



**GEOLOGICAL SURVEY OF CANADA  
OPEN FILE 7466**

**Revisiting legacy core and cross sections from the sub-  
Imperial Devonian of Mackenzie River Corridor with  
emphasis on formation boundaries. Part 1. Wells Kugaluk  
N-02, Norman Wells P32X, Imperial Bear Island R34X,  
Maida Creek F57, and Devo Creek P45**

**P.B. Kabanov**

**2013**



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## INTRODUCTION

The Lower and Middle Devonian of the central and northern parts of the Mackenzie River Corridor contains one giant conventional oil play (Norman Wells) and numerous oil and gas shows in breccias, dolostones and limestones. In this succession, the Muskwa-Canol Member hosts the region's major Paleozoic prospect for shale gas. The package also contains significant shale-gas prospects in the Bluefish and Headless formations (Hannigan et al., 2012). Long-standing uncertainties in formation relationships and sequence boundaries requires improvement in the regional sequence-stratigraphic framework as a critical step towards more successful exploration for both conventional and non-conventional hydrocarbon resources.

## METHOD

Cores from Devonian strata of the Mackenzie River Corridor were examined at the NEB Core and Sample Repository at the Geological Survey of Canada in Calgary. Sub-millimetre scale structures were more adequately revealed by grinding slabbed core surfaces with 35 µm silicon carbide powder (grit 400) and subsequent etching by 10% HCl for 1-2 seconds. These fine structures were photographed in macro regime on water-covered surfaces ([Appendix 3](#)). Cross-sections ([Appendices 1](#) and [2](#)) were created in GeoScout 7 geological module with some touch-up in Corel Draw X5.

## SUMMARY

This report delivers lithological descriptions of five Devonian cores from the central and northern Mackenzie River Corridor: [Kugaluk N-02](#) (2607 – 3845 ft), [Imperial Norman Wells P32X](#) (752.0 – 850.57 m), [GCO Maida Creek F-57](#) (1523 – 1614 ft), [Esso/Imperial Bear Island R34X](#) (674-728 m), and [EOG et al. Devo Creek P-45](#) (327-345 m) drilled in the 1960s through 1990s. All these cores were measured during 2012-2013. The most representative material comes from the CPOG [Kugaluk N-02](#) well of the northern Corridor, which is almost continuously cored from the Imperial Formation down to the base of the Devonian, despite some damage that occurred during its lengthy (since 1970) storage, repetitive sampling, and handling. The measured core intersects the Imperial (lower part), Canol, Hare Indian, Horn River (undivided), Hume, Landry formations, and probably the uppermost part of the Arnica Formation. Updated formation correlations based on studied core and logs are given on two cross-sections ([Appendices 1](#) and [2](#)).

In [CPOG Kugaluk N-02](#), the Landry/Headless, Headless/Hume, and Hume/Horn River boundaries appear to be conformities. The Landry/Headless and Headless/Hume boundaries are gradational, and the Hume top is a sharp contact between argillaceous heterozoan limestone and black calcareous shale of the basal Horn River Group. Numerous previously unknown subseismic-scale sequence boundaries (subaerial disconformities) bounding meter-scale peritidal cycles (cyclothems) are present within the Landry Limestone ([Appendix 1](#)). The Landry cyclothems consist of shallow-subtidal limestones, thick tidal-flat laminites, and non-marine, supposedly palustrine, micritic limestones. The Landry Fm. (948-1164 m of measured depth or MD) contains 35 simple and composite subaerial disconformities. The most developed vadose alteration profiles extend to depths of 3-4 m below the disconformity

surfaces. This spectacular cyclic pattern does not yield a distinct signature on available wirelogs. In the Norman Wells area ([Appendix 2](#)), the abrupt top of the Ramparts Limestone is a “drowning disconformity” with no evidence for shoaling or subaerial exposure ([Norman Wells P32X](#)). In the [Imperial Bear Island R34X](#), the 54 m core penetrating the Carcajou Member of the upper Hare Indian Formation and the basal Ramparts Formation, records the presence of a conformable succession with very gradual upward trend of shallowing and cleaning (argillaceous to non-argillaceous limestones).

Data presented here mostly concur with Muir et al.’s (1984) model of the Ramparts/Kee Scarp carbonate platform evolution and its stratigraphic relationship to the Canol black shale. According to their model, the Hare Indian shale bank (delta front to prodelta settings) stopped forming in response to sea level rise that created conditions for accumulation of shaly and carbonaceous Carcajou limestone. Continuous accretion of a carbonate platform keeping up with the sea level rise created the lower platformal parasequence of the Ramparts Formation labeled K1A by Muir et al. (1984). The top of the reefal Kee Scarp member of the Ramparts Formation is diachronous at Norman Wells and in the adjacent Mackenzie Mountains, recording pulses of backstepping and aggradation. According to Muir et al. (1984), the last Kee Scarp carbonate pinnacles assigned to K6 cycle/parasequence drowned in response to a rapid sea level rise and became blanketed by the Canol formation and the Imperial formation some time after carbonate sedimentation ceased.

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## CORE DESCRIPTIONS

**Abbreviations for sand-sized grainy textures:** vf/g – very fine-grained (0.06-0.125 mm); f/g – fine-grained (0.125-0.25 mm); m/g – medium-grained (0.25-0.5 mm); c/g – coarse-grained (0.5-1.0 mm); vc/g – very coarse-grained (1.0-2.0 mm).

**Other abbreviations:** Fm – Formation; Mb – member; Gp – Group; MD – measured depth; TVD – true vertical depth.

## CPOG Kugaluk N-02

**Well ID data:** 300/N-02-6840-13130/0

Cdn Pacific O&G Lmtd [#027]

SPUD: 1969/04/02 CMPL DRL: 1969/12/15 DAYS: 258 RR: 1969/12/18

Core diameter: 2”

**Interval measured:** 2607 – 3845 ft (794.6 - 1172.0 m)

### **Core condition, damage, inconsistencies:**

1. Position of Hume top in boxes mismatches logs and should be moved to 2934.0'. However, it is difficult to adjust core to logs with available data.
2. Box 324 is missing, but the bottom of the box 323 is marked 3268 ft, and the bottom of the box 325 has bottom reads 3274.5 ft. Therefore boxes 323 and 324 appear to contain one-box interval implying that the box 324 may have not existed.
3. Boxes 382-385 have an inconsistent record in the Well History: Box 382 records 10.3 ft (3687.7-3698 ft), box 383 measures no length (3698 ft at the bottom), box 384 measures 7 ft (3697 – 3704), and box 385 contains 18.5 ft (3704-3722.5 ). In fact, boxes 382-384 are filled with continuous core.

The very bottom of box 384 and the upper tray of box 385 contain rounded fragments corresponding to the "Lost core" fractured interval shown as 5 ft on the striplog from the Well History. The top of the fractured interval on the Striplog is shown at 3710 ft. To correct this inconsistency, the bottom of the box 384 is assigned 3710 ft MD, and boxes 382-384 are assigned nearly equal length, re-aligning the bottom of box 382 at 3695.1 ft and the bottom of box 383 at 3702.7 ft. Box 385, measuring 12.5 ft after correction, is assumed to be where the entire fractured lost-core interval was located.

4. Core from 3831-3845 ft is fragmented with many pieces not matching each other; a confused core sequence is possible so that the number of argillaceous lithoclastic beds may be different (two or three thicker beds instead of five measured).

5. Interval 3845 ft - 3963 ft (boxes 403-499) was destroyed in a warehouse fire (Well history report).

### **Core description:**

#### Measurements in feet

#### IMPERIAL FM

2607-2644.4 Shale: black, monotonous, non-expanding, laminated, with very fine coal detritus in lower half with siltstone laminae defining very low-angle lamination. A fining-upward 10 cm thick sandstone greywacke vf/g with obscure lamination at 2634 ft; oblique to upright curved fractures cemented by a sequence of light brownish dolomite and succeeded by calcite; centres of wide fractures are filled by anthracite-like OM; lamination occasionally disrupted by upright and oblique, short slickensides; lamination at 1-5° to core; few pyritized laminae.

2644.4-2652.8 Alternating black, laminated shale and gray, vf/g sandstone (greywacke) with coal detritus; rare squeezed shale intraclasts; at least 3 main Bouma-type rhythms; basal parts of thickest sandstones massive, enriched in mud intraclasts and siliceous grains, non-calcareous; other sandstones vaguely laminated; minor siltstone; important upright fracturing of the same kind as above.

2652.8-2674 Sandstone: gray, f/g to m/g, moderately to poorly sorted, greywacke, subangular, many coarse, angular fragments; coarser sandstone massive; f/g sandstone tends to be stripey, with obscure compacted bioturbation; siltstone and silty shale intraclasts rare to common in coarser grained sandstone; lower 1 ft represents a sandstone-dominated Bouma rhythm separated from the main massive sandstone by black 1-2" thick pyritized sandy shale with well preserved lamination; upper 2" of this lower sandstone rhythm is laminated with weak burrow disruptions, the main part is massive; load marks in sole.

## HORN RIVER SHALE

2674-2682 Alternating sandstone vf/g gray massive to indistinctly laminated, possibly with obscure bioturbation, and shale brownish black massive, monotonous, fissile. Large plant fragments in sandstone soles. Sandstone beds weakly fining-upward from vf/g to siltstone mode distinctly laminar.

2682-2683 Shale: black, fissile, micaceous, cut by upright pyrobitumen-filled fractures, broken by dense decompaction fractures; large poorly preserved plant fragments. Pyrobitumen fills are solid, crumbling, shiny, resembling anthracite, sampled by someone as "coal" (label left in box).

2683-2684.5 Alternation of shale brownish dark gray and sandstone gray vf/g, with minor siltstone; lamination mostly preserved, bioturbation locally  $\geq 50\%$ . In the lower part thin (5 cm) sandstone beds and shale dominate.

2684.5-2853.5 Shale: indurated, brownish dark gray to black, monotonous, laminated, with very rare weakly bioturbated horizons, with rare 1-3 cm thick laminated siltstones; rare light-weight chertstone recognized by coherency and conchoid fracturing; steep to upright fractures with dolomite-calcite-anthracite veins; lamination at 1-5% angle to core; 10-15% of interval is shale moderately and weakly calcareous; pyritic laminae defining primary lamination and rare pyritic nodules. Sandstone vf/g with carbonate & anthracite cemented fractures at 2697.5-2698.

2853.5-2858 Shale calcareous (marl): brownish dark gray, monotonous and indistinctly microlaminar, no traces of bioturbation; distinct from adjacent shales by being calcareous, harder and monolithic in appearance. Calcite-pyrobitumen filled fractures cross-cutting sedimentary fabrics.

2858-2929 Shale: brownish dark gray to black, laminated, weakly calcareous to non-calcareous. Pyritized tentaculites and possibly rare calcispheres in lower third; commonly occurring tentaculites horizons near the base; no other fossils identified. Locally dissected by thin (1-3 mm) upright fractures filled with calcite spar and pyrobitumen; a thin (1-2mm) stratiform pyrobitumen seam at about 2895 ft was sampled by someone as "coal". A bioturbation horizon (single event?) at 2901.5 ft. Slickensided and crushed interval with *Phycosiphon* or *Chondrites* traces (bioturbation 10-15%) at 2903.5-2905 ft.

HUME FM at 2929 ft – labeled in box; 2935 ft on original striplog.

2929-2933.5 Limestone argillaceous: brownish black; mostly packstones c/g and floatstone bioclastic brachiopodal. Top of interval consists of a thin (10-20 cm) brachiopod-rich bed with articulated brachiopods, crinoid ossicles and bryozoans overlain by a thin (1-2 cm preserved thickness) overcompacted brachiopod packstone-floatstone lying on a wavy top. Below this upper bed, non-compacted micrite-rich brachiopod floatstones, apparently nodular, with mostly disarticulated valves, alternate with more compacted bioclastic packstones. Brachiopods (dominant fauna), disarticulated crinoids, bryozoans, micritic oncoid-like grains (thin section needed to confirm); some bioclasts pyritized, especially in top. Extensively bioturbated (swirly burrowing pattern); no primary lamination.

2933.7-2934.2 Shale calcareous: fissile, with collapsed brachiopod fragments and small pyrite nodules; rare styliolinids



2934-2935.5 Limestone argillaceous; black, calcimudstone with scattered brachiopod valves and rare f/g bioclastic layers (tempestite-like feature); compaction moderate to weak

2935.5-2938 Limestone argillaceous: dark brownish gray, brachiopod wackestones with brachiopod coquina horizons; few articulated shells mostly in base; swirly bioturbation with pre-compaction lithified micrite patches; rare tentaculites; facies gradation to underlying and overlying beds; probably no erosional surfaces.

2938-2973 Limestone weakly to non-argillaceous: dark gray to black, becomes slightly paler downward. Crudely and unevenly bedded, consisting of thick (5-30 cm) micrite-rich non-compacted intervals with complex swirly bioturbation pattern separated by thin (1-5 cm) strongly compacted black packstones and wackestones. Fossils diverse (thick bryozoans, favositid and solitary rugose corals, minor brachiopods and disarticulated crinoids, few in situ brachiopods). Metazoan fossils tend to be encased in micritic vaguely laminar masses; solitary Rugosa occur preferentially in compacted packstones and wackestones. 5-7 cm deep pockets of packstone penetrate non-compacted micrite from supposed discontinuity surfaces. *Asterosoma* traces locally preserved. Base gradational.

2973-3042 Limestone weakly argillaceous: dark gray to black. Alternating nodular, non-compacted wackestones and packstones, and black, compacted wackestones, locally pyritized and bioclastic. Rare pocket-bearing discontinuities in wackstone-wackestone tops (may be burial diagenetic). Common favositids (incl. gen. *Alveolites*; identification of A.E.H. Pedder) and ?bryozoans. Rare horizons with micritic oncoids and algae. Most fossils transported, some of them in situ. Micrite coatings on metazoans thin and relatively rare. Diverse macrofossil assemblage. Swirly fabric in packstones-wackestones suggests bioturbation prior to intrasedimentary lithification. Prominent nodular appearance that resembles breccia in places, increasing downwards. Numerous catagenetic veins of clear, coarsely crystalline calcite, commonly with curved cleavage.

3042-3050 Limestone: beige or gray, weakly argillaceous, with wavy solution seams defining uneven bedding and/or nodularity. Bioclastic wackestones and packstones with prominent swirly bioturbation in the nodules. Rare calcimudstones with bioclastic/coquina storm layers on them. Diverse, transported fauna in coquinas: disarticulated brachiopods, trilobites, bryozoans and favositid corals, and minor crinoids, gastropods.

## HUME-HEADLESS TRANSITION

3050-3068 Marl: light brownish grey, calcareous-dolomitic, prominently fissile, intercalated with thin (1-3 cm) Limestone: beds and lenses. Limestones consist of brachiopod-dominated coquinas resting on calcimudstone beds; features consistent with a tempestite origin. Limestones are more important in upper 2' of the interval. Primary lamination mostly preserved, bioturbation scarce; base and top of interval gradational. Microcrystalline dolomite occurs as laminae/lenses, upright partitions, and mottles. Shale: weakly expanding, resembling palygorskite(?).

## HEADLESS MEMBER

3068-3071 Limestone: argillaceous and weakly dolomitic, beige gray (same color as above); dissected by numerous solution seams; heterozoan wackestones and floatstones (brachiopods, gastropods, erect cephalopods, juvenile bryozoans(?), trilobites). Bioturbated by 50-80% with swirly

burrowing pattern. Some scour surfaces present overlain by basal crude bioclastic beds. Matrix of dense micrite. Top and base gradational.

3071-3080 Marl: light beige gray; fissile and laminated, with thin (<1cm) lenses of dolomitic limestone; facies identical to 3050-3068 ft.

3080-3083 Limestone: patchily dolomitized, grading to dolomite, nodular, intercalated with fissile, laminated marl (as above). Bioclastic wackestones, floatstones and rudstones, with dense micritic matrix. 60-80% bioturbated with swirly pattern; rare *Zoophycos* spreiten. Fossils completely heterozoan (brachiopods dominant, rare bryozoans). Minor calcimudstone intraclasts.

3083-3086 Marl: light beige gray, fissile and laminated, with thin (<1cm) lenses of dolomitic limestone. Facies identical to 3050-3068 ft.

3086-3096.5 Limestone: beige light gray, argillaceous and dolomitic (patchy, finely crystalline dolomitization), with numerous solution seams defining nodular to flaser appearance. Rare fossils. Calcimudstone with coquinas and bioclast beds; fossils consist of brachiopod clasts and large (up to 1 cm) tentaculites; grades downward into alternating marl and calcimudstone. Bioturbation rare or obscure, and only in bioclast-enriched storm layers; rare *Bergaueria* traces.

#### LANDRY-HEADLESS TRANSITION

3096.5-3115 Limestone: beige gray, weakly argillaceous and weakly dolomitic. Common thick (1-10 mm) solution seams imparting flaser to nodular appearance. Dolomite finely crystalline, distributed along solution seams and forms rare partitions. Diagenetic breccia fabric where solution seams form "hyper-nodularity". Calcimudstone with rare disturbed by burrowing storm coquinas containing thin-shelled brachiopods, bivalves, trilobites, and small gastropods. Bioturbation increases downward. Differs from 3086-3096.5 ft with less dolomitization and a bit more bioturbation. Base and top gradational.

#### LANDRY FORMATION

3115-3138 Limestone: beige gray, very weakly argillaceous and locally (?) weakly arenaceous, with numerous black (shale-bitumen?) solution seams imparting flaser to nodular appearance. Bioclastic calcimudstones to wackestones, locally floatstones, with moderate bioturbation (*Planolites* and indistinct fabric); brachiopods, trilobites, ?tentaculites, spherules (0.1-1 mm in diameter). Storm shell layers (coquinas-rudstones) 1-10 mm thick, more frequent than above. Dense micritic matrix, uniform, shows weak pervasive compaction to uncompacted. Lower 2 ft is enriched in spar-cemented oomolds and thin shell fragments with at least one thick (4 cm) crudely graded layer. A 0.5-1 ft thick bed of calcimudstone at the base.

3138-3143 Limestone: dark gray, pure, vf/g to f/g ooid-peloid and bioclastic-ooid grainstone. In upper part contains foraminifera(?)-calcispheres and minor thin-cortex ooids; composite lump (grapestone) admixture throughout. Well to medium-sorted in main part; in upper part medium to poorly sorted. Solution vugs filled by coarsely crystalline blocky calcite in upper 10 cm. Grainstone is cemented by

isopachous marine cement. Numerous low-amplitude stylolites. Mostly no intergrain compaction. Internal erosional surfaces may be present.

3143-3146.5 Limestone: dark gray; alternating bioclastic packstones, weakly compacted aggregate-peloidal packstones-grainstones, mudstones, and mollusk coquinas – rudstones-floatstones with dense micritic matrix. Rare lenses of siliciclastic silt (15-20%). Micritic lithologies locally syndimentary brecciated. Numerous discontinuities covered by automicritic, some vaguely stromatoidal, crusts. No evidence of early compaction in mud-supported lithologies.

3146.5-3149 Limestone: dark gray, clean; grainstone vf/g ooidal-peloidal, medium to well-sorted in top, to base becoming poorly sorted and grains aggregated by micritic cement; syndimentary isopachous cement poorly developed and may be absent in lower part; faint syndimentary lamination in upper part; numerous low-amplitude stylolites, moderate to weak to no intergrain compaction.

3149-3150.5 Limestone: dark gray, pure, peloidal-bioclastic packstone to grainstone; rounded grains (peloids and micritized ooids?) and non-rounded bioclasts in nearly equal proportion; rare black subangular, granules weakly fizzing in HCl – “black pebbles”? moderate intergranular compaction; patches of dense micritic cementation (automicrite?); local piles of broken mollusk shells.

3150.5-3157.5 Limestone: dark brownish gray, moderately nodular due to development of undulating solution seams. Calcimudstones, bioclastic wackestones and floatstones with uncompacted dense micritic matrix. Upper and lower parts of interval contain 0.2-2 cm thick graded bioclastic layers resting on uneven erosional surfaces; middle 30 cm is non-bedded floatstones to in situ brachiopod-mollusk banks cemented by brecciated, patchy to lamellar automicritic matrix; some automicrite patches contain monaxonic spicule molds; local patches of clotted automicrite. A 5 cm thick mollusk bank at base. Micrite is “early lithified mud” type.

3157.5-3196.5 Limestone: dark brownish gray, moderately to weakly nodular. Wackestones and packstones in upper 1-1.5 m grading downward into calcimudstones with minor packstones, wackestones and floatstone patches; patches of thromboid micrite in upper 1 m. Matrix of “early lithified mud”. Swirly bioturbation is locally distinct. Calcimudstones tend to be diagenetically brecciated, with coarsely crystalline calcite veins. A 10 cm-thick laminar-fenestral calcimudstone horizon at 3190 ft. Rare horizons enriched in thin shells. A tabulate coral thicket (two forms, probably auloporids and pyrgiids) at 3184.5 ft. The lower 1 ft is clotted calcimudstone, partly small-fenestral (dismicrite), grading to grainstone. Conformable base.

3196.5-3202 Limestone: dark brownish gray, pure, weakly compacted to uncompacted, intercalated with moderately argillaceous, overcompacted limestone. Alternations of vf/g bioclastic-peloidal grainstones, micropeloidal (dismicritic) calcimudstones, and packstones (contains mostly thin-shelled (?) ostracods), with minor dense micritic calcimudstones; few flattened birds-eye features. Grainstones and micropeloidal calcimudstones-dismicrites intergrade; lamination expressed locally as cm-scale packstone and/or grainstone layers covered by dense micritic drapings. Mass ostracod shells and lenses of ostracod coquina; grainstones cemented by amoeboid to horizontally elongated automicrite mottles.

3202-3206 Limestone: dark brownish gray, nodular from development of solution seams and overcompacted zones probably following originally more argillaceous layers. The interval is rhythmic

and consists of two alternating lithologies: (1) micrite (floatstone-boundstone) brownish gray, uncompact, with disarticulated brachiopod shells and clusters of tabulate corals (gen. *Cladochonus*; identification by A.E.H. Pedder); and (2) calcimudstones, wackestones and floatstones: very dark gray, compacted to various degrees, nodular to lenticular, with patches of non-compacted micrite forming nodules and lenses. At least 4 rhythms in the interval. Tops of floatstone-boundstone beds tend to be sharper than bases, emphasized by compaction, but still conformable; non-compacted micrites become dominant toward the base.

3206-3209.5 Limestone: dark brownish gray, nodular (sometimes breccoid nodularity), non-compacted inside nodules. Texture ranges from pure, dense calcimudstones to grainstones-calcimudstones (dismicrites) with numerous very small (1-2 mm) fenestrae. Fenestral dismicrites are rich in fossils (aulopodid corals, small gastropods, thin shells – mollusks, ostracods and/or brachiopods). A 10 cm-thick peloidal dismicrite-grainstone with syngenetic brecciation, partly having boundstone features. A few thin (1-2 cm) interbeds of black overcompacted calcimudstone.

3209.5-3212.5 Limestone: medium brownish gray (lighter than over- and underlying intervals), micritic, stylolitized, with small (3-4 cm) Stromatactis-like caverns (Stromatactis or solution vugs?) and probably minor simple polymud fabric alternating with vuggy or birds-eye fenestral horizons. Dark greenish gray motley staining (possibly argillaceous?) developed from the top downward. Solution or fenestral nature of vugs needs to be clarified. Small solution-like vugs in top associated with greenish staining. No macrofossils. Indistinct laminae made by vf/g bioclasts or tiny birds-eyes. Interval base is abrupt, brecciated, with marl dykes from the underlying interval.

3212.5-3222 Limestone: dark brownish gray, nodular, with black marl interbeds and seams. Predominantly wackestones, minor bioclastic calcimudstones with dense non-compacted micritic matrix. A 10-20 cm thick marl-dominated interval in top underlain by nodular, differentially compacted calcimudstones, wackestones and peloidal grainstones-calcimudstones with 1-2 cm thick overcompacted marl seams. Thin-shelled ostracods, gastropods, and other small skeletal metazoans; no thick-shelled forms. Some nodule-marl contacts are sharp suggesting seafloor exposure. Catagenetic brecciation with calcite-filled fractures is locally developed.

3222-3231.5 Limestone: dark brownish gray, moderately nodular: tabulate-coral bafflestone with dense “calcimudstone” matrix; locally matrix show overhangs, pockets and windows of loose bioclastic sediment. Thin-shell material present as above; coral bafflestone (gen. *Cladochonus*) alternates with coral-free nodular calcimudstone and thin-shell floatstone.

3231.5-3234.5 Limestone: dark brownish gray, probably constitutes one coral bulidup with the 3222-3231.5 ft interval: pyrgiid(?) bafflestone with bioclastic-peloidal packstone and grainstone matrix alternating with grainstone containing few or no corals. Minor lenses of brecciated automicrite. Top conformable, base unknown (core missing).

3234.5-3238 Limestone: dark brownish gray. Alternation and intergradation of calcimudstones, vf/g to f/g peloidal-aggregate grainstones, oncoidal and/or intraclastic rudstones with grainstone matrix. The lower half of interval is laminite consisting of alternating vf/g grainstones-packstones, minor intraclastic, c/g grainstones, and micrite drapes. Lamination is uneven, disrupted, wavy. Moderate to locally strong intergranular compaction. Few brecciated calcimudstone layers apparently brecciated under burial load.

3238-3244 Limestone: dark brownish gray; calcimudstone and bioclastic wackestone (ostracod-dominated). Mostly non-compacted with moderately to strongly compacted interbeds. Wackestone is bioturbated. Tabulate corals are very rare. There is a 5-10 cm thick layer of overcompacted argillaceous calcimudstone in top.

3244-3245.5 Limestone: dark brownish gray; poorly sorted peloidal-bioclastic packstones and grainstones with small (5-7 cm thick) lenses of automicrite-cemented coral bafflestone (same corals as above). Numerous solution seams and low-amplitude stylolites. Matrix non-compacted in automicrite lenses and weakly compacted in grainstones-packstones.

3245.5-3252 Limestone: dark brownish gray; rounded-grain, vf/g to f/g grainstones with minor m-c/fg ooidal-?peloidal laminae. Locally poorly defined lamination, with numerous amoeboidal mm to cm-size mottles of automicritic cement; most cementation mottles horizontally stretched, locally joining into a web-like pattern. The lower 10-15 cm is alternating and intergradational poorly sorted ooidal-aggregate grainstones, and dense micrites (automicrites to "early lithified muds"). The base of the interval is made of grainstone vf/g to mudstone argillaceous overcompacted.

3252-3260 Limestone: beige gray, slightly lighter in colour than the interval above, gradually darkens downward. Vf/g grainstones, possibly some vf/g packstones, and calcisiltites with numerous calcimudstone drapes defining 1-5 mm thick lamination. No bioturbation. Grain composition obscure, may contain some sand admixture. Uppermost 10 cm with very distinct inclined laminae (herringbone lamination) and thick mud drapes, divided by solution partitions. Supposed unconformity in top: a smooth sharp top of limestone covered by pigeon gray marl with sand-size limestone crumbles and poorly preserved (corroded) bioclasts. No Hopwever, no distinct solution features beneath this surface. The lower half of interval consists of alternating laminar grainstones-calcisiltites and dense calcimudstones, locally catagenetically brecciated. Calcimudstones attain 20 cm thick, they are massive except for thin (102 mm) calcisiltite lenses; numerous solution seams, moderate matrix compaction in grainy textures; black microporosity mottles, oil filled (water repelling surfaces). Basal 10-15 cm is peloidal-aggregate-intraclastic (micrite intraclasts) grainstone with moderate to strong matrix compaction.

3260-3267.5 Limestone: dark brownish gray; packstones mud-poor and mud-rich peloidal-bioclastic with minor brecciated lenses of automicritic wackestones and tabulate-coral bafflestones; the latter cemented by thick micrite. Black mottles of bitumen-plugged matrix microporosity. The lower 0.9-1 m is coral-free packstones and grainstones medium sorted, subrounded, bioclastic-peloidal; amount of grainstones moderately increases to the base. Basal 7 cm contains centimeter-sized knobs of automicrite-algal boundstone in a grainstone matrix. Moderate matrix compaction in grainy textures, no matrix compaction in micrite-cemented textures. Frequent solution seams and low-amplitude stylolites. Base apparently unconformable, but some core there is missing.

3267.5-3271 Limestone: beige in top, darkens downward to common dark brownish gray. Oil impregnation is betrayed by strong water repelling throughout the interval except for 10-15 cm in its top and base. Upper 0.3-0.4 m is calcimudstone dense, barren, massive and without matrix compaction. In the lower half of interval calcimudstone obtains thin vf/g allochemic lenses and matrix compaction gradually increases up to strongly compacted calcimudstone with packstone lenses and algal-micritic nodules near the base. Important high-amplitude stylolitization up to stylobreccia development. Upper 10-15 cm also show post-stylolite fracturing with numerous cracks and associated vugs filled by clear blocky calcite. Important pyritization of solution seams (almost total replacement) in the middle water-repelling part.

3271-3272.3 Limestone: dark brownish gray; grainstone f/g peloidal-bioclastic-?algal, subrounded, with obscure remains of crude inclined lamination in the upper half. Alternation of packstones peloidal-bioclastic and grainstones of the above type in the lower half. No or weak matrix compaction in grainstones but numerous solution seams and smooth stylolites. Packstones tend to be overcompacted; top very gradational, base likely conformable or with 2 or more obscure erosional surfaces.

3272.3-3273.5 Limestone: dark brownish gray; wackestones bioclastic with dense to mesoclotted to small-fenestral matrix (early lithified mud) intercalated by thin overcompacted peloidal-bioclastic packstones. Numerous wavy solution seams defining nodularity. Horizons of stylobreccia may correspond to original intraclastic lenses. Base marked by distinct packstone bioclastic with large (> 3 cm) intraclasts of calcimudstone. Thick packstone rests on alveolar erosional surface with deep (>5 cm) pockets. Grain-supported textures tend to be overcompacted and superimposed by black mottles of bitumen-plugged microporosity.

3273.5-3278 Limestone: dark brownish gray. Wackestones with numerous solution seams as on 3272.3-3273.5 ft, gradation to grainstone in the basal part of the interval. The middle of the interval is admitted by a 10 cm-thick intraclastic grainstone-to-conglomerate horizon. Similarly developed black mottles of bitumen-plugged microporosity. Local water-repelling surfaces indicate oil impregnation.

3278-3279.5 Limestone: dark brownish gray, monolithic, laminated; grainstone ooidal-peloidal (peloids may be micritized ooids), vf/g to f/g, with rare c/g intraclastic laminae; lamination gently inclined at various angles (low-angle herringbone?). Grains connected by micritic bridges, in some laminae micrite cement merges into dismicrite crusts with almost indistinguishable individual grains. Isopachous marine cement rudimentary or absent. Thin-shelled ostracod laminae in basal part indicate transition to underlying interval.

3279.5-3281 Limestone: dark brownish gray, laminated, with mass ostracods and probably other thin-shell material. Alternation of grainstones, packstones, calcisiltites, and calcimudstones. Mass ostracods with strongly preferred horizontal convex-up and tiled orientation occur in all textures except calcimudstones. Packstones have strongest matrix compaction. Black mottles of bitumen-plugged matrix porosity are present; they are horizontally stretched and flattened by compaction.

3281-3281.3 Shale: black, calcareous (marl); probably dolomitic, fissile. Bioturbation present with possible collapsed spreiten.

3281.3-3283 Limestone: dark brownish gray, with thin (1-5 mm) intercalations of black calcareous shale; wackestones and floatstones ostracod and maybe other thin shells. Common charophytes. Thin shells mostly uniformly convex and of constant thickness. Several thin (1-3 cm), graded, poorly preserved packstone beds enriched in subrounded micritic intraclasts and/or peloids. Black mottles of bitumen impregnation in the matrix (microporosity) and lacy inclusions of fine sparitic crystals (dolomite?) are present. Lower 15-20 cm is dolomitic (finely crystalline dolomite). Weak to moderate matrix compaction, marl seams overcompacted.

3283-3288 Limestone: dark gray, a little bit lighter than above, dolomitic; calcimudstones massive brecciated, with wide fractures filled by very dark carbonaceous-calcareous-dolomitic material. Dolomite is finely crystalline throughout; fracture-cementing dolomite locally expands to dolomitization mottles in the rock matrix. These mottles seem to associate with amoeboid mottles of bitumen

impregnation; overall, 20-35% of the rock is dolomite. Rare ostracods and charophyte molds. Locally the rock is split by post-dolomitization clear calcite veins and geodes ("second brecciation phase")

3288-3293.5 Limestone: very dolomitic to dolomite calcareous: dark beige gray; dolomite developed upon primary facies as laminae, flattened mottles, and occasional upright partitions; primary facies is grainstones to packstones f/g bioclastic-peloidal laminated. Lamination expressed in alternating lithologies, dolomite laminae replacing original micritic drapes, and horizontal, undisturbed shell orientation. Bioclastic material: mostly ostracods and probably charophyte molds; rare small (< 1 cm) fragments of pyrgiid(?) corals; rare micritic intraclasts; numerous (every few mm) solution seams to smooth stylolites. Matrix compaction is weak in grainstones and moderate to strong in packstones. Noteworthy, dolomite seems to be associated to more compacted intervals.

3293.5-3294 Limestone: moderately dolomitic dark brownish gray; packstone to rudstone bioclastic with gravel-sized micrite intraclasts. Bioclasts diverse (unlike above): tabulate (pyrgiid?) corals, stromatoporoids, mass ostracods, thick bryozoans, charophytes, etc. No in situ skeletons. Moderate to strong intergranular compaction. Dolomite evenly distributed, referentially in micritic substrates.

3294-3296 Limestone: dark brownish gray, dolomitic in top (dolomite following compacted laminae) to weakly dolomitic to non-dolomitic in base; calcimudstones, wackestones, and thin-shelled floatstones laminated (horizontal orientation of shells). Bioclasts: ostracods, possible brachiopods and trilobites, small pyrgiid(?) corals, charophyte molds. Compaction moderate to strong including some matrix compaction.

Box 329 (3296-3304 ft) was thrown, core mixed. Limestones: dark brownish gray, moderately to non dolomitic; grainstones vf/g, f/g and minor m/g, packstones, more or less distinctly laminated; calcimudstones with contorted flaky fabric (intertidal imprint). These textures feature frequent solution seams and weak to strong matrix compaction. At least 20 cm of grainstone non-compacted m/g bioclastic-peloidal-cortoidal, with diverse algae, micritic stromatoidal laminae, and micrite-encrusted gastropod molds. At least 15 cm of calcimudstone brownish gray, distinctly lighter than other core in this box, with convex-up decompaction fractures and catagenetically fractured base – same facies as 3209.5 -3212.5 ft but without distinct subaerial exposure features in available core pieces. Fracturation of same kind as in the base of 3209.5-3212.5, with dark marl dyke into fractures; this light-colored calcimudstone is likely in the box bottom (3303.5-3304 ft) because the top of Box 330 contains small chips of this facies, and the top of the uppermost core slab is partly matching the dark marl and the surface of the brecciated base.

3304-3304.5 Limestone: dark brownish gray; conglobreccia cemented by dense micrite; clasts variable from micrite to grainstone and dismicrite. Grains merge with matrix in cementing micrite laminae. Black mottles (former bitumen-plugged microporosity) develop both upon grains and in matrix. In the interval top conglobreccia grades to calcimudstone. Vugs filled with blocky calcite are partly fabric selective. Thin section is required to evaluate for paleosol vs. marine origin.

3304.5-3307.5 Limestone: dark brownish gray, with thick solution seams defining nodular fabric. Early lithified calcimudstone with locally present brecciated stromatoidal features, intercalated with thin (1-3 cm) m-c/g peloidal grainstones-packstones with minor thin-shelled bioclast material. These grainstones-packstones rest on uneven calcimudstone surfaces and sometimes grade into calcimudstone.

3307.5- 3317 Limestone: dark brownish gray; grainstones m-c/g, peloidal and bioclastic-peloidal, locally with cm-sized intraclasts-lumps, intercalated by thin mudstones (mud drapes). Grains in grainstone partly merged by micrite cement bridges and moderate intergrain compaction. No isopachous cement observed. Thick (2-10 mm) black-stained solution seams with overcompacted

grainstone fabric. Relatively sorted, f-m/g oolitic grainstone occurs in lower part of the interval. Top (uppermost 20 cm) gradational, with important wackestones and dark, argillaceous bioturbated wacke-mudstones. Identifiable trace fossils: *Planolithes* and *Chondrites* or *Syphonophycos*. Diverse, mostly thin-shelled brachiopods, rare pyrgiid(?) corals, gastropod-enriched layers; various calcareous algae. Larger peloids (lime mud intraclasts?) often enclosed in whitish micrite envelopes. Base marked by a 5 cm-thick oncoid rudstone lying on a thin overcompacted calcimudstone with mass ostracod laminae. Black bitumen mottles are common, indicating matrix microporosity.

3317-3317.5: Limestone: argillaceous (marl), brownish black, overcompacted, fissile. Calcimudstone-wackestone with micritic nodules, rare small (<1.5 cm) pebbles of pale arenaceous(?) micritic limestone. Corroded bryozoans or algae are present.

3317.5-3319.5 Limestone: pale brownish gray, stylolitized; calcimudstone bioclastic (mostly ostracods), vuggy (solution vugs occluded by clear calcite spar cement). Bioclasts sparse in the upper part, growing in number downward; in base ostracods form thin non-disturbed laminae. The top 5 cm is different: breccia of pale vuggy Limestone: with indistinctly laminar fabric enveloping vuggy rounded micrite clasts, with pockets and caverns filled by the black marl probably infiltrated from the above interval; these voids also contain sand and gravel clasts of pale calcimudstone; laminar mass host rare bioclasts (ostracods, brachiopods) of good preservation – may be a stromatoidal automicritic crust on karstic brecciated top rather than a paleosol (needs additional study!). Matrix compaction appraised from ostracod valve flattening is very weak near top (below the upper stromatoidal crust) to moderate in base. Vugs very different size from pinpoint to 3-5 mm. Whitish haloes around some larger vugs.

3319.5-3324 Limestone: dark brownish gray; calcimudstone bioclastic (mainly ostracods and tiny whitish spheres), with dominantly clotted matrix in the upper 20-30 cm giving local transition to grainstone texture; intervals of dense matrix are mostly strongly compacted with flaser texture; clotted matrix fabric may be preserved because of early subaerial cementation. The lower half is dominated by calcimudstone dense, compacted (flaser), with thin ostracod lenses.

3324-3328.5 Limestone: dark brownish gray; packstone bioclastic, ostracodal, with abundant tiny whitish microfossils - unilocular foraminifers? Few wackestone and calcimudstone lenses; poorly sorted grainstones appear in the lower half; rare intraclasts of wackestone-packstone ostracodal; obscure bioturbation; storm erosional surfaces and weakly expressed graded rhythmicity is locally visible; short drapes of dense micrite and micritic peloids are common; thin stromatoidal crusts on some graded beds. Skeletal assemblage moderately diversifies downward (mollusk molds, rare thick-shelled bioclasts). Base marked by 10 cm thick fissile, weakly argillaceous very dark Limestone: – packstone vf/g with rock-forming “tiny whitish microfossils”. Base stylolitic, sharp, may represent a submarine scour surface.

3328.5-3332 Limestone: dark brownish gray; boundstone micritic-stromatoporal in upper 20 cm, grainstones bioclastic-peloidal below, thick domal stromatoporoids in grainstone matrix at 3331-3331.5; the interval base marked by conglomerate-calcarenite intraclastic (micritic pebbles up to 2 cm). The upper boundstone contain stromatoidal-to-thromboidal micrite patches with complex syngenetic brecciid texture; the grainstone in the middle part of the interval is poorly sorted, vf/g to m/g, with rare pyrgiid (?) corals; the conglomerate-calcarenite is distinct by internal blackening of micritic clasts and contains at least one erosional surface with dense calcimudstone drape; pale (“bleached”) envelopes around micrite clasts may be destructive micritization.

3332-3334.5 Dolomite calcareous and minor limestone dolomitic: dolomite finely and uniformly crystalline ( $\leq 30 \mu\text{m}$ ), apparently developed upon dense massive calcimudstone with no macrofossils in it. Faint dark greenish gray staining in the matrix; the interval is riddled with curved upright channels (occluded by clear calcite spar), some of them branching – very much like root voids. These



channels become sparse downward and disappear in basal 10 cm. Paleosol development is likely – needs more study.

3334.5-3336 Limestone: dull brown; nodular stylolitized calcimudstone in top with mottled staining (dark mottles developed in nodule centers); non-calcareous pyritic clay form lenses along stylolites in upper part of the interval; this clay may represent collapsed soil-filled caverns; rare spar-filled solution vugs; calcimudstone clotted to dense in upper part; in lower half, the rock becomes mostly clotted, with some grainstone gradations, enriched in thin bioclasts (ostracods, ?charophytes, etc.). Base sharp, stylolitic.

3336-3341.5 Limestone: dark brownish gray; grainstones poorly sorted, grain-packstones, and minor rudstones bioclastic-peloidal, with many algae, with lenses of subrounded cortoidal grainstones; common amoeboid to horizontal micrite mottles merging original grainstone fabric; many thick solution seams; high-diversity macrofossil assemblage with tabulate corals (auloporideans, probably pyrgiids), small stromatoporoids, bryozoans, broken brachiopods. Top marked by a thick solution seam with micritic and peloidal grainstone intraclasts. Matrix grades to dense micrite in base.

3341.5-3343.7 Limestone: dark brownish gray; calcimudstone dense to clotted (dismicrite), stylolitized with thick solution residue linings, catagenetically brecciated (wide open fractures filled by clear calcite spar).

3343.7-3347.2 Limestone: dark brownish gray; grainstones poorly sorted and rudstones bioclastic-peloidal, with many cortoidal micrite grains and ?oncoids, with micrite-enveloped bioclasts, intercalated by dense micrites; some of those micrites preserve ghost oncoid-peloid rudstone texture; mollusk molds are common; mottles of black staining (bitumen-plugged microporosity?) and some larger cortoids with pale micritic rinds and blackened interior; constructive micrite envelopes (oncoids?) are common; weak matrix compaction and thick, frequent solution seams probably defining nodular fabric; strongly dolomitized thin-shelled (ostracod, brachiopod) wackestone in base

3347.2-3347.6 Dolostone calcareous: dark gray in top, grading to limestone dolomitic in base; packstone vf-f/g, poorly sorted, presumably lithoclastic with some poorly preserved thin-shell bioclasts; faint traces of syngenetic brecciation and polymud-like fabric with crudely layered, greenish calcisiltite sediment distributed in a geopetal manner; a faint karstic top is preserved in dolostone; this fabric may have paleosol origin. The base is enriched in sand-sized lithoclasts from the interval below (lithoclastic calcarenite).

3347.6-3348 Dolostone calcareous: light brown, microcrystalline and fabric retaining: wackestone massive bioclastic (poor assemblage of ostracods and spheres - probably charophytes); all bioclasts internally dissolved and filled by brownish sparitic cement; matrix with light colored sand-sized carbonate clasts, affected by patchy staining; numerous fenestroid horizontal solution cavities floored by microlaminar carbonate sediment; polymud fabric developed along the main upright conduit and adjacent cavities, slightly less important than in the interval above. Basal 2 cm with darkened matrix, strongly degraded original bioclastic texture, and with complex calcrete like veins. Some fenestroid voids have branching, channel-like appearance and whitish calcrete-like linings – possible rhizcretions.

3348-3354 Dolostone calcareous: hard, brownish gray to dull brown, microcrystalline and fabric retaining: the matrix of grainy carbonate (possible primary grainstones and packstones) is broken by abundant solution voids with geopetal dark gray microlaminar sediment; residual space in solution voids is filled with coarse calcite spar; some of these voids have distribution of the internal sediment resembling pedogenic coatings; the solution voids resemble Stromatactis and are connected to each other by fissure-like conduits; internal sediment is probably more argillaceous than matrix and grade

into replacive argillation stringers that are equally abundant. Rounded and subrounded, dominantly f/g whitish cryptocrystalline grains and tiny spheres are visible in the matrix; rare ostracod molds; admixture of siliciclastic sand is possible. The rock is penetrated by fine dendritic network of black staining – either bitumen-plugged microporosity or Mn staining.

3354-3359 Limestone: dark brownish gray, nodular with thick solution seams; calcimudstone massive, dense, with minor lenses enriched in micritic peloids (up to local development of peloidal grainstone); bioclasts extremely rare in upper 20 cm, become more common to base; only thin-shell fragments (ostracods, ?mollusks); stripes of microcrystalline dolomite locally developed along pressure solution zones. Base gradational.

3359-3361.5 Limestone: dark brownish gray; grainstones bioclastic-peloidal alternating with dense calcimudstones and packstones ostracodal in the upper half; below packstones and grainstones poorly sorted, f-m/g, locally grading to calcimudstones clotted; horizons of micrite intraclasts and more than one internal erosional surface; bioclasts diversity increases to base, broken pyrgiid appear; grainstone layers with gently inclined lamination and amoeboid micrite cementing mottles; thick solution seams.

3361.5-3367 Limestone: dolomitic to dolostone calcareous, dark to medium gray: dolomitization selective, developed in matrix and micritic grains; larger skeletal fragments non-dolomitized; packstones and minor grainstones poorly sorted, massive. Fine details of matrix composition obliterated by dolomitization. Common pyrgiid(?) corals throughout the interval.

3367-3374.2 Limestone: dark brownish gray; alternation and intergradation of grainstones-rudstones cortoidal, intraclastic and/or oncoidal, micrites with ghost oncolite/intraclast structures. Micrite cement important, merging original coarse allochem texture; horizons of syngenetic breccia and conglobreccia; algae with micritic thalli may be important; rare horizons of pyrgiid corals and gastropods. Frequent horizons of intergranular pressure solution. Rare dolomitization stripes.

3374.2-3378 Limestone: brownish gray; calcimudstone dense in upper part, with increasingly important clotted texture to base; top sharp, stylolitic, apparently disconformable; tiny thin-shell bioclasts (mostly ostracods, few mollusks) rare in top and common to the base; solution vugs and molds develop from top – these vugs are occluded by coarse clear calcite spar and do not contain geopetal floorings; very faint breccoid texture within calcimudstone in top. A black stained (former microporosity?) layer of intraclastic m-c/g calcarenite at 3377.2-3372.4. Base marked by extensive development of solution seams, otherwise conformable. Numerous stylolites but no matrix compaction in upper part, a weak matrix compaction develops to base.

3378-3380.5 Limestone: dark brownish gray; grainstones bioclastic-peloidal, poorly sorted, f/g to m-c/g, with extensive micrite cementation; minor packstones; common micrite intraclasts and/or peloids, some with whitish micritization rinds; minor mollusk coquinas; obscure swirly bioturbation; common spheres and whitish dense grains of same size (0.2-0.3 mm) – micritized spheres? Moderate matrix compaction and solution seams.

3380.5-3383.8 Limestone: dark brownish gray; wackestones and calcimudstones bioclastic with grainstone lenses, notably bioturbated (simple horizontal and plunging burrows – *Planolites?*), with micritic algal nodules and micritic intraclasts. Tiny spheres throughout the interval, especially abundant in base. Medium to strong pervasive development of solution seams.

3383.8-3384.2 Limestone: dark brownish gray, grading in base to limestone dolomitic; calcimudstones and wackestones f/g bioclastic intercalated by packstones peloidal-bioclastic, predominantly ostracodal; ostracod valves hydrodynamically sorted; primary lamination locally visible,

moderate to weak bioturbation possible; ostracod layers contain flattened calcimudstone intraclasts and likely represent graded storm beds.

3384.2-3385 Dolostone calcareous: brownish gray; a ghost bioclastic texture (wackestone?) and laminar to swirly bioturbation, displacive dolomitization or pedoturbation?) fabric; a distorted bioclastic-calcareous layer in the middle; the calcareous sand is represented by paleosol derived lithoclasts. Thin undulating stylolites and slickensides; stylolite and ghost rugged erosion surface in base -subaerial unconformity.

3385-3389.5 Dolostone moderately calcareous: beige, fabric retaining. The upper 15-20 cm shows complex pre-dolomite fabric with breccia developed from top and complex, indistinctly laminar-to-mottled pattern. Some laminae originate from pressure solution, and others penetrate matrix, variously bending from subhorizontal to upright in a cutan-like manner; these latter laminae or stringers contain dark laminae and ghost clasts, perhaps having soil origin. Matrix sheared and contorted with multilevel development of faint stringers and variously oriented short fissures. Below these upper 15-20 cm, the core is broken into cm-sized pieces with conchoidal surfaces; these pieces retain ghost spheres (charophytes?) and solution vugs and channels filled by dolomite spar; the channels are curved, 0.2-0.35 mm in diameter, bending and occasionally branching; matrix becomes more uniform with faint darker stringers in it. The lower 30-35 cm is a coherent core with numerous solution cavities filled by geopetal faintly laminar sediment containing carbonate clasts; laminae tend to grade into matrix which is faintly mottled, perhaps due to argillation development; the matrix contains solution-enlarged spheres; the basal 5 cm show strongest development of calcrete-type lamination with multiphase coatings/laminae and almost no primary matrix. A rhizcretions-like mottles are present. Residual space in solution vugs and channels is filled by sparry dolomite. High-amplitude stylolite in base.

3389.5-3395.3 Limestone: dark brownish gray. Upper 15 cm is packstones bioclastic (ostracod dominated) with preserved indistinct lamination, with thin-shell coquina laminae, micrite intraclasts, few calcimudstone drapes, and a fenestral horizon in lower part. Below packstones give way to grainstones subrounded, f/g, peloidal, cortoidal, and/or ooidal, with a m-c/g layer at 3391.2, with gentle herringbone cross-lamination; thin isopachous cement in coarser grained laminae; thin micrite drapes on grainstone laminae are common. At 3394.5, grainstones grade to grain-packstones peloidal-ostracodal. Gastropods and rare broken pyrgiid (?) corals occur throughout the interval. Moderate matrix compaction (stronger in top and lower part), abundant solution seams and stylolites. The basal 7-8 cm is a different rock: limestone moderately dolomitic, wackestone ostracodal with churned (bioturbated?) matrix as shown by random orientation of ostracod valves, with faint, disappearing, "paleosol-type" lamination (argillation?); rare internally blackened micrite lithoclasts; the matrix is penetrated by irregular, tapering channels filled by microsparitic(?) brownish calcite. Disconformity in base.

3395.3-3397.5 Limestone: dark brownish gray; calcimudstone and minor wackestone faintly mottled, with charophytes and small ostracods (perhaps 1 species); top stylolitic; matrix is penetrated by microsparite-filled irregular channels and vugs; microsparite in former voids is distributed in a cutan manner with weak geopetal tendency, but no lamination; residual voids are filled by clear calcite spar. In the lower part matrix gradually obtains irregular, faint lamination that tend to follow solution channels. The latter are branching and most likely left by roots. Shrinkage-like structures occasionally occur. No visible matrix compaction; high-amplitude stylolites at several levels and an overcompacted zone (solution seams) in 5 cm below top. Provisional interpretation: palustrine bed.

3397.5-3399 Limestone: brownish gray (lighter than above), moderately fractured, with vertical conchoidal surfaces; calcimudstone ostracodal, bioclasts very rare; grading to wackestone ostracodal to base; calcimudstone has solution zones filled with marly calcareous sediment, some biomolds are solution-enlarged, matrix has cloudy dark staining and horizons of cement-occluded former pinpoint

porosity; no distinct root traces; matrix weakly compacted to non-compact in upper calcimudstone and strongly compacted in basal wackestone; numerous stylolites, thick solution seam swarms in base.

3399-3399.3 Dolostone: pale beige, non-calcareous, microcrystalline, fabric retaining; split by thin (0.2-0.3 mm) catagenetic calcite veins. The fabric is identical to 3385-3389.5 ft: numerous solution vugs and irregular channels surrounded by wrinkled laminar carbonate crusts and thick geopetal sediments – the texture very much like the rhizogenic calcrete; the matrix badly preserved, contains rare thin and tiny ostracods. Core from top and base is missing, but subaerial unconformity in top is obvious.

3399.3-3401 Limestone: brownish gray (relatively light); calcimudstone ostracodal with few small spar-filled solution vugs in top, grading to wackestone and local packstone f/g ostracodal in lower half; matrix compaction weak to moderate, increasing downward; solution seams especially important in the lower half. The rock darkens in base.

3400.6-3401.3 Limestone: dark brownish gray; grainstones f/g with m-c/g laminae, ostracodal, with strong matrix compaction in top, grading downward to peloidal and subrounded, cemented by thin isopachous calcite; rare large *Ortonella* nodules and micritic intraclasts; basal 10 cm enriched in broken skeletal material (rugose corals(?) and brachiopods). Poorly seen primary lamination. No in situ macrofossils. Base chosen on a stromatolite-like stromatoporoid encrustation.

3401.3-3409 Limestone: dark brownish gray; upper part (3401.3-3403.1) is floatstones, rudstones coral-brachiopod with minor coral bafflestones and in situ brachiopod banks; matrix bioclastic-peloidal, with small nodules of dense micrite, probably bioturbated; important solution seams throughout; macrofossils diverse. Below 3403 ft macrofossils become sparse, textures gradually change to grainstones bioclastic-peloidal f/g with possible minor grainstones ooidal, with intraclastic levels, intercalated with mini-nodular calcimudstones; grainstones poorly sorted; lower part of bed contains gastropod molds and rare brachiopod and coral fragments; finely crystalline dolomite develops as stringers upon solution seams. Dolomitization increases to base. The basal 8 cm is limestone dolomitic to dolostone calcareous retaining complex polyphase brecciated to laminar fabric; one population of subangular clasts apparently derived from the underlying truncated bed; no macrofossils preserved in this part of interval; provisional interpretation of the basal 8 cm – in situ paleosol.

3409-3411 Dolostone argillaceous to ?claystone dolomitic: finely crystalline, moderately calcareous to non-calcareous, gray, showing faint brecciated-to-laminar soil-like fabric; laminae and clasts show characteristic curved outlines. Top erosional, rugged, penetrated by curved channels and vugs filled by dark sediment from the above. No skeletal fossils other than very rare ostracods. A piece of micritic Limestone: (calcimudstone with complex texture) in the middle of the interval is probably misplaced. Prominent karstic disconformity in base.

3411-3414 Limestone: brownish gray (relatively light), strongly karstified and stylolitized (up to development of karstic-stylolitic breccia). Dark cloudy mottles (staining) inside Limestone: blocks. Top rugged (35 mm amplitude in core), with overhangs and deep solution pockets filled by gray massive weakly calcareous claystone. Primary texture: calcimudstone bioclastic (monotonous ostracods); bioclasts solution enlarged, associated to pinpoint vugs in upper part, and much better preserved in base; they are distributed in thin (0.2-1 mm) laminae and lenses showing by that non-disturbed lamination. Solution vugs in upper half almost totally filled by the claystone, below taking over by sparry calcite. Stylobreccia horizons become more important to base.

3413-3417 Limestone: brownish gray to dark brownish gray; alternation of calcimudstone and laminated peloidal-ostracodal packstone in upper half, packstone peloidal-ostracodal with wackestone-calcimudstone and dark marl intercalations in the lower half; lamination more explicit in the lower half because of dark marl stripes; weak swirly bioturbation may be present in the middle of the interval. Lamination is also enhanced by low-amplitude stylolites; weak to strong matrix compaction increasing to base. Base conformable.

3417-3419 Limestone: dark brownish gray; fining-upward succession: in top grainstones and mud-poor packstones f-m/g peloidal-bioclastic, downward grading to grainstones m/g and c/g, progressively more rounded, peloidal, aggregate, and intraclastic; mass micritized ooids may be present (=rounded peloids); displaced pyrgiid (?) corals occur in upper part; fenestrae (0.3-1 cm) and/or solution-enhanced fenestrae occur in lower half; strong matrix compaction and thick solution seams in upper part, weak to no matrix compaction to base. No macrofossils in the lower half of interval.

3419-3420.3 Dolostone calcareous to limestone: dolomitic, microcrystalline, fabric retaining, beige to dark beige, lighter than above and below; the upper 5 cm is original grainstone c/g peloidal like in the interval above overprinted by replacement fabric – calcrete-like laminae, geopetals and obliterative mottles, upright irregular crudely laminar replacing zones with completely lost grainstone texture; irregular vermiform spar-filled channels sometimes present in pale beige dolomite replacement mottles; through a stylolite or missing contact, this grainstone is underlain by a dolostone most lightly colored, with complex breccoid – dark-pebble - laminar-coating fabric characteristic of soils. This texture grades downward into dolostone massive beige pelitomorphous with numerous charophytes and ? other spheres, with solution enhanced ostracods, with faint laminar-coating fabric; whitish and blackened carbonate clasts are common; syngenetic wide fissures filled by darker crudely laminar lithoclasts-enriched sediment; irregular vermiform channels locally occur; the rock darkens to base.

3420.3-3424.2 Limestone: dark brownish gray; grainstones poorly to moderately sorted, vf/g and f-m/g, bioclastic-peloidal (mostly ostracods) with some aggregates in the upper half; top marked by a thick (4 cm) black fissile marl with brownish gray micrite lime clasts; a calcimudstone with ostracod laminae and possible erosional top at 3421.3-3421.7 ft; lower 0.5 m is nodular bioclastic wackestone grading to grainstones, with small (5-7 cm) micrite-stromatoporoid-algal bioconstructions, upturned pyrgiid corals (gen. *Cladochonus?*), and brachiopod fragments; micritic and grainstone intraclasts throughout the interval; weak to strong matrix compaction in grainstones; numerous solution seams; micritic lenses tend to be fractured but with no matrix compaction.

3424.2-3426.7 Limestone: brownish gray, relatively light; the upper 20 cm is wackestone bioclastic (ostracod-dominated), bioturbated; below is the alternation and intergradation of syngenetically brecciated micrites, grainstones bioclastic-peloidal, and packstones-wackestones bioclastic, with small pyrgiid corals and other marine fossils (relatively high assemblage diversity); moderate matrix compaction in the upper 20 cm, weak to no matrix compaction and important stylobreccia below; the basal 10 cm separated by erosional surface (ephemeral subaerial exposure). Below this surface, calcimudstone brecciated (solution-enlarged shrinkage cracks?), with obscure lamination, grading down to m/g peloidal-bioclastic grainstone, with numerous micritic intraclasts and grainstone lenses; this grainstone grades downward into compacted bioclastic packstone. Sparite-occluded solution vugs (1-10 mm in size) occur mostly in the middle and lower parts of the interval.

3426.7-3427.7 Dolostone calcareous and argillaceous: micro- to finely crystalline, dark gray to almost black, with faint cloudy fabric, in base and top more argillaceous, with competent, partly collapsed dolostone mottles-clouds in a black fissile matrix; no bioclasts preserved.

3427.7-3433 Limestone: dark brownish gray, slightly lightens to base; packstones and grainstones f/g and m/g with minor c/g laminae, peloidal-bioclastic (ostracod dominated), with large (> 1cm)

intraclasts, laminated in upper 0.7 m, predominantly massive below; an interval of catagenetic brecciation at 0.7-1.0 m below top with fractures filled by blocky calcite; dolomitization stripes along solution seams in upper 0.7 m; small-scale nodularity in lower half of interval made by short and frequent solution seams; moderate matrix compaction throughout the interval except for few micrite cemented layers. No in situ macrofossils.

3433-3437.3 Limestone: dull beige, relatively light; wackestone-calcmudstone distinctly laminated; top conformable, facies transition through laminar alternation of packstone-grainstone ostracodal and calcmudstone in the upper 20 cm; lamination mostly subhorizontal with minor gently inclined series; in basal 25 cm calcmudstone is syngenetically brecciated (tidal-flat desiccation); no macrofossils.

3437.3-3440 Limestone: dark brownish gray, partly weakly argillaceous, in lower half alternated with very dark dolomitic marls; facies different: grainstone poorly sorted m/g peloidal-ostracodal in upper 15 cm followed by 25 cm of strongly compacted breccia and/or polyphase conglobreccia of calcmudstone and wackestone with few small skeletal fossils; tidal-flat desiccation origin of this breccia is probable; below is the alternation of packstones, wackestones, and calcmudstones peloidal-ostracodal partly laminar; a 14 cm-thick layer of fissile calcareous-dolomitic marl with obscure primary texture in 0.1-0.25 m above base. Calcmudstone-wackestone laminar in base.

3440-3440.3 Limestone: light beige; calcmudstone laminar, stylolitized, with rare solution-enlarged bioclasts (mostly tiny ostracods); no large solution cavities. Only 4 cm of core is available, more cores from this interval must be missing.

3440.3-3445.5 Limestone: dark brownish gray, weakly argillaceous in base; upper half is alternation of packstones-grainstones bioclastic-peloidal subrounded with calcmudstones clotted; the 0.5 m below is calcmudstones/automicrites dense, non-compacted, some with ghost grainy (micritic peloidal or intraclastic) texture; rare syngenetic brecciation features; the basal 0.4 m is packstones and minor grainstones ostracodal probably bioturbated and weakly argillaceous, with large (ca. 1 cm) rare intraclasts, compacted with small-scale nodularity very similar to 3437.3-3440; skeletal macrofossils appear in the lower half of interval and grow in number downward: different gastropods, algae, ?charophytes; no corals.

3445.5-3447.5 Dolostone calcareous: dark gray alternating with dolostone argillaceous; few intercalations of limestone; dolostone finely crystalline, fabric retaining: wackestones bioclastic (only ostracods and ?charophytes), the texture is mostly massive with bioclasts uniformly dispersed in matrix; a hydrodynamically sorted layer of ostracod packstone (coquina) in the middle; weak soil-like mottling and branching channels (rootlets?) in massive beds; horizons of subangular intraclasts; no matrix compaction in pure carbonate layers; argillaceous intervals have moderate to strong matrix compaction.

3447.5-3448.5 Limestone: dull beige (relatively light) in top, quickly darkens downward, with interbeds of dolostone calcareous and argillaceous; calcmudstone laminar in top, grading downward to darker wackestone and packstone ostracodal partly laminar with dense non-compacted micritic matrix; gradations to micrite-cemented grainstone develop in base; dolomitized argillaceous intervals show moderate to strong matrix compaction; rare small solution vugs and a small (1 cm) zone of solution brecciation in upper calcmudstone.

3448.5-3451 Limestone: dull beige, distinctly laminar from alternation of darker argillaceous and paler pure carbonate laminae; a complex contorted laminar to cloudy to obscurely breccoid fabric (sabkha) develops in the middle of the interval; mostly calcmudstones; laminae often show small-scale crenulations; basal 10 cm is packstone dark brownish gray, ostracodal, with few calcmudstone laminae; horizons and mottles of tiny solution vugs making spongy appearance.

3451-3455 Limestone: dark brownish gray; grainstones, packstones, and minor wackestones bioclastic and peloidal, with several horizons of in situ and upturned pyrgiid corals and ?large conical bryozoans; broken brachiopod shells and numerous diverse gastropods (preserved as molds); primary lamination rarely preserved; black staining mottles that tend to coalesce into horizons; these mottles probably indicate bitumen-plugged microporosity zones; gradations from grainstones to packstone and wackestones through development of dense amoeboid micrite mottles. Thick solution seams define nodularity; weak to no matrix compaction inside nodules.

3455-3459 Limestone: dark gray, downward increasingly dolomitic and grading to dolostone calcareous, partly moderately argillaceous; wackestones bioclastic (thin-shelled ostracods, charophytes); abundant sphaeric biomolds (charophytes?); common to abundant vermiform channels (rootlets?); all primary voids filled by clear spar calcite. Matrix massive to faintly textured (soil-like brecciation-to-lamination, occasionally with ghost traces of multiphase rootlet penetration). The lower 0.2 m is dolostone weakly calcareous, mostly fabric retaining. Fish sclerites at 3457.5; Most distinct pedomorphic texturing in dolostone in 0.1-0.2 m above base.

3459-3460.2 Limestone: dark brownish gray; grainstones peloidal vf/g to m/g, with common bioclasts (mostly ostracods) and micrite intraclasts; minor wackestones and calcimudstones; extensive micrite cementation; primary lamination mostly lacking (bioturbation?); small (1-2 mm) ovoid birds-eye fenestrae in top. No macrofossils. Weak to no matrix compaction, numerous wavy solution seams. Top unknown, base gradational.

3460.2-3463.5 Dolostone calcareous, with limestone intercalations, in lower half alternation of dolostone and limestone; primary lamination (many laminae wrinkled) defines stripy dolostone distribution; primary texture obscure in dolostone, in Limestone: laminae it is calcimudstones, wackestones, and minor packstones vf/g to f/g ostracodal.

3463.5-3464.5 Limestone: dark brownish gray; grainstones m-c/g, peloidal-bioclastic, ostracod dominated, with gentle cross lamination, in base intraclast-rich; besides ostracods, common curved partitioned tubes (microconchid worms?) and few other groups; no large or thick-shelled macrofossils; a 7 cm interval of dense mottled micrite with spar-filled fenestrae, solution vugs, and/or desiccation cracks; this micrite is nodular (stylobrecciated?) in top.

3464.5-3468.5 Limestone: dark brownish gray, mostly microlaminar (with wrinkled features), partly dolomitic, slightly lighter in the middle. Primary texture different: 10 cm of microlaminar calcimudstone in top followed by 16 cm of grainstone to calcimudstone brecciated to intraclastic conglobreccia; below is a laminar alternation of calcimudstones, wackestones ostracodal, and grainstones f-m/g peloidal rounded (oid presence possible); grainstone increases downward to grainstone-dominated rock in base. Large intraclasts in basal part. Dolomite develops along darker, probably more argillaceous and more compacted laminae. No macrofossils.

3468.5-3470.5 Limestone: dark brownish gray, nodular, partly dolomitic; bioclastic wackestones with patches of f-m/g peloidal-bioclastic grainstone; local evidence of bioturbation (*Thalassinoides?*), no primary lamination preserved; macrofossils diverse: in situ coral clusters and stromatoporoids; matrix dense micritic, "early lithified" type, locally syngenetically brecciated. Rare subangular limestone clasts in base.

3470.5-3471.3 Limestone: deep gray; calcimudstone with buckled, finely brecciated lamination; cracks between laminae fragments cemented by brown sparitic calcite; a sub mm-scale brecciation pattern resembling soil pedality; penetrative tubular structures filled by brownish micritic calcite; vugs and stellate voids filled by micritic coatings and clear sparry calcite in residual space; circular

biomolds (charophytes) and rare tiny ostracods; rare subcircular shrinkage structures; top compacted (flaser), probably argillaceous, disconformable.

3471.3-3472.4 Limestone: dark brownish gray, dolomitic, weakly argillaceous; wackestone ostracodal, with very few worn echinoderm sclerites, syngenetically brecciated (submm-scale rounded brecciation resembling fine soil pedality); dolomite finely crystalline, developed along clay-enriched syngenetic cracks and stringers; base enriched in charophytes and more uniformly dolomitized, with no visible brecciation. Moderate, uneven matrix compaction.

3472.4-3476.7 Limestone: brownish gray, lighter than above and below; calcimudstone faintly microlaminar, karstified from top, grading downward to ostracod wackestones and microlaminar rock (alternation of ostracod coquinas and buckled micrite laminae); subaerial disconformity in top; solution vugs filled by calcareous-dolomitic marl in upper 15 cm; below marl sediment gradually shrinks to geopetals and then disappears at 30-40 cm below the top; the residual cavity space is filled with calcite spar; no matrix compaction but stylolites developed along primary solution zones; in top solution cavities have dark subcoatings; a large marl-filled cavity in 5 cm below top.

3476.7-3480.2 Limestone: dark brownish gray, probably weakly argillaceous; grainstones f/g ostracod-peloidal alternating with ostracod packstones (coquinas) and syngenetically brecciated micrite patches; rare large gastropods. One corallite of tabulate coral found in base. Micrite-cemented intraclastic conglobreccia (subrounded fragments) in base. Compaction moderate to strong, uneven (with local nodular fabric), with frequent solution seams.

3480.2-3482.2 Limestone: brownish gray, in top slightly lighter than above, downward grading back to dark brownish gray; top stylolitized, admitted by weak disconformity or paraconformity on a 3 cm-thick dense micritic crust with few poorly preserved ostracods. This crust is penetrated by oblique solution channels filled by dark argillaceous limestone. This crust grades downward into grainstone-automaticrite riddled with mm-sized solution vugs. Grains in grainstone are f/g to c/g peloids/intraclasts, composite lumps, and indistinct oncoids (thin section need); very rare and poorly preserved bioclasts; rare large subrounded grainstone intraclasts. Grainstone alternates and intergrades with dismicrites. Rare poorly preserved cm-sized gastropod molds. In base gradation to charophyte-ostracod-peloidal grainstone-packstone.

3482.2-3486 Limestone: dark brownish gray; alternation of grainstones f-m/g ostracodal-peloidal, packstones ostracodal, and micrites (dismicrites); tiny microfossils other than ostracods may be abundant; lamination (graded bioclastic laminae) locally preserved; grainstones cemented by micrite and grading to dismicrite laminae; gradation to calcimudstone with distinct disrupted microlamination in basal 15 cm.

3486-3491.7 Limestone: brownish gray, in lower 1 ft darkening; calcimudstone faintly to distinctly laminated, riddled with fenestrae-like solution vugs in upper 1 ft; disconformity in top; base gradational; the 5 m in top with distinct bluish geopetals and "sub-geopetal" calcitans; in lower half, gradation to microlaminar alternation of calcimudstones and packstones vf/g ostracodal; compaction moderate to strong.

3491.7-3496.5 Limestone: dark brownish gray; packstones non-sorted to grainstones peloidal-bioclastic; micritic cementation in grainstones; rounded intraclasts occur throughout, in 10-30 cm above base they form intraclastic conglomerate and/or conglobreccia; at least one erosional paraconformity at 30 m above base; fossils diverse (brachiopods, bryozoans, ?various algae, ?trilobites); a stromatoporoid-tabulate nodule in 4 cm above base; base disconformable, with rare brownish calcimudstone clasts from the interval below; of nodular to lenticular compactional fabric with many smooth solution seams; no matrix compaction inside nodules.



3496.5-3500 Limestone: brownish gray relatively light; calcimudstone microlaminar (finely buckled (wrinkled) lamination), with few sub-mm sized hydrodynamically sorted ostracod valves; very rare solution vugs.

3500-3505 Limestone: dark brownish gray; top and base conformable; flaser to lenticular compactional fabric; alternation of calcimudstones and grainstones peloidal and peloidal ostracodal vf/g to m/g; sedimentary lamination preserved by 50-60%, progressively less laminated subfacies to the base; a 20-thick packstone ostracodal-peloidal, moderately bioturbated, with rare small upturned pyrgiid(?) corals at 3500 ft; occasional intraclasts in grainstone beds; some beds enriched in tiny (<50 µm in size) whitish spheres. Local dolomitization in the form of finely crystalline dolomite "dust" in the host rock.

3505-3507.3 Limestone: dark brownish gray; grainstones f/g peloidal-bioclastic, subrounded, with thin (<50 µm) isopachous cement and bridges of micrite cement; sedimentary lamination partly destroyed by bioturbation(?), partly obscured by flaser compactional fabric.

3507.3-3512.7: Limestone: dark brownish gray, partly weakly dolomitic; calcimudstones and wackestones ostracodal, partly laminar (laminae from 0.5 cm to sub-mm thick; some thicker laminae with graded ostracod coquinas; subangular intraclasts throughout the interval; synsedimentary brecciation in lower 0.5 m up to local development of rip-up breccia; this basal part contains rare whitish clasts from the underlying beds; sedimentary fabrics somewhat obscured by "dolomite crystal dust" and compactional flaser to nodular fabric.

3512.7-3516 Limestone: brownish gray relatively light-colored; calcimudstone laminated (wrinkled and disrupted lamination) grading down to the alternation of calcimudstones and packstones vf/g ostracodal; minor grainstones vf/g ostracodal-peloidal in basal 20 cm; top disconformable, stylolitized, brecciated, with collapsed karstic voids filled by bluish grey slickensided calcareous shale with residual limestone fragments; small sparite-filled solution vugs; penetrate down to at least 1 ft; moderate development of dark pseudocoatings in the karsted limestone substrate; the rock darkens downward, and in basal 1 ft obtains the dark background color. Base conformable.

3516-3516.7 Limestone: dark brownish gray; calcimudstones, wackestones, in base some f/g grainstone bioclastic-peloidal; this grainstone is cemented by micrite (obscured grainy texture) and contains rare micritic clasts 1-3 mm in size; no sedimentary lamination preserved; nodular to lenticular compactional fabric.

3516.7-3522 Limestone: dark brownish gray; wackestones, grainstones, gastropod rudstones (banks); erosional paraconformity in top truncating a 50 cm thick micritic facies (wackestone to local grainstone f/g bioclastic-peloidal); this facies bears few small brachiopods and rare 1-10 m sized intraclasts; below (in the middle of interval) gradation to grainstones f/g, rounded, peloidal-cortoidal, locally probably ooidal, with micritic stringers (burrowing?) obscuring the grainy texture; these grainstones contain several erosional surfaces and intraclast horizons; several erosional surfaces in grainstones including the main one at 3519.6 ft. This surface is underlain by a gastropod bank in a syngenetically brecciated wackestone matrix grading downward to bioturbated mesh of grainstones peloidal and wackestones; a clump of pyrgiid(?) corals in 15 ft above base; the basal 10 cm is wackestone bioturbated bioclastic (ostracod-dominated).

3522-3523 Limestone: argillaceous and unevenly dolomitic, with bluish grey argillaceous dolomitic matrix and brownish gray non-dolomitized pebbles and limestone lenses; complex facies with wackestone charophytic-ostracodal in top; matrix of this wackestone dolomitized; this wackestone grades downward to broken-shell coquina (packstone consisting of thin non-identified dark shells) with a limestone conglomerate in base. Pebbles in this conglomerate are micrites of 2 kinds: light

brownish gray and dark brownish gray. This conglomerate rests on a disconformity detected in the middle of the interval. This disconformity is represented by a finely brecciated and stylolitized, probably pedogenized limestone (wackestone bioclastic). The top of this "incurive limestone" is karstic (rugged or alveolar), with shale-filled vugs. This limestone grades downward to conglomerate matrix-rich, made by subangular to subrounded pebbles of same two kinds. The matrix of this conglomerate is packstone bioclastic with bluish gray calcareous shale matrix; bioclasts are low-diversity, or even one-species, tiny shells –ostracods? Bioclasts become sparse in interval base (gradation into wackestone).

3523-3527.4 Limestone: brownish gray, darkens in base; top disconformable (rugged, erosional karstic). Calcimudstones with obscure lamination to non-laminated, grading downward to bioturbated wackestones and packstones thin-shell ostracodal; solution vugs, in upper 15 cm shale-floored compacted solution cavities and faint pseudocoatings; below, solution vugs mostly tiny (<0.3 mm), tend to develop in ostracod concentrations.

3527.4-3530.4 Limestone: dark brownish gray; wackestone calcispherical (whitish, sometimes hollow spheres ca. 150 in diameter), grading down to packstones ostracodal that become laminar in disconformable base; no macrofossils; compaction moderate to strong: fissile overcompacted zones alternating with flaser to nodular unevenly compacted zones.

3530.4-3532.0 Dolostone: dark gray, hard, finely crystalline (<50 µm), weakly calcareous; faint palimpsestic fabric with cloudy pattern apparently related to dolomitization; this pattern superimposes ghostly soil-type brecciation (fractures filled with darker material), ?large-scale teepee pattern (ghost laminae contorted and inclined at 45-55°), and in the lower half, disrupted microlaminae and mud-flake intraclasts. The soil-like brecciation is most distinct in top.

3532.0-3534.9 Limestone: brownish gray, darkens in base; calcimudstone to wackestone laminar, with 0.1-1 mm thick mildly buckled and disrupted laminae; hydrodynamically sorted ostracod coquinas, minor to locally abundant spheres; no normal-marine fossils; in lower half grades to microlaminar rock consisting of slim vf/g grainstones-packstones draped by calcimudstone blankets; moderate compaction preferentially along sedimentary lamination; no apparent solution vugs.

3534.9-3537.7 Limestone: dark brownish gray; packstones to wackestones vf/g ostracodal-spherical, flaser to mininodular, non-laminated, apparently bioturbated; top and base conformable, gradational; no normal-marine fossils.

3537.7-3540.2 Limestone: dark brownish gray, laminated; thin (0.5-2 mm) alternation of calcimudstones, ostracod packstones (coquinas), and calcisiltites (grains ≤50 µm). Base and top conformable.

3540.2-3542.6 Limestone: dark brownish gray, weakly argillaceous (?), flaser to mini-nodular, prominently bioturbated, with intercalations of packstones vf/g; wackestones f/g, ostracod-dominated, with tiny spheres and crushed bioclasts of other than ostracod affinity; bioturbation probably complies to *Planolites* type (burrows subhorizontal, plunging; no spreiten). Intraclasts of paler limestone and few oncoids in the middle of interval. Base disconformable, contains rare sub-cm sized lime clasts from the underlying interval.

3542.6-3544.6 Limestone: brownish gray, riddled with solution vugs (0.1-10 mm in size); faint pseudocoatings and incipient soil-like brecciation in upper half; rare pseudocoatings developed along solution channels (after rootlets?). Enhanced stylolitization and shale stringers in top.

3544.6-3545 Limestone: dark brownish gray, with obscure lamination; f/g ostracod packstones and wackestones.

3544.6-3548 Limestone: brownish gray, with rare small ( $\leq 1$  mm) solution vugs in top and no or extremely rare solution vugs in main part of interval; wackestones vf/g bioclastic, ostracod-dominated, with rare curved microconchids (?) and mollusk biomolds; no early compaction, only low-amplitude stylolites; matrix locally clotted; bioturbation 80-90%, with oblique circular burrows (Thalassinoides?). Top unknown, base gradational.

3548-3552 Limestone: dark brownish gray; wackestones and minor packstones bioclastic (ostracods, worn non-ostracod bioclasts, mollusk biomolds); lenses of vf/g peloidal-bioclastic packstone; lamination with ostracod coquinas preserved by 30-40% in upper 50 cm (alternation of laminated and bioturbated rock), grades down to totally bioturbated rock; small upright stromatoporoids and rare solitary corals in the middle of interval; basal 20 cm argillaceous, dolomitized, partly (by 20-30%) preserving lamination; marine bioclasts occur throughout the interval; base paraconformable.

3552-3554.5 Limestone: brownish gray; calcimudstones and wackestones bioclastic ostracod-dominated, bioturbated in upper 10 cm and laminated below, with bioturbation less than 30-40%. Ostracods diverse, including large (up to 1 cm) thin-shell forms. Solution vugs present; infrequent birds-eye solution vugs and rare pseudocoatings below the upper unconformity; no early compaction (pre-burial lithification); top unknown, base gradational; weak unconformity(ies) may be present inside the interval, in upper 10 cm separating bioturbated from laminated parts) and in lower one third (the latter unclear because of core incompleteness).

3554.5-3558 Limestone: dark brownish gray; calcimudstones bioclastic, ostracod dominated, with rare gastropods and other marine fossils that appear in the middle of interval and become more common to base; bioturbated by 90-95% (small crawling burrows); intercalations of grainstone bioclastic peloidal, with coalescent texture made by automicritic cement; moderate to strong compaction with flaser fabric; base conformable or paraconformable (sharp contact).

3558-3562.2 Limestone: dark brownish gray, slightly lightens in base; grainstones to packstones to calcimudstones bioclastic-peloidal; calcimudstones tend to be syngenetically brecciated; grainy textures merged by micritic cement; birds-eye fenestrae rare to common; swirly bioturbation; crude (5-20 mm) lamination locally expressed by micritic drapes. Matrix compaction very weak, suggesting early cementation; bioclasts more diverse than below; stromatoporoids, mollusk biomolds, supposed microconchids and possible styliolinids; rare bryozoans. Base sharp – paraconformity?

3562.2-3365.2 Limestone: dark brownish gray to brownish gray, slightly darkens to base; alternation and intergradation of calcimudstones, grainstones, and packstones fv/g-f/g bioclastic, ostracod dominated, with very rare dwarf amphiporids or algae; lamination preserved by 40-60%; grainstone vf/g in base; 1-10 mm sized birds-eye fenestrae are locally common; coating-like stringers of dolomitization in base; the base sharp, inclined at  $10^\circ$  to horizon, conformable (compactional) or disconformable.

3365.2-3566 Dolostone argillaceous and calcareous: fissile, grading downward into dolostone calcareous massive; ghost bioclasts; primary texture probably wackestone; here core is split along shearing slickensided planes at about  $45^\circ$ , the interval base is overcompacted (shale) and inclined in the same way.

3566-3569.5 Limestone: dark brownish gray; calcimudstone to grainstone peloidal with cm-sized fenestrae; texture may be described as thrombolithic or clotted (automicritic); local syngenetic brecciation associated to short shearing planes; fenestrae simple, amoeboid to ovoid to

subrectangular in shape, without geopetal sediments (only two thin geopetals encountered); 2-3 cm thick overcompacted argillaceous limestone at 3568.4 ft; rare amphiporids and gastropods; no distinct lamination; no or little early compaction, but high and low amplitude stylolites are common.

3569.5-3572 Limestone: brownish gray to dark brownish gray, slightly lighter than above; calcimudstone intercalated by ostracodal packstone-wackestone, with disrupted lamination (micritic "microbial" drapes) preserved by 50-70%; stylolites, locally black Mn dendrites; no normal-marine fossils.

3572-3573 Limestone: argillaceous, fissile, dark brownish gray, flaser; alternating disrupted brownish micritic laminae, fissile shale, and overcompacted micritic microbreccia; apparently shale contaminated tidal-flat facies.

3573-3574 Shale: dark pigeon gray to dolostone argillaceous and calcareous dark gray microcrystalline; subrounded to subangular lime clasts occur in minor quantity throughout the interval, in lower 4 cm they tend to be less rounded (para-autochthonous), to base concentrating into limestone conglobreccia in dolomitized shaly matrix; no fossils other than well-preserved charophyte oogonia 0.3-0.5 mm in diameter; no fossils at all in lower 3 cm (in situ topsoil?). Fabric complex and changing from top to base: fissile shale with rounded lime clasts and oogonia in upper 3 cm followed by a 10-cm dolomitized unit with faint soil-like brecciation pattern and minor lime clasts, then 2 cm of nodular dolomitized marl with most distinctly preserved soil-like polyphase brecciation (polymud-like pattern); it is underlain by overcompacted zone (core destroyed); the basal 3-4 cm is conglobreccia with hard dolomitized shaly matrix. Prominent subaerial unconformity in base.

3574-3577.5 Limestone: brownish gray to dark brownish gray, in top disintegrated into breccia; calcimudstones laminar, stylolitized, with characteristic disrupted and buckled lamination; in lower half of the interval, laminar alternation of ostracod packstone-wackestone and micrite ("mud drapes"). Very few large (> 1 mm) solution features, but solution microvugs, microfissures and microchannels (<0.5 mm) develop abundantly in some ostracod-rich layers. An oblique (70°) slickensided shale-lined solution fissure crosscuts the core at 3775.5 ft. Base slightly more argillaceous, finely stylobrecciated, contains pigeon gray argillation mottles/coatings. Base unknown (core missing), probably conformable or paraconformable.

3577.5-3580.6 Limestone: brownish gray to dark brownish gray; calcimudstones non-laminated, with large solution vugs, channels, with many stylolitized and manganized (black dendrites) zones of brecciation; solution caverns mostly filled by calcite spar; an upright solution zone lined with thick steel dark slickensided shale occurs at 3578.0-3578.5 ft (sampling for paleosol?). In lower 25 cm calcimudstone obtains faint wavy disrupted "microbial" texture grading downward into laminated pattern of the underlying interval. Solution vugs also mostly extinguish in base. No macrofossils, very few ostracods.

3580.6-3583.5 Limestone: brownish gray, darkening to base; calcimudstone ostracodal laminar with minor wackestone in the lower part of interval, stylolitized along bedding planes; distinct 0.5-2 mm thick lamination in top, less disrupted than at 3574-3577.5 (interp.: lower subaerial exposure index), gradually becoming obscure downwards where it is expressed only by horizontal orientation of ostracod microcoquinas; manganese dendrites develop along some laminae in the upper 20 cm. Top and base conformable.

3583.5-3586 Limestone: moderately argillaceous: dark brownish gray to almost black (numerous black solution seams), nodular; wackestones to packstones to grainstones f/g bioclastic-peloidal and only peloidal, clotted textures (automicrites); bioclasts diverse, probably ostracod dominated;

calcareous algae present; rare gastropods, bulbous stromatoporoids, and pyrgiid(?) corals; top and base gradational.

3586-3588.5 Limestone: dark brownish gray; grainstones f-m/g, peloidal, bioclastic, and ooidal, amalgamated by micritic cement; minor packstones; no or rudimentary isopachous cement; all intergranular pore space occluded by sparite cement; rare branching pyrgiid (?) corals, thin-shelled brachiopods, calcareous algae (?), and other small marine fossils; nodular compactional fabric; no or little intergranular compaction inside nodules; lamination obscure, mostly in base. Paraconformable base.

3588.5-3591.3 Limestone: dark brownish gray; laminar alternation of ostracodal wackestones, packstones, and calcimudstones; ostracods (strongly dominating), tiny spheres, other thin-shelled microfossils; minor intercalations of vf/g grainstone in lower 20-30 cm; lamination smooth, not buckled, without distinct microbial "mud drapes"; fractured zone with catagenetic calcite-filled vugs in 20 cm above base. No macrofossils.

3591.3-3592 Limestone: dark brownish gray; clotted grainstone to wackestone very similar to the 3583.5-3586, but non-argillaceous; intergranular space in grainstone locally occluded by milky white cement (marine isopachous radial cement?); no intergranular compaction; microconchid-like curved tubules, various microfossils; rounded intraclasts in grainstone subfacies.

3592-3593.3 Limestone: dark brownish gray, slightly lighter than above; wackestones ostracodal laminar; minor tiny spheres and other microfossils; lamination non-disruptive.

3593.3-3594: Limestone: dark gray, partly moderately argillaceous; wackestone ostracodal-charophyte, bioturbated (chaotic orientation of bioclasts in non-compacted lenses), faintly mottled (incipient soil-like brecciation), in upper half penetrated by spar-filled solution channels (rootlets?); moderate to strong flaser to lenticular compactional fabric. Top and base probably conformable.

3594-3595 Limestone: dark gray; a fining-upward unit with disconformity in base; from base to top: a calcimudstone-automicrite grading through amalgamated clotted fabric into grainstone peloidal, with faint syngenetic brecciation fabric and superimposed soil-like marly windows with limestone breccia (7 cm); this layer grades upward into laminar alternation of grainstone, packstone, and calcimudstone (3 cm); this in turn grades into laminar (laminae 1-5 mm thick) calcimudstone with postdepositional brecciation (20 cm); transition into overlying interval through development of grainstone laminae at expense of attenuating calcimudstone laminae; thin brachiopods shells and relatively diverse bioclasts throughout the interval, preferentially in its lower 10 cm; stylolites and solution seams, but no early intergranular compaction.

3595-3596.7 Limestone: gray, slightly brownish; calcimudstone (dismicrite) small-fenestral, with faint syngenetic brecciation pattern and dark gray pseudocoatings; fenestrae of two types: vug-like birds-eyes and upright to oblique gently curving channels 0.3-0.5 mm in diameter (rootlets?) All fenestrae occluded by clear calcite spar; minor to common ostracods but no normal-marine fossils; no lamination preserved, ostracod valves randomly oriented; no or weak matrix compaction, numerous stylolites. Syngenetic brecciation and some rounded intraclasts are distinctly present in base. Base unknown (no core), supposedly paraconformity.

3596.7-3599.3 Limestone: dark brownish gray; laminar (1-5 mm) alternation of grainstones f-m/g subrounded, bioclastic-peloidal, and ostracod rich packstones-wackestones; locally laminae show inclination at 1-5°, tapering, and onlap terminations (herring-bone lamination); lamination fades out to interval base; the lower half of interval is dominated by grainstone; grains cemented by micritic bridges, no distinct isopachous cements; base conformable, through gradation into packstone; rare

large intraclasts in base; lower part of interval contains rare large (1-3 cm) solution vugs (probably catagenetic) surrounded by strongly manganized zones of micro-brecciation; bioclasts dominated by diverse ostracods; thin-shell brachiopod fragments, very rare upright bryozoans; no matrix compaction in grainstone and weak to moderate matrix compaction in packstones.

3599.3-3600 Limestone: argillaceous very dark brownish gray, overcompacted; wackestones bioclastic with large collapsed micritic oncoids and/or intraclasts; fine stringers of microcrystalline dolomite preferentially replacing matrix.

3600-3601.3 Limestone: dark brownish gray; calcimudstone-wackestone bioclastic intergrading with grainstone peloidal f-m/g micrite cemented; weak syndepositional discontinuity surfaces; bioclasts are predominantly ostracods, relatively diverse, minor thin-shelled brachiopods; some juvenile brachiopods occur in life position in micritic patches; stylolitization, locally up to fine stylobrecciation; base strongly dolomitized with lost primary texture.

3601.3-3602.6 Dolostone calcareous: microcrystalline, partly fabric retaining, dark grey with pale beige stripes; buckled, locally disrupted lamination, in the middle brecciation; the middle of interval is admitted by disconformity: multiphase brecciation of the laminated facies, channels, dark pseudocoatings along some channels; this unconformity is overlain by a 3-4 cm thick dolomitized f/g grainstone with pebbles of fenestral carbonate; the breccia under disconformity is cemented by pigeon gray dolostone matrix, probably moderately argillaceous, with indistinct cloudy fabric; this type of matrix becomes dominant to base and contains charophyte molds; compaction weak to moderate in base.

3602.6-3603.3 Limestone: brownish gray; calcimudstone to packstone ostracodal indistinctly laminated (lamination expressed by ostracod microcoquinas), with dolomitization stripes developed along primary lamination. Top and base probably conformable.

3603.3-3605.5 Dolostone calcareous to non-calcareous: microcrystalline, beige with dark gray stripes and mottles (they are usually more calcareous than the tight beige dolostone); dolomitization partly fabric selective; primary lamination mostly preserved; minor rip-up breccia, locally minor buckling; laminar alternation of calcimudstones, f/g grainstones and packstones; lower half of interval contains numerous oblique infiltrations of bluish gray argillaceous (?) carbonate (polymud-like fabric) that may have originated from vadose diagenesis (most likely) or dolomitization process.

3605.5-3614.8 Limestone: dark brownish gray; upper 20 cm is packstones fine-grained bioclastic, non-laminated to obscurely laminated, grading downward to packstones-grainstones and grainstones peloidal-bioclastic, f-m/g, poorly sorted, subrounded to non-rounded, non-laminated, with micrite-rich intercalations; grainstones mostly cemented by micrite bridges, locally contain thin isopachous cement and oolite admixture; diverse marine fossils locally abundant (brachiopod fragments, auloporidean corals, gastropods, etc.); a 25 cm thick weakly laminated packstone-wackestone without macrofossils in the middle of interval; compaction uneven, flaser to nodular.

3614.8-3617 Limestone: brownish gray, slightly lighter than above; wackestone charophytic, with polyphase, largely indistinct, soil-like brecciation, abundant root-like channels, submm-sized solution vugs and birds-eye fenestrae (palustrine facies); some fenestrae floored by geopetal sediment. The uppermost 8 cm is tidal-flat laminite: alternation of buckled and fractured calcimudstone laminae and ostracod packstone. Finely crystalline dolomite develops as stringers and "crystal dust" along partitions in brecciated fabric.

3617-3618 Dolostone argillaceous and calcareous: dark gray; limestone in upper 8 cm: a distinct brownish nodular limestone, overcompacted, strongly dolomitized, with ostracod and charophyte rich

matrix; nodules have cloudy, complex, partly calcrite-like fabric with ghostly upright structures resembling rhizocretions. Below is dolostone argillaceous, compacted, locally with obscure disrupted lamination, with lithoclasts of brownish micritic limestone 0.5-5 mm in size. In the base abundant lithoclasts form lithoclastic calcarenite with small pebbles; matrix of this calcarenite is dolomite; charophytes are common in matrix throughout the interval.

3618-3622.3 Limestone: dark brownish gray; wackestones and packstones bioclastic ostracod-dominated, minor clotted micrites and grainstones bioclastic-peloidal; common to abundant spheres 0.1-0.2 mm in diameter; no distinct lamination; rare solution voids in upper 0.5 m; the rock stylolitized and stylobrecciated, with manganese dendrites developed along shearing planes; a nodular pattern is locally developed. Macrofossils represented by gastropods. An obscure disconformity or paraconformity in top, but no prolonged subaerial exposure. Base conformable.

3622.3-3624.8 Limestone: dark brownish gray; grainstones f-m/g, poorly to well sorted, subangular to subrounded, bioclastic-peloidal-aggregate (aggregated peloids or lumps), cemented by micrite, intercalated by overcompacted packstones (some of them possibly original grainstones); nodularity like in the interval above, but no stylobrecciation and manganese staining. Grainstones contain tight 1-10 mm sized automicrite patches. At least one internal discontinuity (erosional surface) is recorded. Base conformable, gradational.

3624.8-3628.1 Limestone: dark brownish gray; alternation and intergradation of grainstones bioclastic-peloidal and wackestones-automicrites with complex cloudy fabric; micrite-cemented auloporid boundstone at 3627.3 ft. Grainstone layers contain automicrite intraclasts. Relatively diverse bioclastic material. No primary lamination. Nodular compactional fabric emphasizing syndimentary lithification.

3628.1-3629.6 Limestone: dark gray weakly argillaceous and dolomitic in top, grading downward into dolostone calcareous; limestone is packstone-wackestone f/g ostracod dominated, with diverse bioclast material, compacted (flaser fabric); dolostone is very finely crystalline, with rare poorly preserved bioclasts and limestone intraclasts, with residual, poorly seen lamination and/or fissility; primary texture in dolostone is probably calcimudstone. The whole interval is dissected by high-angle (75-90°) shear surfaced and partly disintegrated along these surfaces.

3629.6-3632 Limestone: dark brownish gray; grainstones subrounded, vf/g to m/g, bioclastic-peloidal and locally ooidal, with crude multidirectional cross-lamination, locally rich in intraclasts, with several ravinement surfaces. Mud drapes on grainstone laminae locally developed. Isopachous marine cement variously developed; in base grainstone-packstone spherical-ostracodal with disrupted lamination; rare convex-up brachiopod shells and other fragmented macrofossils. Moderate to strong stylolitization, but almost no intergrain compaction.

3632-3634.4 Limestone: brownish gray; thin fenestral laminite (sub-mm scale alternation of grainstone and micritic crusts with moderate buckling and locally desiccation crack features; extensive chains of small flattened fenestrae; locally numerous solution channels surrounded by dark brown alteration haloes; few large (up to 1 cm) solution vugs; all syndimentary pores occluded by equant sparitic calcite; top is crumbled off, dissolved and brecciated, with stringers of bluish grey slickensided marl penetrated downward from the top; in base lamination becomes more crude and wrinkled; top disconformable, base conformable.

3634.4-3636.4 Limestone: dark brownish gray; top 10 cm is packstone vf/g ostracodal, massive, with common intraclasts of pale micrite, riddled with tiny (<0.5 mm) solution vugs (dispersed karstification); grades downward into calcimudstone rich in tiny (<0.05-0.1 mm) bioclasts probably belonging to ostracods; few intercalations (graded beds) of packstone f/g bioclastic with micritic intraclasts; this

calcimudstone grades in base into wackestone vf/g to f/g bioclastic, bioturbated, with progressively more diverse bioclasts (upright rod-like bryozoans, in-situ thickets of branching algae - photo); moderate, very evenly distributed matrix compaction; minor nodularity; plain stylolites.

3636.4-3639 Limestone: dark brownish gray, a bit lighter in the middle; alternation of grainstones peloidal-bioclastic subrounded and packstones bioclastic ostracod dominated; the middle 20 cm of the interval moderately laminated and riddled with tiny solution vugs; this level contains rare collapsed and slickensided stringers of pale bluish gray shale; surface of unconformity inside the interval not detected, subaerial alteration features apparently extinguish upwards; grainstones subrounded, locally with distinct isopachous cement rinds; the middle of the interval is microporous (water adsorption). Bioclasts relatively diverse, dominantly thin-shelled (ostracods, probably small trilobites, etc.).

3639-3640.3 Limestone: brownish gray; thin fenestral laminite like at 3632-3634.4 ft, grading downward into indistinctly laminated calcimudstone (wrinkled "microbial" lamination); many fenestrae are solution vugs; thin coatings of pale bluish clay develop in larger solution voids in the interval top; this clay also develops as collapsed (stylolitized) vug-filling stringers in base and below, in upper part of underlying bed. Top unconformable, base gradational.

3640.3-3646.7 Limestone: brownish gray; calcimudstone massive, with rare wackestone lenses, thin-bioclastic (bioclasts all <0.1 mm), with collapsed solution voids and zones of pinpoint matrix dissolution in upper 20 cm; in the lower half, gradation into wackestone ostracodal bioturbated; weak to moderate matrix compaction, regular stylolites.

3646.7-3650.5 Limestone: dark brownish gray, stylolitized and locally stylobrecciated; grainstones-packstones f-m/g peloidal-bioclastic, poorly sorted, with aggregated grains, grading in lower half of bed into the intermixture of tight wackestones, m-c/g micrite-cemented peloidal-oncoidal grainstones, and a molluscal (bivalve?) coquina with grainstone-wackestone matrix; grains in grainstone subrounded, with distinct white micrite envelopes (cortoids and possible oncoids); back to f-m/g poorly sorted grainstone in base; no or weak matrix compaction; base stylobrecciated, contains scattered mm-sized lithoclasts of bluish grey shale.

3650.5-3652.5 Limestone: dark brownish gray; calcimudstones clotted with tight laminae, locally grading to grainstone peloidal, locally with flattened birds-eye fenestrae; buckled "microbial" lamination is locally distinct; rare cm-sized fenestrae (small Stromatactis-like type) occur in lower half of interval; ostracods common, other thin-shelled bioclasts rare to minor; pinpoint solution vugs and solution-enlarged intergranular voids possible; Disconformity in top: intensely slickensided non-calcareous, non-fossiliferous shale in bed top; this shale may represent an upper paleosol horizon; the limestone in top 20 cm contains replacive mottles and stringers of bluish grey clay. Downwards these stringers gradually obtain geopetal character of internal sediments in larger fenestrae and solution cavities. Brecciated, half-replaced zones are common. Interval base chosen by disappearance of bluish grey shale features.

3652.5-3658 Limestone: dark brownish gray; wackestones vf/g bioclastic intergrading with grainstones vf/g bioclastic-peloidal, grading downward into nodular (stylonodular) wackestones polybioclastic, bioturbated, vf/g to m/g. Skeletal assemblage includes gastropods and maybe tentaculites. Primary lamination sporadically preserved only in upper 30 cm of interval; top and base conformable; no to weak matrix compaction.

3658-3661.5 Limestone: brownish gray, dark brownish gray in top; alternation of calcimudstone dense, calcimudstone clotted, and wackestones, vf/g ostracodal, laminated by 40-60%; clotted calcimudstones grade into vf/g peloidal grainstones; important stratal stylolitization; no macrofossils.



3661.5-3669.3 Limestone: dominantly packstones and wackestones bioclastic, ostracod-dominated, locally rich in tiny (<100 µm) spheres, with minor calcimudstones and vf/g grainstones transitional to packstones; rare f-m/g grainstones; primary even, gently inclined lamination preserved only at two levels; rare thin-shelled macrofossils, but no corals or stromatoporoids; stylolization and modern nodularity; uneven matrix compaction (micrite-cemented grainstones uncompacted); local catagenetic fractures and solution vugs cemented by coarse brownish calcite. Rare mm-sized clasts of pale grey limestone in 5 cm above disconformable base.

3669.3-3674.2 Limestone: brownish gray; upper 15 cm is calcimudstone stylobrecciated, with mm to cm sized solution vugs and channels; matrix contains pseudocoatings (staining haloes aligned with cavity walls). Below 15 cm, laminar alternation of grainstones-calcimudstones clotted and calcimudstones dense; laminate undulating, non disrupted; ostracods and tiny spheres; vf/g peloidal grainstones and clotted calcimudstones dominate in the lower half of interval; base conformable, by disappearance of lamination.

3674.2-3686.7 Limestone: dark brownish gray; packstones and grainstones vf-f/g bioclastic and bioclastic-peloidal, rich in ostracods and tiny spheres, bioturbated; grainstone texture is coarsening downward, giving m/g patches in lower part of interval; grainstones mostly subrounded (peloid-like grains predominate), but bioclastic material is also abundant and mostly angular. Oolitic admixture is possible. Sporadic cm-sized fenestrae (after sponges?); bioclastic material is mostly thin shelled; gastropods, very rare pyrgiid (?) corals. Top and base conformable. Local micritic cementation (grainstone texture merges into micrite); no isopachous cements; weak to moderate intergranular compaction, moderately developed nodular to flaser fabric.

3686.7-3690.0 Limestone: brownish gray to dark brownish gray, slightly lighter than above; wackestones "automicritic" dense to clotted, locally grading to grainstone, bioclastic, bioturbated, in upper 30-40 cm with early matrix fractures grading to fenestrae; diverse bioclasts and mollusk biomolds, mostly thin shelled in top, with progressively more numerous thick shells downward; the lower two-thirds of the interval obtain automicritic boundstone features with rare bulbous stromatoporoids, amphiporids, and pyrgiid(?) corals. All primary voids occluded by sparry calcite; local stylonodular fabric; no matrix compaction; base shows catagenetic, probably stylolite solution related, patches of fine porosity impregnated by black bitumen. Top and base conformable, gradational.

3690.0-3695.1 Limestone: dark brownish gray; wackestones and packstones f/g bioclastic, practically non-sorted, bioturbated in the upper one half, and with primary lamination locally preserved in lower 0.6 m; this lamination is expressed in 1-10 mm thick, "subtidal type" slightly differentiated rhythms from more grainy (vf/g grainstones-packstones) to more muddy (vf/g wackestones) textures as well as preferential orientation of thin bioclasts; no distinct erosional surfaces; the matrix of wackestone and packstone is mostly particulate (micropeloidal?) with minor mottles and laminae of dense micrite; rare pyrgiid(?) and pachyporid corals; tiny (50-90µm) whitish "spheres" and subspherical microfossils consisting of dense minimicrite (to be identified); thin-nodular to locally flaser compactional fabric; weak matrix compaction suggesting moderate degree of early lithification.

3695.1-3697 Limestone: dark brownish gray; grainstones f/g peloidal-bioclastic subrounded in top, grading downward into grainstones-to-automicrites with amoeboid mottles of tight micrite cementation; these cementation mottles encase macrofossils; diverse mollusks, one bryozoan, diverse thin-shelled ostracods, small brachiopods, etc.; no isopachous cements in grainstones, only micritic bridges locally coalescing into mottles and stringers; weak intergranular compaction in grainstones, no matrix compaction in automicrites; important stylolization. Top and base conformable.

3697-3699.7 Limestone: dark brownish gray; packstones vf/g and f/g calcispherical-peloidal-bioclastic, minor packstones-grainstones f-m/g with same grain composition; microfossils diverse, in upturned position, include *Spongonaria* (Rugosa; identification of A.E.H. Pedder), tabulatomorphs, brachiopods. Base enriched in fragments of solitary tabulate corals and amphiporids; weak to moderate matrix compaction, stylolitization. Interval 3695-3700 contains catagenetic(?) mottles of pinpoint porosity plugged by black bitumen.

3699.7-3701.7 Limestone: dark brownish gray; wackestone vf/g peloidal-bioclastic, grading downward into grainstones and packstones peloidal-bioclastic, with abundant calcispheres, distinct by partial (50-60%) preservation of sedimentary lamination; grainstone m/g subrounded bioclastic-peloidal, faintly laminated, with minor intraclasts; no isopachous rims in grainstones; rare to minor bioclasts of the same kind as above. Moderate matrix compaction, moderate stylolitization.

3701.7-3702.5 Limestone: dark brownish gray; wackestone to packstone f/g bioclastic, rich in calcispheres, bioturbated, with nodular to flaser compactional fabric.

3702.5-3705 Limestone: dark brownish gray; grainstones f-m/g bioclastic-peloidal with micritic intraclasts or oncoids in top 20 cm, grading downward to grainstones-wackestones/automicrite (development of early lithified micrite); no isopachous cement; in basal 10 cm, horizontal micrite stringers develop a faint, discontinuous sedimentary lamination; no to weak matrix compaction superimposed by thin-nodular compactional fabric.

3705-3705.2 Shale calcareous: dark, almost black, overcompacted, with strongly dissolved (collapsed) bioclasts (brachiopods, etc.) and fragments of micritic limestone; grading downward to micronodular (stylobrecciated) limestone with same grainstone-automicrite fabric as in the interval above. Thin wrinkled pale gray stringers (post-compactional dolomite?); tiny (submm-sized) birds-eye fenestrae, some may be solution enlarged.

3705.2-3707.6 Limestone: dark brownish gray; grainstones peloidal-bioclastic, f-m/g, grading through thick micritic cementation into automicrite clotted; intercalated by thin (3-7 cm) strongly compacted bioclastic wackestones (thin shells: ostracods and brachiopods, small gastropods; no stromatoporoids nor corals). Rare to common small ( $\leq 1$  cm) fenestrae, some having smooth geopetal floors of dense micrite and rugged roofs, others having subspherical shape (typical 'birds-eyes'); rare channel-like fenestrae (burrows?). All primary voids occluded by sparitic calcite. No matrix compaction; stylolites. Top gradational; base sharp (upon overcompacted shale), probably paraconformable.

3707.6-3708.6 Dolostone: dark gray, argillaceous and calcareous, with wrinkled lamination; in top shale overcompacted dolomitic, laminar, alternating with residual (largely dissolved under pressure) laminae of brownish micritic limestone; origin of lamination is unclear: either dolomitization-compaction pattern or diagenetically modified primary tidal-flat lamination (more likely); patches of finely crystalline pyrite in argillaceous dolostone; no evidence of vadose diagenesis.

3708.6-3709.5 Limestone: dark brownish gray, with blackish zones of solution seam concentration; grainstones f-m/g bioclastic-peloidal to automicrites, in top with numerous intraclasts; primary lamination tends to be preserved in lower part (automicritic crusts); diverse small (mostly  $\leq 1$  mm) thin-shell fossils including numerous ostracods; enhanced stylolitization: frequent subhorizontal stylolites and solution seams impart laminated appearance (to be differentiated from sedimentary lamination).

3709.5-3716.5 Breccia of dark brownish gray limestone (disintegrated core from a fractured zone). The bottom of Box 384 (top of fractured interval) contains calcimudstones to wackestones bioclastic

(ostracods, small trilobites, etc.); obscure primary lamination expressed in weak preferential shell orientation and weak, unsteady color differences between laminae. Black stratal surfaces on some of these pieces suggest contacts with argillaceous lithologies; enhanced stylolitization in fragments, but matrix compaction is weak to moderate. Dust of finely crystalline dolomite in limestone matrix. The top of box 385 (main fractured interval) is represented by grainstones to automicrites, locally with obscure primary lamination; same facies as 3708.6-3709.5 ft. Probably distinct nodularity: nodules with no matrix compaction divided by thick, blackish, argillaceous and dolomitized, solution seams. A coral or bryozoan is encountered.

3716.5-3717.3 Limestone: dark brownish gray, with thin replacive stripes and mottles of medium crystalline dolomite; this bed is a distinct fining upward rhythm: basal 15 cm is grainstone m/g, subrounded, peloidal-cortoidal, with intraclasts and composite lumps; very thin, discontinuous isopachous cement; grainstone grades upward into wackestone bioclastic with faint flaser fabric; weak to moderate matrix compaction. Base not preserved, probably disconformity.

3717.3-3717.7 Limestone: gray, lighter than above; grainstone to automicrite to wackestone f-m/g, peloidal-bioclastic, with solution enhanced intergranular voids, vugs, and syngenetic fractures (all occluded by sparry calcite); rare amphiporids, relatively large articulated brachiopod; common subrounded intraclasts. Enhanced stylolitization.

3717.7-3719.7 Limestone: brownish grey, slightly darker in top; calcimudstones faintly laminated to locally massive, riddled with solution vugs; no bioclasts; many vugs are solution enhanced fenestrae; enhanced stylolitization up to stylobreccia; micro-fracturing zones with fractures filled by black bitumen.

3719.7-3722.5 Limestone: brownish grey; early lithified, partly brecciated wackestones alternating and intergrading with grainstones-packstones f/g and m/g, poorly sorted, bioclastic-peloidal, and rudstones oncoidal; the latter appear only in lower two thirds of interval; disrupted, thick (1-5 mm) primary lamination locally preserved. Diverse macrofossils: oncoids, brachiopods, large (cm-sized) bulbous solenoporacean algae; return to predominantly wackestone texture in the interval base; solution-enhanced sedimentary voids and stylolitization like in the interval above; thick solution seams forming lenticular to flaser fabric in bed base. Top conformable, base not preserved, probably disconformity.

3722.5-3723 Limestone: dark brownish gray, speckled, grading downward to limestone dolomitized and probably argillaceous; upper 5 cm is conglomerate f/g (lithoclasts 1-3 mm) made of clasts of calcimudstone and minor grainstone. Strong intergranular stylolitization. Presence of oncoids possible. Below is complex multiphase conglomerate grading to marly rock with obscure microbrecciation and numerous upright curving tubular structures filled by dark brownish carbonate – rhizocretions? Matrix is dark dolomitic calcareous shale to argillaceous limestone; matrix is water repelling, apparently microporous and impregnated by bitumen. Replacive windows of pale bluish gray shale in upper 5 cm.

3723-3725 Limestone: dark brownish gray, partly argillaceous, stylolitized, locally stylobrecciated; clotted micrite with multiphase syngenetic brecciation, penetrated by 0.5-1.0 mm thick, curved, dark brown rhizocretions; local grainstone-like texture; rare charophyte oogonia, no marine fossils. Top not preserved, probably disconformable, admitted by multiphase fine-grained conglobreccia with rounded fragments (soil-like reworking) emphasized by black argillaceous matrix; common whitish intraclasts of clotted micrite in upper 3-4 cm. No distinct lamination. Weak to no matrix compaction. Base gradational, defined by color paling and disappearance of rhizocretions.

3725-3727.2 Limestone: brownish gray wackestones vf/g, bioclastic (ostracodal) and minor calcimudstones; lenses of vf/g (micropeloidal) calcarenite. Sedimentary lamination preserved by 40-60% in the form of discontinuous stripes of dense micrite; dispersed vadose karstification: numerous submm-sized vugs and pinpoint dissolution voids locally giving spongy appearance; rare larger solution vugs; bioclast diversity increases in base. Stylolites and rare thick solution seams, no matrix compaction. Base gradational.

3727.2-3729.9 Limestone: light brownish gray; wackestones and packstones non-sorted bioclastic, with brachiopods, small pyrgiid (?) corals, ostracods, mollusk fragments (biomolds), and spherical microfossils; swirly bioturbation; rare solution vugs and solution-enlarged biomolds; important stylolitization, local stylobreccia; weak or no matrix compaction.

3729.9-3730.1 Dolostone argillaceous and calcareous: light bluish gray, with residual limestone fragments; upper half of his interval contains spherical bioclasts (charophytes?) and sand-sized, dark and light clasts of micritic limestone; the lower half retains patches of brownish spongy micrite cementing subrounded cm-sized clasts of light-colored calcimudstone with solution vugs and dark pseudocoatings; this interval contains disconformity surface in the middle.

3730.1-3732.1 Limestone: light brownish gray; calcimudstone faintly laminated, stylobrecciated, with solution vugs in top, grading downward into grainstone poorly sorted, bioclastic- peloidal and peloidal-bioclastic (bioclasts diverse), cemented by micrite, without isopachous cements, bioturbated; stylolites.

3732.1-3737.1 Limestone: light brownish gray, very gradually darkening to base; wackestones bioclastic with several intercalations of 5-7 cm thick grainstones (facies very similar to 3730.1-3732.1 ft); in lower one-half, calcimudstones to wackestones bioclastic; bioclasts mostly thin-shelled, diverse; rare in situ tabulate corals (auloporids?) and thick upright bryozoans (also rare); no primary lamination; small solution vugs rare to common. Weak to no matrix compaction, important high-amplitude stylolites. On the interval of 3730-3735 ft, all sedimentary and vadose voids occluded by sparry calcite.

3737.1-3738.5 Limestone: dark brownish gray with lighter colored stripes; grainstone f/g, subrounded, bioclastic-peloidal, alternating and intergrading with wackestones and packstones that may happen to be original peloidal grainstones with compacted grain fabric; fossils diverse (ostracods, brachiopod fragments, upturned amphiporids, small gastropods); thick obscure lamination locally present (lamination preserved by 20-30%); thin isopachous cement locally developed, preventing grainstone texture from collapsing into packstone and wackestone; moderate to weak matrix compaction, regular low amplitude stylolites and solution seams; minor nodular fabric in packstones and wackestones.

3738.5-3740.0 Limestone: dark brownish gray; in top grainstone f-m/g, bioclastic-peloidal, with wackestone stringers (burrow pattern with grainstone introduced from above), grading downward into intermixture of grainstone and wackestone and then into wackestone and calcimudstone dominated texture; moderate matrix compaction, nodularity.

3740.0-3740.7 Limestone dolomitic to dolostone calcareous: residual limestone patches (windows) dark brownish grey; replacing dolostone finely to medium crystalline, bluish grey, vaguely laminar ("fluidal"). Limestone texture is wackestone to calcimudstone bioclastic with very rare patches of grainstone subrounded (burrow fills), same facies as in the base of the interval 3738.5-37340 ft. Base stylolitic, probably paraconformable.

3740.7-3743.8 Limestone: dark brownish gray to brownish gray (lightening to base), with dolomitization patches and stripes; in top dolostone calcareous (strongest dolomitization), bluish grey,

with “fluidal” fabric and residual patches of brownish limestone; sedimentary texture is calcimudstone bioclastic (ostracodal) with finely buckled lamination, probably brecciated in top (obscured by dolomitization). The lower two-thirds of the interval contain pisoids, laminae, and breccia-like patches of pinkish dense, minimicritic calcite that displace (buckle) lamination; these patches occasionally preserve cubic rims suggesting that they might be replacements after salt nodules; a thick (2 mm) overcompacted shale in 2-3 mm below the top; above this shale, patches of obscurely laminar calcimudstone pierce into the base of the overlying interval through a high-amplitude stylolite. A thick replacement of argillaceous dolostone in base. Weak to moderate to locally strong matrix compaction, stylolitization. Base supposedly conformable, obscured by dolomitization and core incompleteness.

3743.8-3749.2 Limestone: brownish gray, darkening to base, with “dusty” stripes of dolomitization. In lower one-half, dolomite is finely crystalline (50-80 $\mu$ m), distributed along pressure solution seams. Calcimudstones bioclastic, with only ostracods present in top. Bioclast diversity grows downwards, with rare brachiopod fragments and probably fenestellid bryozoans in the lower one-half of the interval. Obscure lamination preserved by 50% near the top, but gradually disappears to the middle of the interval. Moderate to locally strong matrix compaction, important lenticular to flaser compactional fabric.

3749.2-3750.6 Dolostone dark brownish gray in top to almost black in base; the upper one half (labeled 3750) is dolostone calcareous with 30% of non-replaced brownish micritic limestone (calcimudstone?) and patchy to laminar replacement pattern resembling supposed salt nodules at 3740.7-3743.8 ft; dolomitization becomes almost complete to the middle of the interval; some patches resembling cm-sized intraclasts; vague cloudy dolostone fabric in lower part of the interval; vertical fracturation, a window of white catagenetic(?) dolospar in the middle.

3750.6-3751.9 Limestone: very dark brownish gray to almost black, dolomitic and argillaceous, grading to dolomite weakly calcareous in base; dolomite is finely crystalline; nodular pattern with relatively small nodules of brownish limestone separated by thick, black in color, heavily dolomitized and strongly compacted argillaceous internodules; limestone is wackestone and calcimudstone bioturbated, sparsely fossiliferous (fragmented brachiopods and mollusks); some nodules sheared, split by sigmoidal fractures filled by sparry calcite.

3751.9-3758.5 Limestone: brownish gray, relatively light colored, in lower one-half dolomitic through development of finely crystalline dolomite along sedimentary laminae; packstones, calcisiltites (relatively well-sorted microallochems <50 $\mu$ m in size), minor grainstones vf-f/g ostracodal, laminated. Lamination, preserved by 70-90%, is expressed in horizontal shell orientation, weak, disappearing differences in lithologies, and infrequent “mud drapes” (0.2-2 mm thick crusts of dense micrite). 5-7 cm thick domal micritic stromatoliths occur in the middle of interval. Moderate matrix compaction, regular low-amplitude stylolites developed along lamination.

3758.5-3760.2 Limestone: dark brownish gray, probably partly weakly argillaceous; wackestone to packstone bioclastic, bioturbated, with diverse fossils (brachiopods, ostracods, upturned amphiporids); distinct nodular fabric: internodules thick, black, weakly to moderately dolomitized; moderate matrix compaction in nodules. Basal 15 cm is boundstone algal-amphiporid with mesoclotted, moderately recrystallized matrix and numerous ostracods and tiny tubes (to be identified). Boundstone is also nodular. A layer of enhanced dolomitization just above the boundstone. Top and base conformable.

3760.2-3761 Dolostone calcareous to non-calcareous, probably argillaceous, almost black, finely crystalline, with ghosts of light colored mm-sized subangular to subrounded limestone clasts and rare brachiopods; lamination-like pattern locally visible – most likely *Zoophycos* bioturbation or compactional pattern; collapsed brachiopod shells suggest moderate compaction prior to lithification

(conversion into dolostone); convex-up decompaction surfaces and vertical fractures. Important disconformity in base.

3761-3764.5 Limestone: dark brownish gray in top 10 cm, and lighter, brownish gray below, with large replacive-displacive mottles of dolostone finely crystalline, pale bluish gray; limestone is grainstone (in upper 10 cm) to fenestral laminar grainstone-calcimudstone to pure calcimudstone; local disrupted tidal-flat lamination alternating with non-laminated texture; the rock is heavily karstified, with solution-enlarged birds-eye fenestrae and irregular vugs; in upper 10 cm, dominant texture is grainstone f/g, strongly modified by vadose processes, locally with spongy appearance from intergranular dissolution, with replacive chambers of soil-like microbreccia ("rotten rock") and thin (0.5-1 mm) rhizocretion like tubular structures in the very top. Dolostone tends to develop in and around solution vugs, sometimes replacing argillaceous geopetal sediments. Base diagenetic, defined by pervasive dolomitization below. Important stylolitization, no matrix compaction.

3764.8-3767.5 Dolostone calcareous, finely crystalline: pale brownish gray; dolomite replacement non-selective, through "dusty" crystal growth in limestone matrix; the original texture is probably wackestone or calcimudstone indistinctly laminated. Disappearing solution seams preferentially following residual limestone.

3767.5-3768.5 Limestone: beige gray, relatively light, moderately dolomitic ("dusty" inclusions of finely crystalline dolomite); calcimudstones and minor vf/g peloidal grainstones with lamination becoming distinctly disrupted (teepee structures) in the interval base; 1-10 mm sized calcimudstone intraclasts; small vugs and pinpoint solution cavities (all occluded by sparite); sigmoidal sheer fractures; high-amplitude stylolites.

3768.5-3769.2 Limestone: brownish gray, slightly darker than above; micrites clotted, with abundant mm-sized flattened fenestrae (dismicrites), locally grading to vf/g peloidal grainstones and syndimentary microbreccia with subrounded fragments; rare rhizocretion-like structures; sedimentary lamination preserved. In top fenestrae are occluded by dark brownish microcrystalline calcite, rhizocretion-like tubular structures are more numerous; top not preserved, supposedly a weak disconformity; base stylolitic, apparently conformable. Weak to no matrix compaction.

3769.2-3770.2 Limestone: brownish gray; calcimudstone microlaminar, with very obscure syndimentary brecciation, with few solution vugs, penetrated by deep (10-15 cm) upright, gently curving, 7-10 mm thick channels with smooth walls (burrows or root molds); many of these channels are surrounded by weakly developed dark pseudocoatings; some channels contain loose peloidal sediments, but most of them stayed hollow until burial diagenesis (cemented only by clear blocky calcite spar). Large replacive mottles of pale bluish gray dolostone.

3770.2-3774 Limestone: dolomitic to dolomite calcareous, light beige gray, with thick collapsed (stylolitized) tongues of greenish gray argillaceous dolostone and shale. These tongues have contorted "cloudy" lamination and probably originate from preferential replacement of argillaceous geopetal sediments of large solution cavities. Primary facies: calcimudstones and minor wackestones bioclastic, ostracod dominated, bioturbated, with rare brachiopods, microconchid-like forms, and tiny tubules (calpiolinids?). High-amplitude stylolites, local stylobreccia; matrix dolomitization finely crystalline, patchy to evenly distributed "dusty", increases in base. Convex-down and weak vertical decompaction fractures.

3774-3778 Limestone: dolomitic to dolomite calcareous, brownish gray (darker than above), mottled; wackestones and minor packstones bioclastic, bioturbated, dominated by diverse thin-shelled forms (ostracods, minor brachiopods); mottling from (1) intermingling of dark and pale mottles in limestone matrix and (2) replacive dolomite patches; dark and pale mottles express bioturbation, bleaching

probably caused by deep flushing of vadose waters; rare solution vugs; important small-scale nodularity emphasizing limestone mottling, stylolitization; matrix in pale mottles non-compacted, dissected by sigmoidal fractures, in darker intermottles may be more argillaceous and weakly to moderately compacted. Top and base conformable.

3778-3779.7 Limestone: brownish gray; calcimudstones bioclastic (sparse ostracods and spheres) with dense micritic to micropeloidal matrix (calcisiltites in the latter case), massive to indistinctly laminated; moderate matrix compaction detected by somewhat collapsed thin shells; regular low-amplitude stylolites.

3779.7-3782 Limestone: dolomitic, brownish gray to dark brownish gray; calcimudstones, wackestones bioclastic, minor brachiopod floatstones and poorly sorted vf/g grainstones; intense swirly bioturbation; diverse macrofossils: disarticulated brachiopods, gastropods and probably other mollusks, rare bryozoans and small colonial Rugosa; in basal 20 cm gradation to brownish calcimudstone resembling 3778-3779.7 ft. Dolomitization distinctly patchy, finely crystalline; crystal size is likely unimodal; dolomitization declines to base. Moderate matrix compaction throughout; important small-scale nodularity in upper one half of interval; regular stylolites. Top and base conformable.

3782-3783.5 Limestone: dolomitic dark brownish gray in top, grading downward into dolostone dark gray encasing residual micritic intraclasts and bioclasts; packstones and wackestones bioclastic bioturbated; brachiopod fragments, diverse sub-mm sized bioclasts; base may be enriched in argillaceous admixture facilitating dolomitization; dolomite distribution "dusty" to patchy, in lower one half distinctly stripy or "laminar", following thick solution seams; moderate matrix compaction, moderate nodularity.

3783.5-3792.5 Limestone: very dolomitic to dolostone finely crystalline ( $\leq 70 \mu\text{m}$ ), calcareous, moderately mottled brownish gray to dark gray; packstones, wackestones, and minor calcimudstones bioclastic, usually ostracod dominated, with diverse macrofossils: tiny thin-shelled curved tubes (polychaetes?), brachiopods, gastropods and possibly other mollusks, rare bulbous stromatoporoids, rare small upright amphiporids or algae; bioturbation locally intense, imparting "mininodular" and mottled fabric; thick (4-5 cm) coquina of mass bivalved ostracods in base; rare cm-sized micritic intraclasts; dolomitization patchy, partly following burrows and other irregularities in sedimentary texture; rare storm graded beds with bioclastic basal concentrations that avoided bioturbation; moderate to weak matrix compaction, local small-scale nodularity, some stylolites.

3792.5-3794 Dolostone pigeon gray, very finely crystalline ( $< 30\text{-}40\mu\text{m}$ ), weakly calcareous; dolomite replacement pervasive, without the patchy pattern characteristic of the interval above; poorly preserved small-fenestral pattern (original dismicrite?) and possibly rare solution vugs; former fenestrae filled with dark pyritized material; matrix contains chalky white sand and pebble sized carbonate clasts; top supposedly disconformable (core from the very top missing); base admitted by a high-amplitude stylolite with thick shale lining.

3794-3802.6 Limestone: very dolomitic to dolostone calcareous finely crystalline; color mottling, sedimentary texture, and dolomite replacement pattern very similar to 3783.5-3792.5; brachiopods, ostracods; rare intervals of preserved lamination expressed in horizontal orientation of thin-shell brachiopods-ostracod coquinas; basal 10 cm is grainstone poorly sorted, f-m/g, subrounded, bioclastic-peloidal (grains encased in thin isopachous rims), with cm-sized lithoclasts of pale brownish micritic limestone and dolomitized clasts of bluish argillaceous rock (reworked paleosol). Important disconformity in base.

3802.6-3805.8 Limestone: beige gray; birds-eye to locally tight calcimudstones grading downward into the alternation of ostracodal wackestones, dismicrite-type calcimudstones, and minor f/g calcispherical-peloidal grainstones; the rock laminated by 50-60%: laminae mostly faint and disappearing, <1 mm in thickness, gently buckled but mostly non-disrupted. Upper 5 cm is distinct by numerous small solution vugs and channels, many of them are floored by whitish coatings; solution voids tend to be surrounded by dark pseudocoatings and organized in chains (vadose water conduits); many solution vugs developed upon primary fenestrae; core from the very top is missing. Small (< 1 mm) solution vugs, pinpoint pores, and solution-enlarged sedimentary voids occur throughout the interval; matrix compaction is weak to moderate in the base and almost lacking in top; important stylolitization, in top up to stylobreccia.

3805.8-3807.6 Limestone: dolomitic to dolostone calcareous finely crystalline, dark brownish gray, partly mottled, with thick (up to 1 cm) overcompacted and dolomitized intervals (weak argillaceous admixture?). These latter intervals impart crudely laminar appearance to the rock. Primary facies: packstone-grainstone f/g bioclastic-peloidal in top 5 cm, grading downward into wackestones and calcimudstones bioclastic; mottling from bioturbation (swarms of small burrows) and dolostone patches; lamination rarely and poorly preserved (by up to 5%); weak to no compaction and short sigmoidal fractures in micritic matrix; local flaser texture and fissility in overcompacted intervals.

3807.6-3810.7 Limestone: beige, relatively light colored; wackestones and packstones massive (no lamination preserved), in base grading to calcimudstone massive; diverse macrofossils: ostracods, tiny cones (styliolinids?), brachiopods, amphiporids, rare pelmatozoan fragments, diverse mollusks; shell structure characteristically recrystallized or dissolved, mostly preserved as sparite-filled biomolds; minor cm-sized solution vugs cemented by clear blocky calcite (catagenetic cement); short open fractures in micritic matrix probably resulted from burial load stress on a semi-lithified sediment; basal part contains solution seams and stylolites lined by pale greenish gray shale; rock obviously bleached either in vadose zone or in burial. Top does not contain any clear evidence of proximity to the subaerial surface, but some core from the top is missing.

3810.7-3812 Limestone: dark brownish grey very dolomitic in top, grading downward into dolostone dark pigeon gray, probably argillaceous; dolomitization almost non-selective, leaving residual limestone clasts of brownish micrite; sedimentary texture in upper dolomitic limestone is wackestone bioclastic bioturbated. Lower 6 cm of dolostone is separated by a thin (1-5 mm) crust of dark brown micritic limestone with obscure lamination and likely obscure tiny vermiform structures; this crust is corroded by dolomite; below this crust, the residual dolostone fabric is different: faint, mm-scale mottling, no lamination, and upright elongated structures resembling rootlet channels in non-replaced palustrine limestone (fine mottling in this case may manifest original microbrecciation). Conclusion: interval may contain disconformity inside.

3812-3818 Limestone: beige, relatively light colored; facies very similar to 3807.6-3810.7 ft, but no amphiporids detected; diverse skeletal macrofossils; faint mottling reflecting bioturbation patterns and superimposed on them bleaching pattern. Solution vugs, solution-enlarged biomolds and matrix fissures exactly like at 3807.6-3810.7 ft. Basal 20 cm is clotted wackestone grading downward into poorly sorted bioclastic-peloidal grainstone with micritic intraclasts; weak to no matrix compaction, moderate intergranular compaction in basal grainstone; important stylolitization.

3818-3820.1 Dolostone calcareous pinkish beige gray with residual laminae of limestone light brownish gray, recrystallized, dolomitic; dolomite finely crystalline, chalky white opaque (probably from abundant microinclusions), with black dusty pinpoint inclusions or speckles (redistributed organic matter?); in top, limestone partly retains texture of grainstone subrounded, f-m/g, probably ooidal to peloidal, with thin isopachous rims; below the texture is unrecognizable after recrystallization; collapsed, heavily recrystallized valves of big (3-4 cm) brachiopods in base; large (1-3 cm) subangular clasts of ooidal grainstone throughout the interval; contorted sedimentary lamination. Top



probably conformable. Base manifests thin (1 cm) breccia (paraconformity or weak disconformity), but other features are obscured by non-selective dolomite replacement. Moderate to weak stylolitization.

3820.1-3822.3 Dolostone light beige, finely to medium crystalline ( $\leq 120 \mu\text{m}$ ), weakly calcareous to non calcareous, massive in top and becoming obscurely laminated to base; rare unidentifiable (poorly reserved) bioclasts, in the lower half of interval with preferential horizontal orientation; no other sedimentary features preserved; supposed primary facies is wackestone and/or calcimudstone bioclastic, partly laminated; small “dusty” mottles of intercrystalline porosity plugged by black bitumen. Base gradational.

3822.3-3823.5 Dolostone light beige with black-stained striping (bitumen in pores) along sedimentary lamination, calcareous in base; mm-scale, gently buckled but non disrupted lamination in top 25 cm; to base lamination becomes obscure. Basal 10-25 cm contains residual windows of brownish moderately recrystallized limestone (calcimudstone-wackestone bioclastic, some vf/g grainstone). Base with dark gray mottles (argillaceous admixture), retaining cm-sized subrounded carbonate lithoclasts; other sedimentary features vanished; regular low-amplitude stylolitization.

3823.5-3825.6 Dolostone light beige gray, weakly calcareous, finely to medium crystalline, in basal 15 cm very calcareous (ca. 40-50%), retaining windows of brownish moderately recrystallized limestone (wackestone bioclastic, f/g grainstone, and brachiopod floatstone); obscure sedimentary lamination characteristic of about 40% of interval; brachiopods in basal floatstone disarticulated, valves predominantly convex up; moderate to strong matrix compaction read from collapsed brachiopod shells. Basal 2 cm are dark bluish grey from abundant mm to cm sized lithoclasts of argillaceous carbonate (totally replaced by dolomite). Major disconformity in base.

3825.6-3826.9 Disintegrated core with complex fabric: dolostone weakly calcareous, retaining the fabric of matrix-rich breccia. Fragments of breccia are different size, original grainstone f/g rich in calcispheres, downward grainstone texture in fragments become completely obscure; fragments retaining original tidal-flat lamination occur in lower one half of interval; larger (cm-sized) fragments subangular to subrounded; mm-sized clasts tend to be rounded. Matrix in upper one half is cyanic grey argillaceous dolostone with ghost dark, pyritized tubular structures (rootlets?); downward this layer grades into neutral gray to whitish, less argillaceous to non-argillaceous very finely crystalline dolostone retaining crumbled soil-like multiphase brecciation and sand-sized lithoclasts; in this less argillaceous layer, fragments tend to be encased in carbonate envelopes (pedogenic coatings) forming by that pisoidal fabric.

3826.9-3828.5 Dolostone finely-medium crystalline, calcareous, beige gray, with dark stripes and mottles, retaining crude sedimentary features; tidal-flat laminite with gently buckled lamination, with swellings, presumably former evaporate nodules, in lower half of interval; original texture not preserved against medium-crystalline dolostone (supposedly f/g grainstones, calcimudstones, and fenestral dismicrites). Zones of vadose/pedogenic dissolution and brecciation with fissures and vugs filled by patches and coatings of very dark colored micritic material (totally dolomitized) and succeeding bluish argillaceous dolostone; thin whitish calcrete-like stringers. Sedimentary lamination declines in lower 5 cm. No core in the very base.

3828.5-3829 Limestone: very argillaceous, overcompacted, grading in top to shale dark greenish calcareous; rudstone lithoclastic (micritic lime clasts), normally graded (fining upward), fissile, with extensive intergranular stylolitization; bioclasts rare, only broken brachiopod fragments. Erosional paraconformity in base.

3829-3830 Dolostone light beige gray, weakly calcareous, non-laminated, fabric destructive; undulating stripes and mottles of dark material defining a weak nodularity; no signs of primary lamination.

3830-3831 No core (core taken out by someone)

3831-3831.5 Same rock as 3829-3830 ft (supposedly one bed).

3831.5-3832.7 Limestone: khaki gray, weakly argillaceous; small-pebble (1-5 mm), matrix-poor conglomerate or rudstone lithoclastic, consisting of dark brownish gray and light beige lime clasts of clotted and dense micrite; strong intergranular compaction; lithoclasts subangular to subrounded; crude normal grading in the whole interval; top replaced by dolomite, more argillaceous, without matrix compaction, with original texture of f-m/g lithoclastic, matrix-rich rock textured by faint dark stringers and root-like structures and soil-like brecciation; dark brownish stringers and rhizcretions(?) occur in the entire interval; infrequent patches of f/g clotted grainstone-grading micritic matrix reveal shallow water depositional environment of conglomerate accumulation. Core patchy, pieces do not match each other, apparently very incomplete (bed thickness increase!)

3832.7-3833.1 Dolostone light beige gray, very finely crystalline, mimically replacing non-laminated rock with soil-like syngenetic brecciation, dark thick geopetally distributed coatings and pseudocoatings (polymud-like fabric), and dolospar-filled, 1-5 mm in size, vugs and/or fenestrae.

3833.1-3834.5 Alternation of limestone and dolostone calcareous light beige gray. Limestone: in top calcimudstone-wackestone bioclastic (ostracods and spheres) with distinct buckled lamination visible by alternating dense micritic and clotted laminae; spar-filled solution vugs and fractures; dolostone is mostly fabric destructive, but retains dark elongated mottles, probably left after vadose structures. No matrix compaction; regular stylolites in limestone.

3834.5-3835.7 Limestone: khaki gray, weakly dolomitic and partly weakly argillaceous; grainstone m-c/g, bioclastic-lithoclastic, with numerous small (<5 mm) micritic and dismicritic pebbles, poorly sorted, subrounded to subangular; one piece of pigeon gray, matrix rich packstone with dolomitized argillaceous matrix; bioclasts seem diverse, fragmented (brachiopods, calcispheres); local presence of thin isopachous cement rims; moderate matrix (intergrain) compaction in upper part, almost no matrix compaction to base; rare dark brownish rhizcretions and likewise calcrete stringers.

3835.7-3837.8 Dolostone calcareous to limestone dolomitic: distinctly mottled, with residual patches of dark brownish gray limestone surrounded by thick pale gray medium-crystalline (120-170 $\mu$ m) dolostone. Texture in limestone: calcimudstone massive with rare ostracods and tiny cones; nodularity, some low-amplitude stylolites.

3837.8-3839.1 Limestone: dolomitic, almost white, stylolitized and with numerous decompaction convex surfaces; calcimudstone laminated (wrinkled), riddled with small (0.5-1 mm), spar-filled solution vugs; rare larger vugs; sedimentary fabric mostly poorly preserved; rare vugs or curved channels surrounded by dark pseudocoatings; strong stylolitization.

3839.1-3839.5 Dolostone very calcareous, argillaceous: bluish gray, grading downward to limestone weakly argillaceous khaki gray; grainstone lithoclastic, poorly sorted, closely similar to 3834.5-3835.7 ft although finer-grained; lithoclasts are same type, ranging in size from <0.2 mm to 4 mm; the top of this graded bed is more argillaceous, matrix-rich; minor dark brownish stringers, rare and small replacive clay mottles suggesting incipient pedogenesis.

3839.5-3842 Alternating patches of pale beige limestone, dolomitized limestone, and pale grey, finely to medium crystalline dolostone: primary texture in limestone is poorly preserved (recrystallized?), calcimudstone indistinctly laminated with very rare ostracods and other tiny bioclasts; top brecciated, dissolved, collapsed in catagenesis (stylolitized); numerous sub-mm sized vugs and pinpoint solution pores, all occluded by sparite; faint dark gray mottles in dolostone.

3842-3842.4 Dolostone finely crystalline, dark brownish gray, almost massive with very faint reminders of brecciation, retaining branching 0.5 mm thick upright channels, apparently rootlets; original palustrine facies?

3842.4-3844.6 Dolostone calcareous: finely-medium crystalline, pale gray, with minor limestone (calcimudstone non-fossiliferous); tiny solution vugs and pinpoint voids; dolostone retains blurred dark mottles and stringers (soil penetrations?). A 5 cm long core of dolostone argillaceous – matrix-rich lithoclastic conglomerate with faint rhizcretions and other soil-like features.

3844.6-3845 Dolostone calcareous to limestone dolomitic: light pinkish gray, retaining very contorted lamination resembling laminar rhizogenic calcrete or upper tidal-flat microbial lamination transitional to sabkha.

## Eog et al Devo Creek P-45

**Well ID data: 300/P-45-6530-12730/0**

EOG Rsrcs Cda Inc

SPUD: 2002/01/05    CMPL DRL:    DAYS: 70    RR: 2002/03/15

DRL RIG:    AKITA/SAHTU #51

**Interval measured:** 327-345 m

Measurements in metres

### **Core description:**

HUME LIMESTONE

Little porosity seen in the rocks.

327.0-328.3 Limestone: brown, with black overcompacted (stylolitized) zones; various boundstones (amphiporid-dominated bafflestones-framestones, calcisponge-stromatoporoid framestones with rare solitary rugose corals and erect bryozoans); local rudstone, grainstone with degraded primary texture, and wackestone bioclastic with early lithified micrite matrix; locally boundstones are matrix poor or matrix free, with recrystallized, up to 1 mm thick, isopachous cement; many amphiporids strongly micritized; bridges of micritic cement and micrite encrustations are common. Matrix is locally represented by diagenetic (?) black wackestone with corroded bioclasts; gastropods, disarticulated bivalves and brachiopods are common. Light beige subangular clasts (up to 2 cm in size) of calcisphere-rich calcimudstone are common in base. The base disconformable.

328.3-328.55 Limestone: beige, distinctly mottled (black massive to dendritic staining - former microporous zones?). The top 5 cm is calcimudstone-wackestone ostracodal, with calcispheres and rare small amphiporids, with small (1-2 mm) rare solution vugs, grading down to boundstone amphiporid with diverse assemblage (incl. auloporids and solitary Rugosa), cemented by thick micrite; the boundstone in turn grades down to thick clotted micrite with minor fenestral, polymud, and syngenetic brecciation features; this micrite encases amphiporid thickets, rare solitary Rugosa, and small brachiopods in life position; no matrix compaction; swirly bioturbation-like fabric, no primary lamination preserved.

328.55-332.5 beige; automicrites clotted to dense, fenestral, faintly laminar to massive, with important polymud fabric; fenestrae are flattened, floored by microlaminated geopetal sediment and with rough roofs, occluded by brownish calcite sparite; they are connected through a system of short early fractures; curved tiny (<0.5 mm in diameter) tubes locally present – stiff-substrate burrows? Matrix is uncompacted; rare but high-amplitude stylolites throughout the bed; top stylolitic, apparently

disconformable, with black dendritic staining penetrating to the depth of 4-5 cm; fossils: disarticulated ostracods, rare dwarf amphiporids mostly in upturned (horizontal) position; basal 30 cm has more diverse fossils besides ostracods: rare solitary Rugosa, amphiporids, and molds of large bivalves, and one small bulbous stromatoporoid. High-amplitude stylolite in base.

332.5-338.0 Limestone: dark brownish gray, stylonodular, with black overcompacted zones, locally with white branching calcite veins (catagenetic fracturation); packstones and wackestones early lithified, with intense swirly bioturbation fabric and occasional oblique spreiten in matrix, with common potential reef builders - stromatoporoids (amphiporid, bulbous, encrusting forms), branching rugose corals, rare pachyporids, auloporids, and ?erect bryozoans; these forms locally form small in situ thickets; gigantic (>20 cm) bulbous stromatoporoids also occur; matrix contain diverse bioclasts, abundant spheres ( $\leq 0.1$  mm) and tiny unilocular foraminifers; tiny rounded peloids (<0.2 mm) are locally abundant, but larger bioclasts are all non-rounded; rare angular and fractured fragments of light greenish (glauconitized?) micrite in basal 1.0 m; locally bioclasts are degraded, merging with matrix; base stylolitic, probably conformable.

338.0-338.5 Limestone: brownish gray, lighter than above and below; rudstones lithoclastic-bioclastic with micrite-poor grainstone matrix, grading in upper 15 cm into boundstone stromatoporoidal, with clotted to dense automicrite matrix; boundstone or rudstone stromatoporoidal, strongly stylolitized, matrix-poor in top; matrix-free space in rudstone and boundstone contain whitish recrystallized sparitic calcite cement locally retaining radial pattern; lithoclasts are subangular, chalky tight micritic calcite with poorly preserved bioclasts or without recognizable allochems; most lithoclasts internally glauconitized; a 7 cm thick interval of tight micrite cementation in the middle; this interval contains the largest quantity of lime clasts.

338.5-345.0 Limestone: dark brownish gray, stylonodular, generally same facies and same fossil assemblage as 332.5-338.0 m; upper 0.5 m is enriched in sand-sized chalky lime clasts and locally with large (around 1 cm) glauconitized lithoclasts; black overcompacted zones are locally dolomitized in the lower half of bed; basal 0.7 m more distinctly brecciated (catagenetic fracturation). Most stromatoporoids and corals occur in situ. Fossil assemblage diverse: gastropods, other mollusks, curved polychaete(?) skeletons, brachiopod fragments.

# Imperial Norman Wells P32X

**Well ID data:** 304/M-46-6520-12645/0

SPUD: 1997/06/16    CMPL DRL:    DAYS: 22    RR: 1997/07/07

DRL RIG:    SHEHTAH #1

Deviated section at ca. 60° on around 755 m MD (see dev. report)

**Interval measured:** 752.0 – 850.57 m

**Core condition:** good preservation, core relatively coherent.

Measurements in metres

**Core description:**

CANOL SHALE

752-755.8 Shale: largely indurated brownish black, non-calcareous, micaceous, microlaminar, with large ( $\geq 10$  cm) flattened pyrite nodules, with common black organic fragments 0.1-1 mm in size – lignite detritus; base sharp, blanketing undulating Limestone: top.

KEE SCARP LIMESTONE

755.8-755.9 Limestone: chalkified, partly argillaceous and overcompacted, yellow with thick swarms of black solution seams in clay-enriched stringers and massive brown nodules with obscure but apparently non-compacted texture; common amphiporids in life and upturned position; matrix obscure, chalkified, partly microporous (yellow chalkified zones); local preservation of a faint m/g grainstone texture with biolithite laminae; rare cm-sized limestone clasts (intraclasts?).

755.9-756 Limestone: pale yellow, chalkified, ghost primary texture distinctly less grainy than above and below, with numerous spar-filled fenestrae and/or solution vugs; some fenestrae have channel shapes; faint contorted calcrete or biocrobialite-like laminar patterns in matrix locally visible; top disconformable, with a brown dense massive microcrystalline crust beneath a scalloped, partly stylolitized erosional surface.

756-759.9 Limestone: yellow (pale yellow when extracted), with chalkified microporous matrix; common to abundant amphiporids in upturned and life position; minor large (>20 cm) domal stromatoporoids forming in situ calyptrae; proportion of in situ Stromatoporoidea grows to the base where amphiporids tend to form thickets; matrix distinctly grainy, with larger bioclasts preserved as ghosts – probably original grainstones and packstones; crude cross-lamination especially developed

in the upper part; fenestral/solution channel horizons, large (3 cm) geopetally filled vugs (Stromatactis or solution?) in upper 20 cm.

759.9-766.7 Limestone: yellowish brown, ?dolomitic, chalkified (matrix most affected); framestones stromatoporoid (large domal forms) and bafflestones amphiporan with minor grainstones or packstones; matrix looks grainy (bioclastic) where chalkified, but in dense brown mottles (supposedly better preserved) it is massive and pelitomorphic, more resembling wackestones with local pockets of peloidal grainstone; stromatoporoids sometimes bear crusts of bulb-like overgrowths of faintly stromatoidal micrite; abundance of frame-building stromatoporoids decrease in base; the base marked by a chalky light horizon of large (2-3 cm) oncoids, some with amphiporan nuclei; base along a thick solution seam.

766.7-767.4 Limestone: dolomitic and dolostone calcareous, pale yellowish gray to brown, nodular from development of abundant solution seams with thick black shale linings; primary texture largely obscure, with amphiporan bafflestone, rudstone, and floatstone; important brecciation and spar-filled solution voids: vugs, some channel-like voids, fractures; voids; ghost micritic texture with overhangs and grainstone-filled pockets.

767.4-768: Dolomite calcareous: yellowish beige, with solution and/or shrinkage spar-filled cavities, some cavities seem to contain carbonate geopetals; floatstone oncoidal in top; base gradational, doubtful disconformity in top.

768-769.8 Limestone: pale yellow, chalkified, massive, with large (up to 5 cm) oncoids; primary texture obscure, seems to be grainy, possible grainstones with horizons of oncoidal rudstones.

769.8-778.1 Limestone: pale yellow, chalkified, mostly massive with local crude lamination, mottled in the middle and lower parts of bed (development of dense brown micritic cementation mottles with obscure texture – primary micrite cementation?); main texture grainy, possibly primary grainstones and packstones; scattered small (< 5 cm) domal stromatoporoids and local amphiporan thickets.

778.1-779.1 Limestone: yellowish brown, with unevenly chalkified matrix, distinct by presence of solution seams and stylolites with black bitumen and shale linings; same kind of crude mottling; dominantly framestones stromatoporoidal, locally bafflestones amphiporan with grainy to micritic matrix (grainstone c/g rounded is locally preserved); common recrystallized disarticulated brachiopods; top 20 cm (MD) is still non-biohermal grainstone like above but with solution seams.

779.1-780.7 Limestone: yellow chalkified with dense brown mottles, mostly massive, with solution seams and stylolites lined with black shale; upper 10 cm pelitomorphic with solution vugs and/or fenestrae, below grading to grainy texture, probably packstone bioclastic alternated with floatstones and rudstones oncoidal and amphiporan; minor in situ stromatoporoids; top stylolitized, probably disconformable.

780.7-782 Limestone: yellowish beige, chalkified, mostly massive with some instinctive crude lamination, original f/g packstones and/or grainstones; scattered in situ and upturned *Amphipora*, and upturned bulbous stromatoporoids in base; other scattered macrofossils: an euomphalid gastropod and disarticulated brachiopods.

782-782.4 Limestone: light beige microlaminar (wrinkled tidal-flat lamination), densely stylolitized along laminae contacts, fenestral; laminae disrupted, sometimes with typical upturned margins; limestone predominantly micritic in upper part and has alternating micritic and grainy (vf-f/g) laminae in base; a major solution seam in base; top stylolitized, disconformable, with solution pockets filled by lithoclastic grainstone.

782.45-782.8 Limestone: light yellowish beige, pervasively chalkified, with frequent low-amplitude stylolites; fabric monotonous; original texture grainy, with larger bioclasts (brachiopods, amphiporids) common throughout the bed and large (2 cm) brown limestone intraclasts in top.

782.8-787.5 Limestone: yellowish brown, with thick stylolites and solution seams at some intervals, mottled with large (up to 10 cm) amoeboid and connected of dense brown mottles and strongly chalkified, light yellow intermottles; the mottles seem to correspond to primary zones of tight (micritic?) cementation, whereas intermottles may represent original porous grainstones; a strongly compacted intraclastic conglomerate at 784.7, and rare intraclasts elsewhere in bed; primary texture is alternation and intergradation of grainstones with few broken macrofossils (m-c/g rounded-grain grainstone fabric rarely preserved) and amphiporan rudstones-bafflestones; the latter preferentially occur in strongly mottled zones. Locally numerous molluscs including large bivalves and coiled cephalopods.

787.5-789 Limestone: light yellow (light beige when extracted), strongly chalkified and microporous, with few blurred brown mottles, massive; original grainstones; common large molluscs (gastropods, bivalves) and locally amphiporan fragments.

789-790.3 Limestone: yellowish brown, mottled, unevenly chalkified, very similar to the interval 782.8-787.5: original amphiporan rudstones and floatstones intercalated by grainstone beds; solution seams locally developed.

790.3-795 Limestone: yellow (light beige when extracted), strongly chalkified and microporous, locally dissected by thick solution seams, with brown mottles retaining relatively well preserved primary texture: packstones-grainstones vf/g, with abundant calcispheres; some mottles with invisible graininess but still with abundant calcispheres conform to allomicritic(?) calcimudstones and wackestones; cm-sized oncoids in upper 1 m; below macrofossils infrequent: upturned and broken *Amphipora*, small (<5 cm) bulbous and encrusting stromatoporoids, large gastropods.

795-797.8 Limestone: yellowish brown, mottled, unevenly chalkified, with solution seams and stylolites; nodular fabric in compacted zones; original texture: upper 1.0 m is dominated by bafflestones amphiporan (badly preserved, no skeletal structure) alternating with strongly chalkified original grainstones and floatstones; intraclasts present; below brown mottles change their original texture to calcimudstones-grainstones vf/g, calcisphere-rich, with rare upturned amphiporids, locally penetrated by tubular curved spar-filled voids (1 mm in diameter burrows or dissolved baffling skeletons) these zones also contain solution vugs. Lower 1.5 m is a chalkified limestone with scattered brown mottles. This bed may display shoaling downward trend. Base enriched in thin-shell bioclasts and upturned amphiporids.

797.8-799.1 Peritidal cycle. Limestone: light beige in top 25 cm and slightly darker, yellowish beige below; top disconformable, compacted, with collapsed overhangs; a disrupted, wrinkled stromatoidal lamination in upper 4-7 cm, grading downward to massive, probably bioturbated fabric; fenestrae or solution vugs (1-10 mm in size) develop down to 25 cm MD from the top; original texture is laminite in top and massive texture with obscure, probably thoroughly bioturbated fabric (chaotically oriented bioclasts); common amphiporids (becoming abundant to base) locally create floatstones and bafflestone thickets; rare small bulbous stromatoporoids, large gastropods; a typical yellow-brown mottling develops to base.

799.1-799.6 Another peritidal cycle. Limestone: yellow and light brown, mottled, stylolitized and nodular, chalkified; primary texture mostly obscure, seems to be massive and bioturbated; rare upturned amphiporids; top stylobrecciated (subaerial solution breccia?); at least 10 cm from top is



riddled with chaotically oriented spar-filled “birds-eyes” and sub-mm “matrix vugs” – primary vadose solution features? Upturned amphiporids and rare brown intraclasts in top.

799.6-800.2 Another peritidal cycle. Limestone: pale yellowish brown, mottled; upper contact is not available (slab had been taken away); just below the top, limestone with poorly preserved disrupted stromatoidal lamination and numerous spar-filled solution voids (vugs and channels); brown mottles in this upper part partly retain rounded-grainstone fabric; some channels tend to displace sedimentary grains – burrows or root casts? Below, limestone mottled, massive, chalkified and obscure primary texture – calcimudstone to vf/g grainstone? Rare amphiporid bafflestone thickets. Grainstone vf/g calcispherical, massive to weakly laminated, with channel-like fenestrae in base – gradation to underlying facies?

800.2-801 Peritidal unit: Limestone pale beige in top 25 cm and yellow, pervasively chalkified below. Upper 30 cm: laminite fenestral, with wrinkled and disrupted stromatoidal fabric, with isometric to elongated birds-eye solution voids; rare dwarf *Amphipora* in situ; below gradation to obscure chalky to badly preserved subrounded grainstone texture with crude cross lamination and minor upturned, rarely in situ, *Amphipora*; base stylolitic, its erosional character is likely but unclear from pervasive chalkification; large (up to 5 cm) intraclasts in lower part.

801-802.55 Limestone: yellow to brown, mottled, with frequent undulating solution seams: primary texture mostly obscure, most likely a packstone and wackestone bioturbated (randomly oriented bioclasts) in brown mottles; local amphiporan thickets; many mottles contain ghosts of curved micritic tubular structures – chalkified amphiporas, algae or burrows? Abundant sub-cm sized thin shells (ostracods?); common large *Amphipora* in upturned, rarely in situ position; rare oncoids; top marked by dense micrite (preserved in mottles, surrounded by chalky matrix) – erosional discontinuity in top is possible; notably more amphiporids than at 800.2-801.

802.55-804 Limestone: brown with relatively thin yellow intermottles; primary texture is micrite (mudstone to wackestone to packstone) with local gradation to grainstone oncoidal(?), intraclastic, and/or peloidal, poorly sorted; the primary texture has no matrix compaction; common spheres (<100 µm in size); amphiporids common only in upper 20 cm, very rare and small below; rare to common flattened fenestrae (0.5-2 cm in size) with thin internal sediment throughout the bed; no distinct primary lamination; solution-like cavities in the middle and in base geopetally filled by intraclasts and/or peloids (photo 0124-26); base consumed by chalkification, transition to underlying bed distinct by change from fenestral micritic to laminated fabric with *Amphipora*.

804-805.65 Peritidal unit: Limestone brownish yellow with few brown horizontally stretched mottles, with wrinkled and disrupted lamination in upper 10 cm MD; lamination attenuates gradually downward; the upper 1 m with common to abundant *Amphipora* and very rare small bulbous stromatoporoids; the latter becomes common, including large ones (>15 cm), in the lower 0.5 m; primary texture strongly dominates in grainstone subrounded, f-m/g; no fenestrae, matrix seems to be moderately compacted throughout; grainstone just above disconformable base contains granule-sized limestone clasts.

805.65-810.7 Limestone: yellow with brown mottles, unevenly chalkified, with rare and relatively thin solution seams; primary texture is dominantly grainstones weakly laminated to non-laminated in upper half, grading to wackestones and floatstones bioclastic and biomorphic to base; local amphiporan bafflestones (thickets) and floatstones; top sharp, erosional, with solution pockets and cylindrical pipes – perhaps solution-enhanced burrows (photo 0121-23); all solution cavities filled by c/g grainstone from the bed above; no solution voids seen already in 15-20 cm MD below the top. Stromatoporoid assemblage strongly dominated by upright amphiporids; bulbous forms grow in number and size to base; progressively more thick shells (brachiopods, tabulate corals, possible mollusks and trilobites) to base.

810.7-811.9 yellow chalky matrix between stromatoporoids; framestone stromatoporoidal (with large domal forms and minor amphiporan thickets in the interstices); original matrix is packstone and grainstone with micritic crusts and cement patches, locally syngenetically brecciated; very diverse macrofossils: brachiopods, large ostracods, possible polychaetes (curved thin-wall tubes, often embedded in stromatoporoids), etc.; base gradational.

811.9-816 Limestone: brown to yellow, mottled, unevenly chalkified, with rare thick solution seams; stylolites lined with thick black shale in the middle; original grainstones f/g to m-c/g, mostly syndepositionally lithified and brecciated, with replacive clouds and stringers of micritic cement (including vaguely stromatoidal crusts); this rock may partly comply to "automicritic framestone"; minor amphiporid thickets, rare oncoids and bulbous stromatoporoids including large ones; macrofossil assemblage diverse, shells mostly broken.

816-819.05 Limestone: brown to yellow, mottled, unevenly chalkified, with abundant amphiporids and common bulbous stromatoporoids; original texture badly preserved, supposedly alternation of amphiporid bafflestones, vf/g to micritic and grainstones-automicrites partly syngenetically brecciated; bulbous stromatoporoids sit apart, sometimes seem upturned; diverse macrofossils; coiled polychaetes symbiotically embedded in stromatoporoids; a high-amplitude solution zone in the middle of bed; base gradational.

819.05-821.2 Limestone: yellow with blurred brown mottles; primary packstones and grainstones f/g, apparently less converted to automicrite and without syngenetic brecciation, with rare large bulbous stromatoporoids and rare small (5 cm) amphiporan thickets; strongly stylolitized lithoclastic-amphiporan rudstone/conglomerate in base.

821.2-822.1 Peritidal cycle: Limestone brownish yellow, uniformly chalkified, stylolitized; automicrite-grainstone laminar, fenestral (birds-eye fenestrae) in upper 20 cm MD, grading downward to small-amphiporan bafflestones, packstones, wackestones, and minor non-laminar grainstones; rare amoeboid, vug-like fenestrae in micritic facies; strongly compacted amphiporan bafflestone in disconformable base.

822.1-822.8 Peritidal cycle: Limestone yellowish beige, chalkified, stylolitized in the middle; top 10 cm is laminite fenestral (birds-eye) with disrupted, contorted, and largely degraded lamination; supratidal imprint is possible; texture mostly micritic, modified by chalkification; downward gradation into light chalky limestone possibly packstone bioturbated (random bioclast orientation) with minor, largely in situ *Amphipora*, small badly preserved stromatolith nodules in the middle, and with minor solution vugs. Top and base stylolitized. Large intraclasts and upturned amphiporids in base.

822.8-822.9 Limestone: brown, with yellow chalky spots, strongly corroded by stylolites from top and base; primary texture is grainstone vf/g to automicrite with massive-to-swirly fabric, with calcispheres and large (1-2 cm) geopetally filled fenestrae (polymud fabric); minor syngenetic brecciation and solution vugs; late diagenetic brecciation with fractures filled by dolomite spar.

822.9-826.7 Limestone: yellow to beige, uniformly chalkified, in lower half with blurred brown mottles; original texture is mostly grainy with distinct layers of f-m/g rounded grainstones; merged vf/g grainstone texture in brown mottles; minor to common amphiporid bafflestones and rudstones; solution vugs with locally derived geopetal sediment in top 50 cm; stromatoporoids mostly upturned (rudstones) in upper 1 m and progressively more autochthonous to base.

826.7-831.05 Limestone: yellow to brown, mottled, unevenly chalkified, with frequent undulating stylolites, numerous amphiporid thickets and rare small bulbous stromatoporoids (mostly upturned); primary texture is amphiporid bafflestones, rudstones, wackestones and minor calcimudstones in

mottles and more grainy packstones and/or grainstones in chalkified intermottles; in lower 1.2 m grading back to yellowish beige, less mottled limestone with mostly upturned amphiporids (primary f/g grainstones); basal 10 cm is mottled again; base conformable.

831.05-847.4 Limestone: brownish yellow, with chalkified matrix between stromatoporoids; boundstones (bafflestones and minor framestones) amphiporid, in upper 5 m with minor bulbous and very rare encrusting stromatoporoids; a graded grainstone bed with large (up to 10 cm) oncoids at 833.85-834.4; this grainstone is mostly chalkified, but c/g grainstone texture in base is well preserved; below amphiporid framework gradually becomes very dense; matrix probably complies to primary f/g packstones and grainstones; rare brachiopods (some in situ), crinoid ossicles, and polychaete tubes; very rare small solitary Rugosa; moderate interparticle stylolitization; base conformable.

847.4-850.1 Limestone: light brownish beige, moderately to weakly chalkified; practically no chalky replacement in base; bindstones lamellar-stromatoporoidal with grainstone and f/g packstone matrix alternating with grainstones m-c/g, polybioclastic, with abundant crinoid and/or blastoid sclerites; amphiporids disappear in framework, but their fragments are abundant in grainstone; compaction-enhanced primary lamination in grainstones is observed from preferential bioclast orientation; minor disarticulated brachiopods, solitary Rugosa, worm tubes, and mollusks; a non-chalkified vc/g grainstone with common lithoclasts in base.

850.1-850.57 Limestone: brown with few chalky stringers in top, grading downward to yellow as chalkification increases; top erosional, with solution pockets and overhangs; in top 10 cm grainstone vf/g to micrite clotted, fenestral (birds eyes), with indistinct swirly pattern, with abundant calcispheres; rare dwarf amphiporids in life position; some larger fenestra-like voids appear to be early solution vugs; below residual patches of grainstone-micrite irregularly laminar and limestone chalky with lost primary structure but preserved solution vugs.

# Imperial Bear Island R34X

**Well ID data:** 302/E-46-6520-12645/0

Imperial Oil Ltd.

SPUD: 1979/10/07    CMPL DRL:    DAYS: 19    RR: 1979/10/25

**Interval measured:** 674-728 m

**Core condition:** Good, relatively coherent

Measurements in metres

**Core description:**

KEE SCARP LIMESTONE

674.00-681.25 Limestone: beige, unevenly compacted (frequent solution seams and stylolites); bafflestones-bindstones, rudstones, and floatstones pachyporid-stromatoporoidal, with minor erect bryozoans, with bioclastic packstone matrix, intercalated by 10-30 cm thick layers of packstones bioclastic m/g (crinoid, stromatoporoid, coral and brachiopod fragments, minor small gastropods and/or goniatites); bioturbation throughout; no rounded grains except for one 30 cm-thick layer of matrix-poor packstone at 674.3 with possible minor subrounded bioclasts (or non-rounded crinoid fragments). Weak to moderate, even matrix chalkification affecting micritic and finest grain components only; chalky material concentrates in upward-open pits developed on growth surfaces of large frame-builders; packstone non-sorted bioclastic in base; the very base overcompacted, directly underlain by a stromatoporoid-pachyporid boundstone. No direct evidence of erosional surfaces throughout the bed.

681.25-683.1 Limestone: beige gray, darker than above, returning to common light beige color in base; loose pachyporid-stromatoporoid framework with packstone to wackestone matrix; tight mottles of micritic cementation (preserved as nodules) make difference from beds above and below; base conformable; weak matrix chalkification.

683.1-685.5 Limestone: light beige gray; packstones non-sorted m-c/g bioclastic, massive, intercalated by loose bafflestones-to-rudstones pachyporid-dominated, with minor stromatoporoids and erect bryozoans; weak matrix chalkification. Base compacted, conformable.

685.5-686.00 Limestone: dark brownish gray, probably weakly argillaceous, strongly stylolitized, nodular; boundstone with diverse pachyporid, encrusting stromatoporoid, "solenoporid", bryozoan

framework; common intergrowths of frame builders; matrix contains nodules of early micritic cementation with wackestone texture, outside nodules matrix overcompacted; base and top conformable.

686.00-688.85 packstones massive, m-c/g, bioclastic, with swirly bioturbation fabric, grading to bafflestone stromatoporoidal-pachyporid; frequent unevenly distributed (preferentially in boundstones) solution seams; bioclastic material not rounded except for matrix-poor packstone in base with possible minor subrounded bioclasts; the base sharp, compacted, but probably conformable. Weak to no matrix chalkification.

688.85-692.00 Limestone: brownish gray, slightly darker than above, returning to beige color in base; bindstones-bafflestones loose pachyporid dominated, alternating with packstones m/g and c/g; minor nodules of early micritic cementation in upper half of bed; strong to moderate stylolization throughout the bed. Matrix darker in upper half of bed probably from admixture of coal attritus and/or very weak shaliness.

692-702.5 Limestone: weakly argillaceous, beige with plenty of thin black solution films and stylolites; bafflestones-to-bindstones with loose stromatoporoid-bryozoan (and/or coral) framework grading to packstones bioclastic m-c/g massive with swirly bioturbation fabric; micrite framework or cement is nowhere present; stromatoporoids often encrust corals/bryozoans; bioclasts include coral, stromatoporoid, brachiopod, and minor echinoderm fragments; many bioclasts blackened; no rounded grains or primary lamination; an interval with less frame builders (packstone dominated) at 700.00-701.3 m; base very gradational.

702.5-713.05 Limestone: weakly argillaceous to argillaceous, more compacted and darker than above from more abundant black solution seams that penetrate matrix throughout; this compacted rock alternates with less argillaceous and less compacted rock of the type dominant at 692-702.5 m; matrix in non-compacted intervals is as light and above in top of bed and darkens very gradually to base; texture is boundstones of the type above (corals with subordinate stromatoporoids and ?bryozoans); matrix is bioclastic packstone in top, becomes muddier and slightly finer-grained downward - in lower 1.8 m it is packstones and wackestones argillaceous f/g bioclastic bioturbated. Macrofossil assemblages changes from top to base: stromatoporoids reduce from common to rare, fossil occurrence becomes more autochthonous (in situ corals, brachiopods).

#### *CARCAJOU MEMBER*

713.05-715.9 Limestone: argillaceous, with dark gray fissile marl matrix and white massive frame-building fossils, intercalated by marl fissile, almost black, bioclastic, with abundant coal detritus; bafflestones and floatstones-rudstones coral-bryozoan with matrix of detrital-bioclastic wackestone; autochthonicity of benthic fossils decreases downward (transported material takes over); bivalved in situ and disarticulated brachiopods; bryozoans become as numerous as corals and locally take over in lower part of bed; bioturbation vigorous, with multiphase pattern including Siphonophycos and ?Astrosoma. Top and base completely gradational. Base of Carcajou bed is chosen at the base of the lowermost bryozoan bafflestone.

## HARE INDIAN SHALE

715.9-720.3 Shale: greenish gray, fissile, calcareous to weakly calcareous, mostly flaky and expanding in water, but locally silty and more monolithic; texture in top 0.5 m is wackestones bioclastic bioturbated with scattered in situ and upturned corals, with common disarticulated brachiopods; main part of bed below is a mudstone-dominated tempestite with bioturbation-disturbed 0.5-3 cm thick coquinas (brachiopod shells, corals and bryozoans) on storm scour surfaces; bioturbation tends to obliterate thinner and finer-grained storm layers; only badly preserved, vf-f/g coal attritus.

720.3-728.0 Shale: gray, fissile, calcareous to weakly calcareous, flaky and expanding in water, intercalated by more consolidated muddy siltstones; all rock well bioturbated; rare and thin storm bioclastic layers; scattered in situ brachiopods, rare disarticulated crinoid ossicles; moderate admixture of finest coal detritus throughout.

## MCD CAN GCO Maida Creek F-57

**Well ID data:** 300/F-57-6540-12800/0

McDermott J Ray [M013]

SPUD: 1970/07/10    CMPL DRL: 1970/08/09    DAYS: 31    RR: 1970/08/12

**Interval measured:** 1523 – 1614 ft

**Core condition:** Four boxes containing the 1614-1631 ft interval are missing from the stock.

Measurements in feet

### **Core description:**

#### KEE SCARP LIMESTONE

1523-1534.6 Limestone: brown moderately stylolitized; loose bafflestones and bindstones stromatoporoidal (amphiporids and large encrusting forms); matrix micritic, dense, probably chalkified, microporous to dense, ?original packstones and wackestones bioclastic; macrofossils: gastropods, crinoid ossicles, and brachiopods; many burial dolospar-filled sigmoidal cracks probably associated to chalkification; bioclasts mostly badly preserved, half-converted into chalky matrix; skeletal structure in many stromatoporoids degraded and superimposed by chalky bands and thin stringers developed along compressional fractures.

1534.6-1535.5 Limestone: brown with whitish residual mottles; grainstone c/g, intraclastic-peloidal-bioclastic, subrounded, with thin isopachous rims around grains; top and base conformable.

1535.5-1555 Limestone: brown moderately stylolitized; loose bafflestones and bindstones stromatoporoidal (amphiporids and large encrusting forms) grading down to boundstones more densely populated by encrusting stromatoporoids and subordinate amphiporids; the latter become equally abundant to base; rare to minor pachyporids; matrix chalkified, original packstones and wackestones bioclastic; chalky stringers in frame-building skeletons; short sigmoidal dolospar-filled fractures are equally numerous; base very gradational; moderate stylolitization.

1555-1565 Limestone: brown moderately stylolitized; bafflestone amphiporan with few erect bryozoans and pachyporid corals; matrix is wackestone to packstone bioclastic, bioturbated, with some poorly sorted grainstone in base;

1565-1582 Limestone: brown, microporous, oil saturated; grainstones thick-bedded but mostly without distinct lamination, vf/g to c/g in different layers, rounded to subrounded, peloidal-bioclastic, with few bulbous and encrusting stromatoporoids in upper 1.3 m and in base; grains selectively chalkified; alternation of grainstones bioclastic, peloidal-bioclastic, and oolitic; many obsolete amphiporan fragments and small echinoderm sclerites; minor (<1%) admixture of black non-carbonate grains throughout the bed (fish or coal detritus); three or more scalloped erosional surfaces (at 1573.3 ft, 1567 ft, and 1568.5 ft); two upper surfaces bound fining-upward parasequences (from grainstones m-c/g in base to grainstones-packstones vf/g in top).

1582-1594.7 Limestone: brown, with strongly chalkified, probably microporous matrix; boundstones stromatoporoidal, with diverse amphiporids, bulbous, and encrusting forms; the framework is loose and strongly dominated by bulbous and encrusting forms in upper 0.7 m; the framework is most dense in the middle of bed and becomes loose, with packstone interlayers, in the lower 0.7-0.9 m; original matrix texture, where preserved, is packstones f/g and minor grainstones f/g; locally matrix is dark brown to black stained (bitumen); many bulbous stromatoporoids contain symbiotic microconchids; moderate to weak stylolitization and ?uniform matrix compaction.

1594.7-1599.0 Limestone: brown with dark brown (bitumen impregnated?) mottles, moderately stylolitized and nodular; strong, uneven chalkification obliterates most of primary fabrics incl. stromatoporoid skeletons; primary textures: alternation of packstones, wackestones, and bafflestones-floatstones amphiporan with packstone matrix; minor rounded-grain grainstones; wackestones are less chalkified, stand out as pale (non-stained) stylolite-accentuated nodules of early lithification; primary lamination not preserved; wackestones are rich in mollusk fragments. Top conformable; base supposedly conformable, consumed by a high-amplitude stylolite.

1599.0-1600 Limestone: brown, chalkified, with dark brown patches in matrix; rudstone-bafflestone amphiporan grading down to rudstone stromatoporoid-oncoidal (diverse stromatoporoids in oncoidal cortexes); ghost (chalkified) diverse skeletons – trilobites, brachiopod valves, etc; the strongest alteration occurs in base, with few ghost upturned amphiporids in tight cherty rock; base may correspond to event scour surface.

1600-1605 Limestone: brown, with a dark (more compacted, bitumen-stained) interval at 1600.7-1601.3 probably corresponding to increased shale content; the upper 40 cm is micrite-dominated (chalky rock) with ghost amphiporids and rare in situ massive stromatoporoids, with thin (2-4 cm) intercalations of amphiporid rudstone; matrix is totally chalkified with obscure primary texture; downward gradation to bafflestone amphiporid, with relatively dense skeletal framework, with rare erect bryozoans and pachyporids; matrix is strongly chalkified, locally retaining f/g grainstone texture; the densest amphiporid framework at 1602.3-1604 ft is matrix-poor, with geopetally distributed matrix, and completely matrix-free in base of this interval; frame cavities filled by coarse calcite blocky spar. The basal 1 ft (1604-1605 ft) is a rudstone coarse stromatoporoidal (diverse forms); some fragments encased in thin oncoidal envelopes; matrix is chalkified with locally preserved grainstone texture. Base conformable.

1605-1614 Limestone: brown, mottled, unevenly chalkified, nodular from development of non-compacted and light colored micritic nodules; primary textures mostly preserved in nodules: wackestones and grainstone-to-wackestones f/g, rich in chaotically oriented gastropods and bivalves, with rare large bulbous stromatoporoids and thin intercalation of stromatoporoidal boundstones-rudstones; thick pervasively chalkified intervals between nodules may correspond to primary vf-f/g grainstones-packstones.



## References

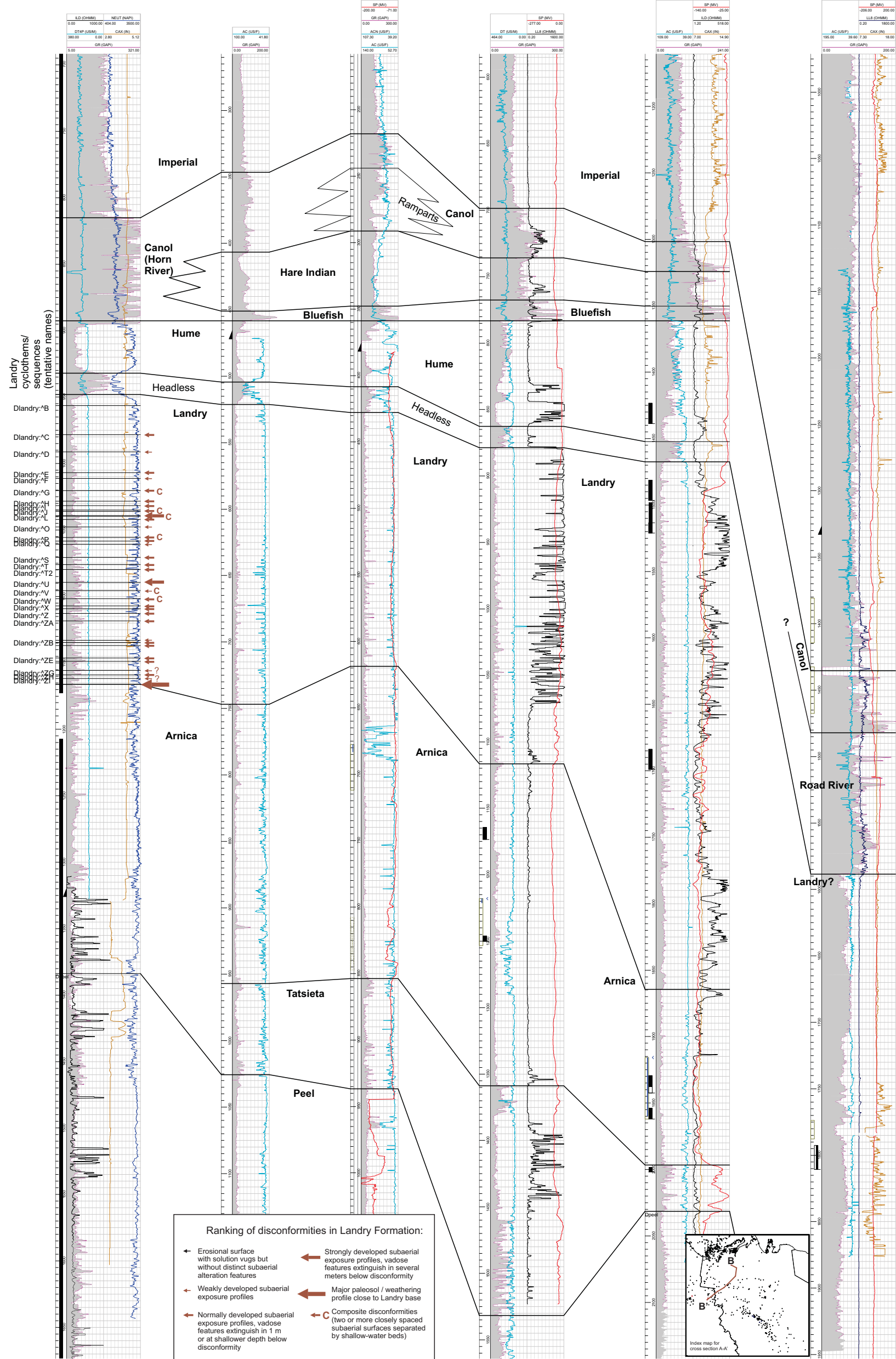
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Muir, I., Wong, P. and Wendte, J., 1984, Devonian Hare Indian – Ramparts (Kee Scarp) evolution, Mackenzie Mountains and subsurface Norman Wells, N.W.T.: Basin-fill and platform development, *in*: Eliuk L., Kaldi J., and Watts N. (eds.): Carbonates in Subsurface and Outcrop, CSPG Core Conference, Oct. 18-19, 1984: 82-102.

**Appendix 1.** Cross-section Northern Mackenzie River Corridor (TVD mode)

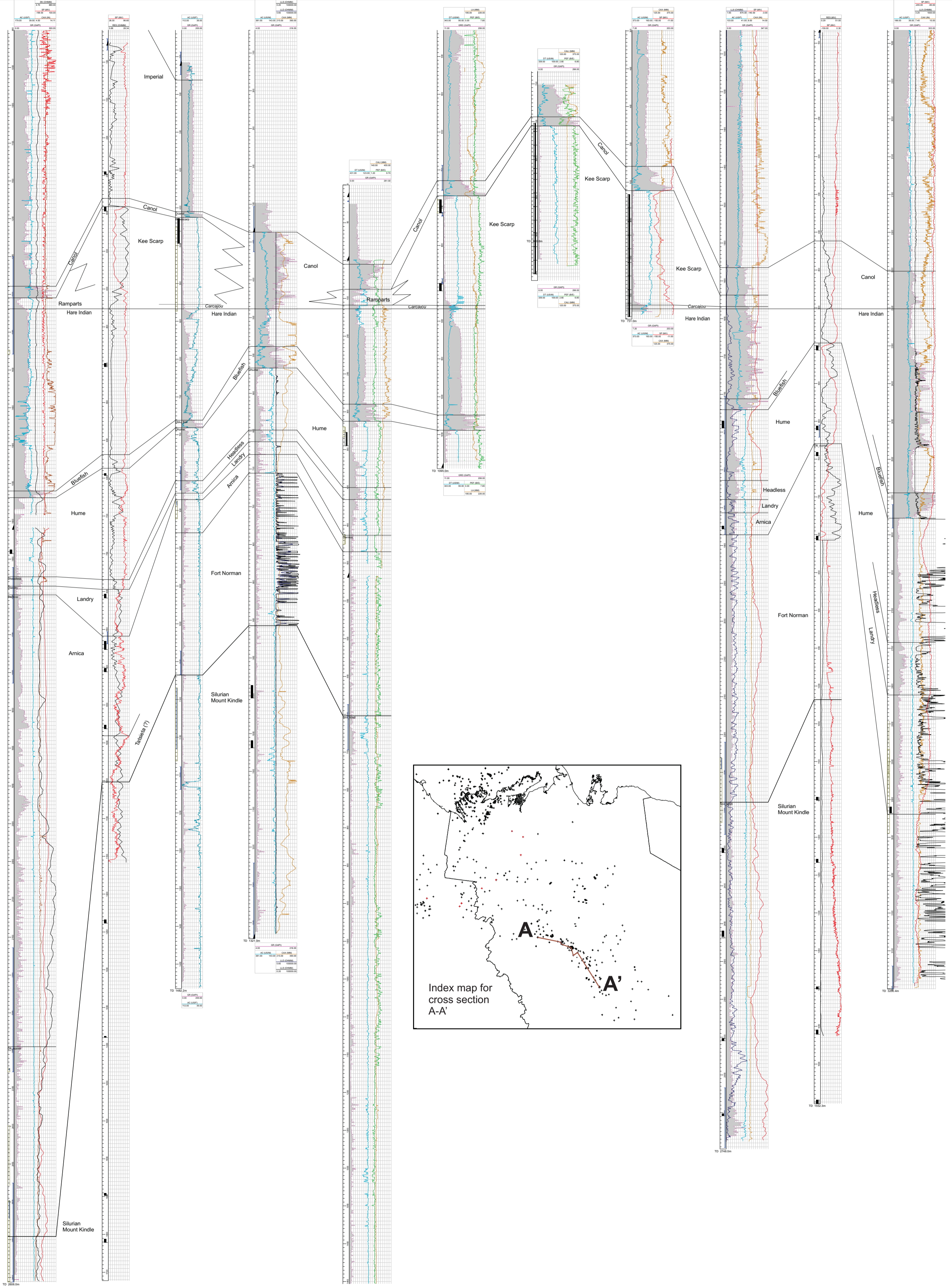
**Appendix 2.** Cross-section Norman Wells – Middle Mackenzie River Corridor (MD mode)

**Appendix 3.** Digital macro photographs of measured core



Appendix 1. Cross-section Northern Mackenzie River Corridor (TVD mode)





Appendix 2. Cross-section Norman Wells - Middle Mackenzie River Corridor (MD mode)