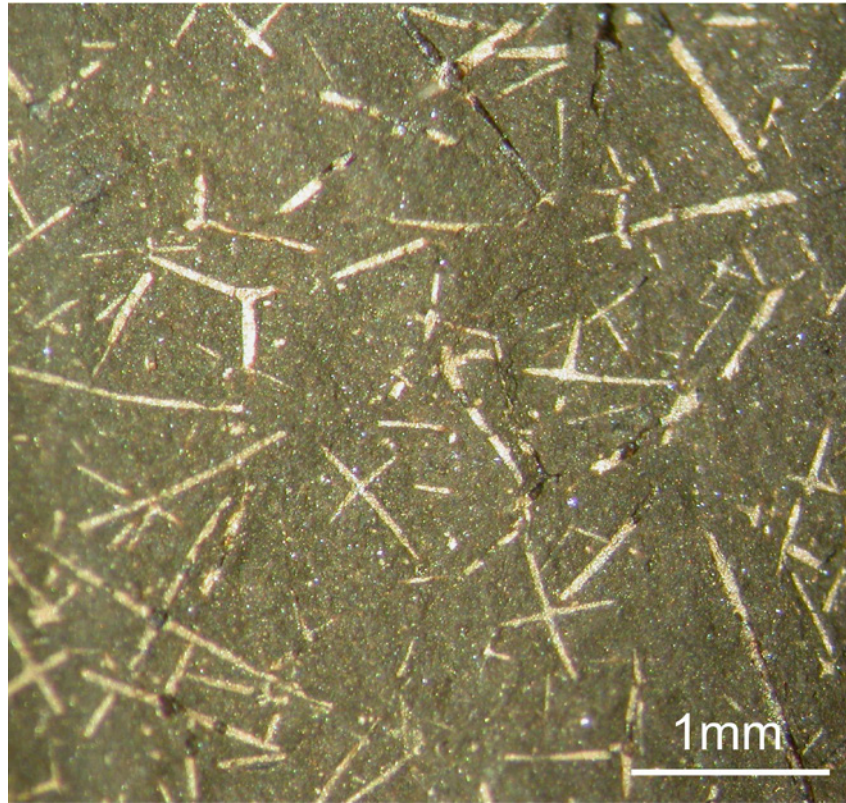


Figure N-20-6. Spicule mesh, binocular microphoto of bedding plane, 1911.9 m MD

1912.60-1912.80 Siltstone to mudrock: similar to 1910.75-1912.60 m but with enhanced pyrite content (pyritic streaks and “dust”). Abundant sponge spicules.

1912.80-1914.20 Siltstone: hard, subfissile, dark to pale gray, muddy, with distinct heterolithic lamination. The lamination is mostly even, with rare thin (1 mm) sets of starved ripples. Rare levels with disturbed lamination probably indicating planar trace fossils. Fewer sponge spicules than above.

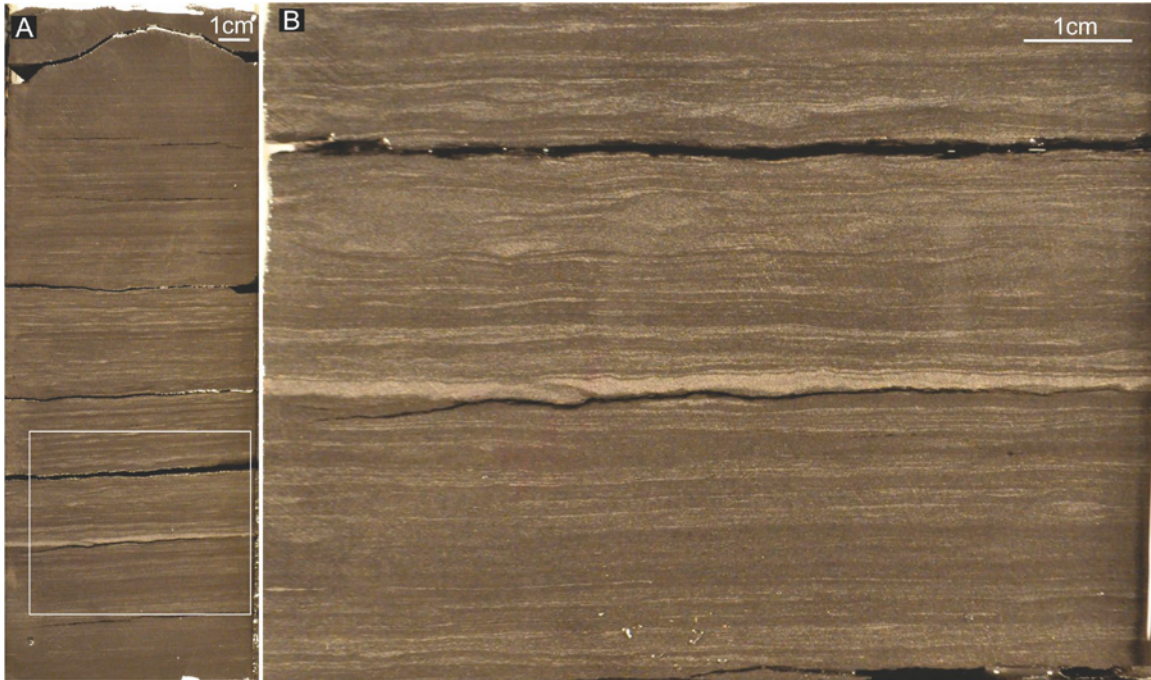


Figure N-20-7. Siltstone with heterolithic laminae, 1912.95 m MD

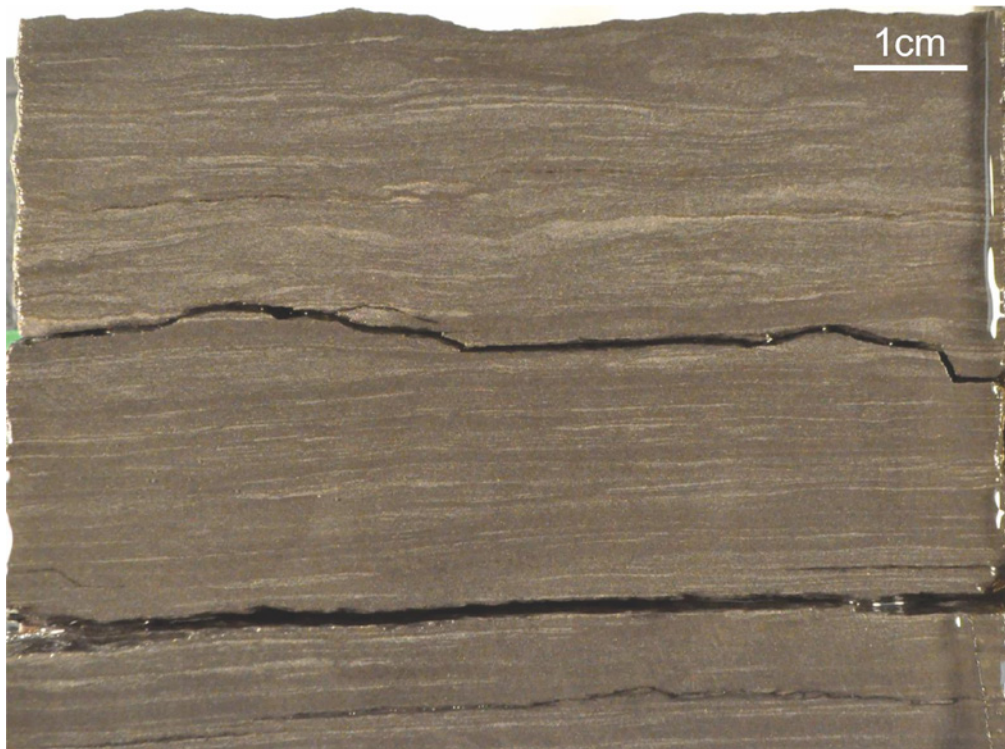


Figure N-20-8. Siltstone with disturbed lamination, 1914.1-1914.2 m MD

1914.20-1915.30 Mudrock: dark gray, silty, with fewer heterolithic siltstone laminae than at 1912.80-1914.20 m. Common to abundant sponge spicules including large triaxonic ones.

1915.30-1916.50 Mudrock: dark gray, hard subfissile to fissile, more homogeneous than above, with fewer and very thin heterolithic siltstone laminae; distinct by higher content of water-expanding clay. Common sponge spicules and rare planes with collapsed tentaculitids.

1916.50-1916.88 Mudrock to siltstone: hard subfissile, dark gray to gray, with distinct thin heterolithic lamination and rare small starved ripples; base shows increased pyritization. Rare sponge spicules.

1916.88-1918.78 Mudrock: hard, silty, thin-subfissile, dark brownish gray, with lamination emphasized by thin (0.1-0.2 mm) paler colored siltstone laminae; rare 5-10 cm thick intervals with more frequent siltstone laminate (mudrock-siltstone heterolithic alternation). Common to rare sponge spicules (non-pyritized). Rare post-compactional pyrite nodules. Base indicated by decline of pale-colored siltstone laminae and slight increase in water-expanding clay content.

1918.78-1924.85 Mudrock: hard, silty and with minor very fine sand admixture; very dark brownish gray, monolithic to thick-subfissile, notably homogeneous, with faint lamination (weak lithological contrasts). Sponge spicules are small, very rare, and are found only in top and basal one-third. Common small (1-5 mm) post-compactional pyrite nodules; minor "pyrite dust" in the lower half. Rare coaly detritus. Small (1-1.5 cm) elliptical pyritic-calcareous nodules at 1920.65 m. Different from the above by the conchoid aspect of many fissility surfaces.

1924.85-1927.18 Mudrock: very homogeneous monolithic to subfissile cryptolaminated silty shale to muddy siltstone with straight upright microstriated (sheared) fractures. Similar to the above but distinct by upright fractures; similarly low pyrite content. No sponge spicules; infrequent coaly detritus.

1927.18-1930.25 Mudrock: brownish black subfissile homogeneous silty shale with common to abundant sponge spicules; no upright fractures; rare to common coaly detritus. Lamination is faint, defined by slight lithological contrasts (paler and darker laminae, more or less clayey laminae). Small (0.5-1 cm) post-compactional pyrite aggregates.

1930.25-1930.28 Anhydritic shale: distinct brick red, expanding in water; contains soft authigenic whitish sparitic crystals which are completely replacing the rock in base (forming a graded layer).

1930.28-1932.20 Mudrock: brownish dark gray subfissile to fissile silty shale, similar to 1927.18-1930.25 m, with abundant, sometimes large silicisponge spicules and common

coaly detritus. The basal 20 cm are finer-grained (pelitomorphic shale), hard, black, contain rare pre-compactional pyritic nodules with admixture of calcareous material.

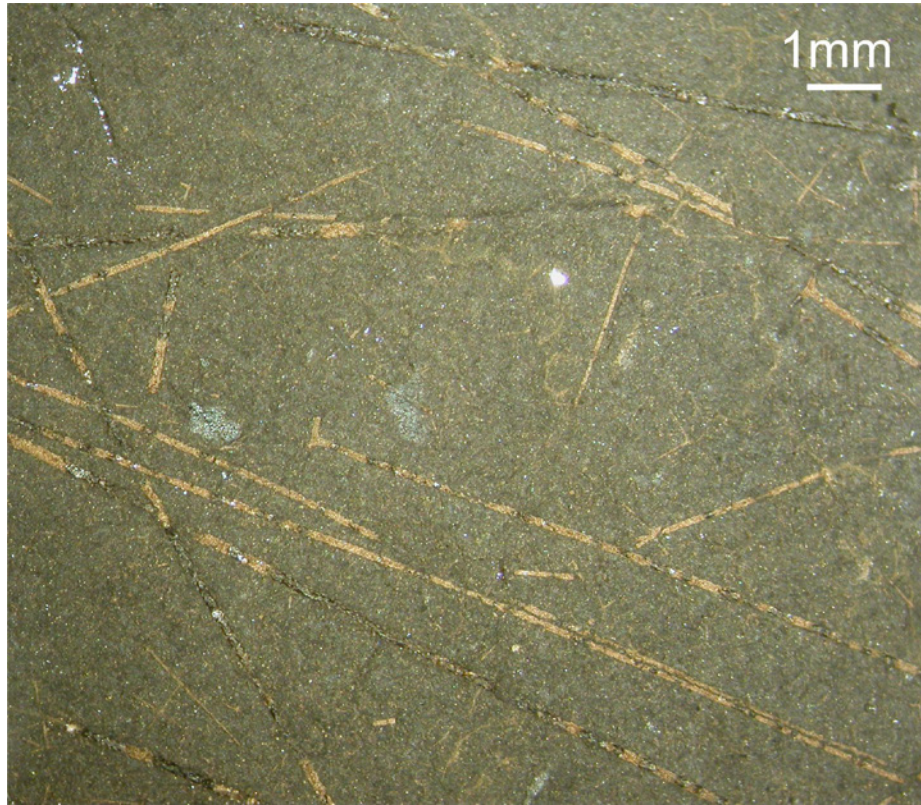


Figure N-20-9. Large sponge spicules, 1931.1 m MD; scale ruler on the left in millimeters.

1932.20-1932.37 Mudrock: black silty and weakly calcareous shale; hard, with conchoid fracturing; lamination defined by distribution of whitish silty material. Rare sponge spicules.

1932.37-1933.27 Mudrock: dark brownish gray subfissile silty shale with abundant sponge spicules; contains two 1 cm thick seams of heavily pyritized and sulphatized brick-red shale (one in the middle, another in the base). Elliptical pyrite nodules throughout.

1933.27-1934.00 Mudrock: black, hard, pelitomorphic (shale), thin-subfissile, with thin non-pyritized sponge spicules in the upper half; the lower half lacks spicules (or contains very few of them) and have rare radiolarian-rich laminae. Common conchoid aspect of bedding/fissility planes. Rare elliptical pyrite nodules.

1934.00-1935.08 Mudrock: hard brownish black subfissile laminated silty shale to minor muddy siltstone. Distinct by abundant silicisponge spicules including large ones. Low pyrite content (rare elliptical pyrite nodules).

1935.08-1935.15 Mudrock: hard, black, monolithic, weakly calcareous, with thin chertified pale-colored laminae composed of calcisiltite and poorly preserved small tentaculitids. Low pyrite content.



Figure N-20-10. Calcareous mudrock with calcisiltite laminae, 1935.1 m MD

1935.15-1936.0 Mudrock: hard brownish black monolithic to subfissile silty spiculitic shale. Abundant non-pyritized spicules. Faint microlamination.



Figure N-20-11. Homogeneous subfissile mudrock with poorly formed small pyrite nodules in the middle, 1935.5 m MD

1936.0-1936.35 Mudrock: black, subfissile silty shale with increased pyrite content (“dust”, streaks, and small nodules). Distinct by upright weakly mineralized fractures. Common, smaller-sized silicisponge spicules.

1936.35-1936.58 Mudrock: dark gray, hard, monolithic, weakly calcareous, distinctly laminar; similar to 1935.08-1935.15, but with fewer or no tentaculitids. No spicules preserved. Low pyrite content.

1936.58-1937.30 Mudrock: black, subfissile, partly silty, spiculitic, with low pyrite content; similar to 1935.15-1936.0 m.

1937.30-1941.10 Mudrock: black hard subfissile silty shale with increased pyrite content (pyritic streaks and minor “dust”); minor monolithic intervals; sponge spicules common to abundant. Two weakly calcareous 2-7 cm thick intervals enriched in chertified calcareous silt (1937.60 m and 1938.18 m). A poorly formed pre-compactional nodule with “stellate carbonate aggregates” (0.3-0.5 mm in size) at 1938.3 m. Rare to common

plant remains including “cardiform remains”. Lamination is emphasized by regular pyrite streaks and occasional laminae spaced at 2.0-3.0 mm from each other. More pyritic intervals tend to contain fewer and smaller spicules.



Figure N-20-12. Mudrock with carbonate stellate aggregates and a poorly formed pyritic-carbonate nodule, 1938.3 m MD

1941.10-1941.30 Mudrock: black, very homogeneous, coarser-grained than above and below; non-sorted silty and sandy shale to muddy fine-grained sandstone. Low pyrite content (no pyritic streaks). Sponge spicules are very rare and relatively small. Infrequent coaly detritus. Top and base are gradational.

1941.30-1942.0 Mudrock: brownish black subfissile homogeneous moderately pyritic silty shale with local admixture of fine sand. Pyrite mostly as “dust”, minor intervals with regular pyrite streaks. No sponge spicules.

Mirror Lake Member

1942.0-1944.50 Mudrock: dark brownish gray, subfissile to locally fissile homogeneous silty shale. Lamination faint, locally indiscernible. Slightly higher content of water-expandable clay. No sponge spicules. Low pyrite content: small (1-5 mm) nodules, mostly no matrix pyritization. Base by appearance of pyritized tablets (*Tasmanites* s.l.).

1944.50-1950.72 Shale: gray, fissile, partly silty, rich in water-expanding clay. Distinct by mass *Tasmanites* on fissility planes. Sponge spicules are evenly and totally pyritized (similarly to *Tasmanites*) and mostly rare; one level with abundant sponge spicules at 1947.40 (photo). Pyritized *Tasmanites* pavements become sparse in the lower half; base by disappearance of evenly pyritized *Tasmanites*.

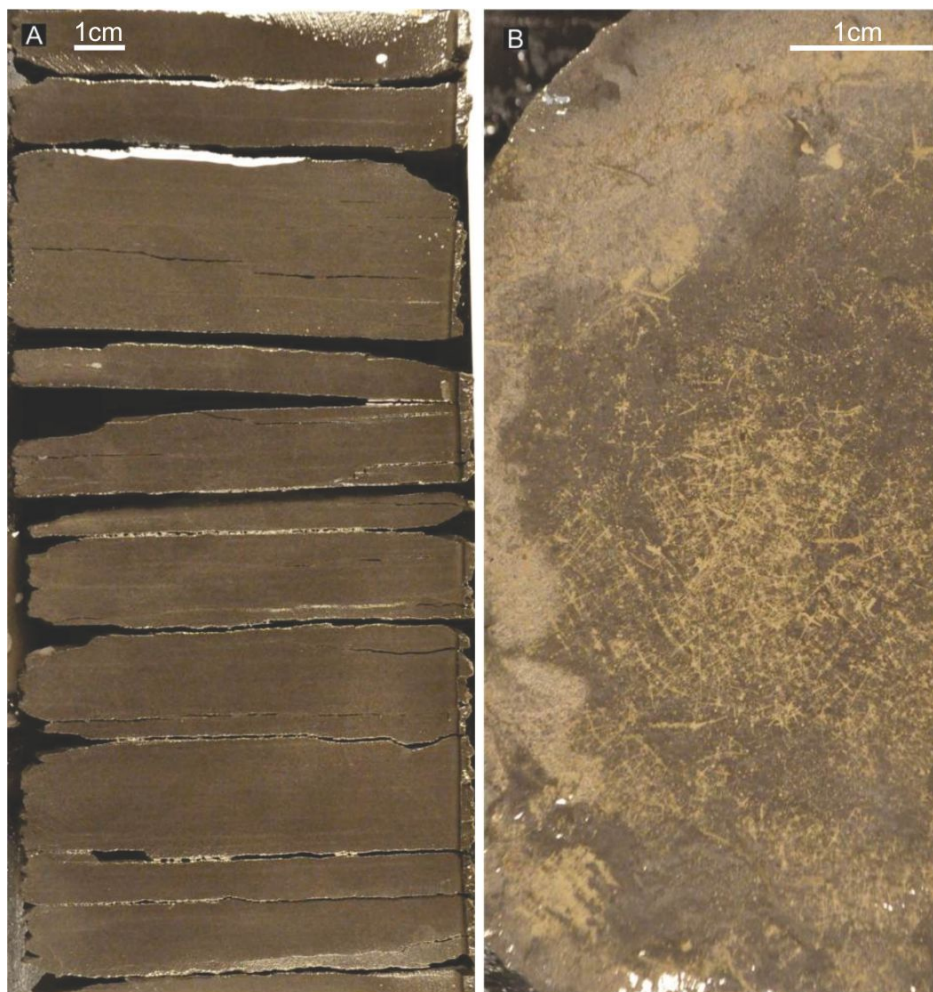


Figure N-20-13. Gray fissile shale (A) and pyritized spicule mesh (B), 1947.4-1947.5 m MD

1950.72-1955.9 Shale: dark gray, fissile, partly silty and sandy, homogeneous, faintly and evenly laminated, rich in expandable clay. Pyritized *Tasmanites* pavements recur at 1951.5-1951.65 at two or three thinner (1-3 cm) levels below. Common flaky coaly detritus. Rare and small sponge spicules. Rare to common mm-sized pyrite nodules. Some planes reveal very poorly preserved, faint impressions with organic skins that can be non-pyritized *Tasmanites*. Very rare pavements of pyritized sponge spicules.

1955.9-1956.08 Shale: dark gray, homogeneous, pelitomorphic, clay-rich, slightly harder than above and below (subfissile) and with elliptical pre-compactional siderite nodules 1-20 mm in size, otherwise similar to 1950.72-1955.9 m.

1956.08-1956.55 Shale: dark gray, fissile, clay-rich, partly silty, with small rare to common pyritized sponge spicules.

1956.55-1957.98 Mudrock: dark gray silty shale; slightly harder than above and with less expandable clay; thin-subfissile to fissile; low pyrite content; very rare small sponge spicules. An interval with gray lenticular siderite (?) nodules at 1957.20-1957.37 m. Base is gradational.



Figure N-20-14. Dark gray subfissile non-pyritic mudrock with small carbonate (siderite?) nodules, 1957.30 m MD



Figure N-20-15. Small pyritized sponge spicules, binocular microphoto of bedding plane, 1957.8 m MD; scale ruler on left in millimeters.

1957.98-1963.45 Mudrock: very dark gray, hard, subfissile, homogeneous, alternation of silty and sandy shales and muddy very fine-grained sandstones. Pyritized sponge spicules detected only in upper 30 cm and no spicules below. Pyrite content mostly low; minor intervals with moderate “pyrite dust” and occasional pyritic streaks. The lower 3.0 m contain small gray non-calcareous carbonate (?) lenses.

1963.45-1963.87 Mudrock: hard black monolithic to subfissile homogeneous silty shale rich in “pyrite dust”. Weak conchoid aspect of bedding planes. Top and base are gradational.

1963.87-1963.95 Calcareous mudrock: hard very dark gray microlaminar silty shale to siltstone enriched in calcareous silt; small poorly preserved tentaculitids are common.

1963.95-1965.40 Mudrock: black hard pyritic silty subfissile clay-lean shale with weak conchoidal aspect of bedding/fissility planes. Several intervals of stellate calcite aggregates. Pyrite as “pyritic dust” and streaks. A normally graded bed of pyritized styliolinids in the base. No sponge spicules.

CANOL FORMATION

Dodo Canyon member

1965.40-1970.0 Chertstone to mudrock: black, pyritic, with several intervals of stellate carbonate crystal aggregates; distinct by hardness, brittleness, and intensive conchoid and straight upright fracturing. The mudrock interbeds are subfissile. Pyrite in the form of “dust” and streaks.



Figure N-20-16. Graded pyritized tentaculitid bed, 1966.0-1966.1 m MD

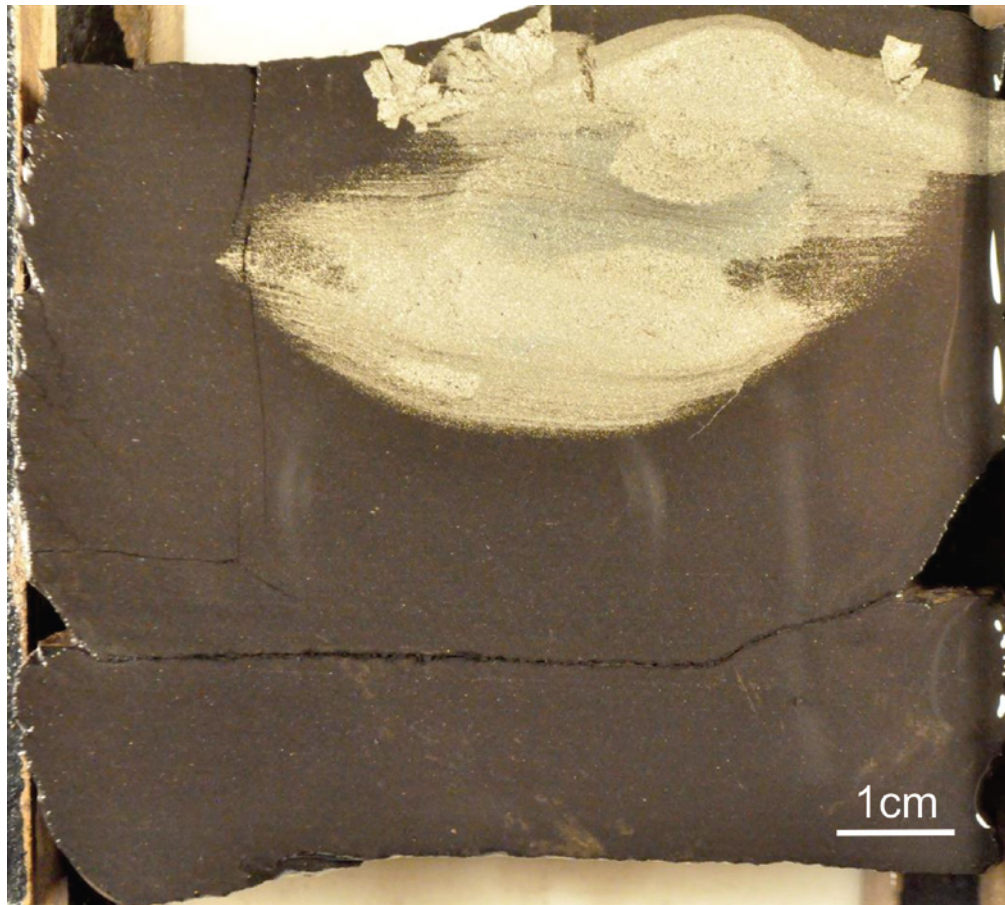


Figure N-20-17. Cherty fractured mudrock with pyrite nodule, 1967.4 m MD; note conchoid upright fracture to the left of nodule.

End of description.