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# Geological and geochemical data from the Canadian Arctic Islands. Part XV: basal strata of Devonian clastic wedge on Banks Island and correlation with mainland Northwest Territories

**P. Kabanov**

**2018**

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# Geological and geochemical data from the Canadian Arctic Islands. Part XV: basal strata of Devonian clastic wedge on Banks Island and correlation with mainland Northwest Territories


## P. Kabanov


## 2018




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

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## SUMMARY

The Ellesmerian foreland basin encroached onto present-day Banks Island by the Early-Middle Devonian boundary and depressed Blue Fiord carbonate shelf into the starved foredeep. From mid-Devonian onward, the foredeep filled with thick turbiditic to floodplain siliciclastics known as the Devonian clastic wedge. Stratigraphy of foredeep strata and adjoining units remained unsettled since 1970s. This study revises nomenclature and proposes correlation with coeval strata of the N.W.T. mainland. In two wells, the upper 10-25m of the Blue Fiord are underlain by thin black shale correlated with the Headless Member. The Orksut Formation (new definition) includes shales onlapping the Blue Fiord and laterally grading to its upper part. The part onlapping the upper Blue Fiord is correlated with the Bluefish Member. The Nanuk Formation is discarded. Overlying shales and turbidites are downgraded from formations to members of the Weatherall Formation. Canol anoxic shales do not extend north of 70°.

## RÉSUMÉ

Le bassin d'avant-pays ellesmérien à empiété sur l'île Banks actuelle à la limite entre le Dévonien inférieur et moyen et a écrasé la plateforme carbonaté de Blue Fiord dans l'exogéosynclinal appauvri. À partir du Dévonien moyen, l'exogéosynclinal a été rempli par un dépôt silicoclastique composé de dépôts turbiditiques épais à des dépôts de plaine inondable et appelé prisme clastique dévonien. La stratigraphe des strates exogéosynclinales et des unités adjacentes est restée indécise depuis les années 1970. Deux puits montrent que les 10 à 25 m supérieurs de la plateforme de Blue Fiord reposent sous une mince couche de shale noir corrélée avec le membre de Headless. La Formation d'Orksut (nouvelle définition) intègre les shales qui recouvrent la plateforme de Blue Fiord et montant latéralement jusqu'à sa partie supérieure. La partie recouvrant le haut de la formation Blue Fiord est corrélée avec le membre de Bluefish. La formation de Nanuk est abandonnée. Les shales et les turbidites sus-jacents sont rétrogradés de formation à membres de la formation de Weatherall. Les shales anoxiques de Canol ne s'étendent pas au nord du 70e parallèle.

## INTRODUCTION

The Devonian clastic wedge is an encompassing name for the Middle-Upper Devonian siliciclastic sequences of the Canadian Arctic Archipelago (Tozer and Thorsteinsson, 1964). These clastic units are up to 5 km thick, and most of these strata were deposited in a foreland setting sourced from the northeasterly located (modern coordinates) Ellesmerian Orogen (Embry and Klovan, 1976; Embry, 1988; Lane, 2007; Anfinson et al., 2012).

Stratigraphy of the Devonian rocks of Banks Island has seen little study since the works of Miall (1976) and Embry and Klovan (1976). Nomenclatures proposed by these authors for basinal mudrocks occurring in and just below the base of the clastic wedge still await reconciliation. Wells Tiritchik M-48, Kusrhaak D-16, and Ikkariktok M-64, drilled in 1974-75, were mentioned by Miall (1976) as new arrivals essentially without lithostratigraphic analysis, but Embry and Klovan (1976) included these wells in their work. Two more wells, Parker River J-72 and Muskox D-87, were drilled in 1979 and 1982 (Table 1). Dewing and Embry (2007) gave the most recent GSC update on formation tops and compiled tops from other sources. Surface stratigraphic sections compiled by Klovan and Embry (1971), Embry and Klovan (1976), and Miall (1976) do not expose representative sections below the Weatherall Formation, and Miall (1976) in his very detailed study had to lean almost entirely on cutting samples and well logs. This report incorporates well data from Banks Island, including paleontological information, and provides a new look at the stratigraphic interval near the base of the Devonian clastic wedge developed through correlation with better studied Middle-Upper Devonian strata of the northern mainland N.W.T.

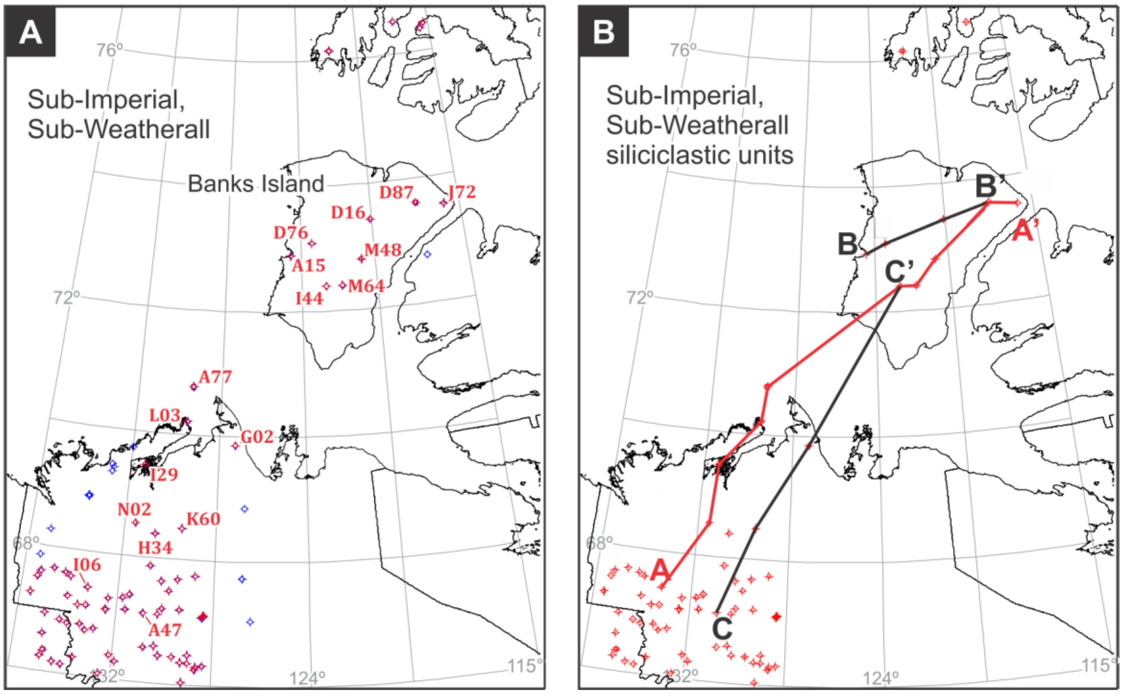


**Figure 1. Exploration wells intersecting one or more Middle-Upper Devonian units below Imperial and Weatherall formations. Blue subset on (A) includes Landry, Headless, Hume, Road River, Bluefish, Hare Indian, Ramparts, Canol, Blue Fiord, Kitson, Orksut, Ibbett Bay, Cape de Bray, and Blackley. Red subset includes units overlying pre-Givetian shelf carbonates: Bluefish, Hare Indian, Ramparts, Canol, Kitson, Orksut, Ibbett Bay, Cape de Bray, and Blackley. FPS unit-sections label wells tackled in this study. (B) Traces of cross-sections from Figures 2-4.**

## MATERIALS

Nine exploration wells penetrate sub-Weatherall Devonian in the subsurface of Banks Island and adjacent Victoria Island (Fig. 1A). Basinal mudrocks (a.k.a. black shales) historically assigned to Eids, Ibbett Bay, Kitson, Orksut, or Nanuk formations are intersected by eight of these wells (Fig. 1B and Table 1). Wendte (2012) characterized lithofacies of Blue Fiord carbonates in cores. Unfortunately, none of these cores is longer than 7.6 m, and none of them intersects stratigraphic contacts. Core inventory of basinal mudrocks between Blue Fiord carbonates and foreland siliciclastics of the Devonian clastic wedge is limited to just one short (5.5 m) core from 1354.8 – 1360.3 m of Nanuk D-76 as listed in the NEB Core & Samples inventory. Description and ED-XRF geochemical log of this core are placed in Appendix 1.

Biostratigraphic age constraints of the Banks Island sections are dominated by data from Storkerson Bay A-15, but unfortunately, use of this well for correlation is hindered by lack of geophysical logs below 5916 ft (1803.2 m).

| Well name | Date Rig Released | Lithostrat unit (this study) | Lithostrat unit (this study) MD, m | Lithostrat unit (this study) MD, ft | Lithostrat unit (reference1) | Lithostrat unit (reference1), m | Reference1 | Lithostrat unit (reference2) | Lithostrat unit (reference2), m | Reference2 |
|---|---|---|---|---|---|---|---|---|---|---|
| IKKARIKTOK M-64 | 1974-04-16 | Weatherall (bas sh) | eroded | eroded | Weath (sh) | eroded | Dewing & Embry, 2007 | Weath (sh) | eroded | PanArctic |
| IKKARIKTOK M-64 | 1974-04-16 | Orksut | 848.6 | 2784 | Eids | 848.6 | Dewing & Embry, 2007 | Eids | 848.6 | PanArctic |
| IKKARIKTOK M-64 | 1974-04-16 | Blue Fd. (u.mb.) | 889.4 | 2918 | Blue Fiord | 889.4 | Dewing & Embry, 2007 | Blue Fiord | 889 | PanArctic |
| IKKARIKTOK M-64 | 1974-04-16 | Blue Fd. (bsh. mb.) | 897.9 | 2946 | Blue Fd. (bsh. mb.) | N/D | Dewing & Embry, 2007 | N/D | N/D | PanArctic |
| IKKARIKTOK M-64 | 1974-04-16 | Blue Fd. (lower) | 904.3 | 2967 | Blue Fd. (lower) | N/D | Dewing & Embry, 2007 | N/D | N/D | PanArctic |
| ORKSUT I-44 | 1973-03-28 | Weatherall (bas sh) | 1828.8 | 6000 | Cape de Bray | 1828 | Dewing & Embry, 2007 | Orksut | 1828.8 | Miall, 1976 |
| ORKSUT I-44 | 1973-03-28 | Orksut | 2158.0 | 7080 | Kitson | 2158 | Dewing & Embry, 2007 | Orksut (lower pt.) | N/D | Miall, 1976 |
| ORKSUT I-44 | 1973-03-28 | Blue Fiord (u.mb.) | 2220.5 | 7285 | Blue Fiord | 2220.5 | Dewing & Embry, 2007 | Blue Fiord | 2220.5 | Miall, 1976 |
| ORKSUT I-44 | 1973-03-28 | Blue Fd. (bsh. mb.) | 2245.5 | 7367 | Blue Fd. (bsh. mb.) | N/D | Dewing & Embry, 2007 | Blue Fd. (bsh. mb. | N/D | Miall, 1976 |
| ORKSUT I-44 | 1973-03-28 | Blue Fd. (lower) | 2254.9 | 7398 | Blue Fd. (lower) | N/D | Dewing & Embry, 2007 | Blue Fd. (lower) | N/D | Miall, 1976 |
| TIRITCHIK M-48 | 1974-04-06 | Weatherall (bas sh) | 1043.0 | 3422 | Cape de Bray | 1043 | Dewing & Embry, 2007 | Weatherall | 765 | Miall, 1976 |
| TIRITCHIK M-48 | 1974-04-06 | Orksut, upper mb. | 1300.0 | 4265 | Kitson | 1305 | Dewing & Embry, 2007 | Orksut | 1226 | Miall, 1976 |
| TIRITCHIK M-48 | 1974-04-06 | Orksut, middle mb. | 1352.0 | 4436 | N/D | N/D | Dewing & Embry, 2007 | N/D | N/D | Miall, 1976 |
| TIRITCHIK M-48 | 1974-04-06 | Orksut, basal mb. | 1400.0 | 4593 | N/D | N/D | Dewing & Embry, 2007 | N/D | N/D | Miall, 1976 |
| TIRITCHIK M-48 | 1974-04-06 | Blue Fd. (lower) | 1408.0 | 4619 | Blue Fiord | 1407 | Dewing & Embry, 2007 | Blue Fiord | 1407 | Miall, 1976 |
| STORKERSON BAY A-15 | 1971-12-10 | Weatherall (Blck) | 1565.5 | 5136 | Blackley | 1565.5 | Dewing & Embry, 2007 | Weatherall | 1565.5 | Miall, 1976 |
| STORKERSON BAY A-15 | 1971-12-10 | Weatherall (bas sh) | 1750.0 | 5742 | Nanuk | N/D | Dewing & Embry, 2007 | Nanuk | 1732.8 | Miall, 1976 |
| STORKERSON BAY A-15 | 1971-12-10 | Orksut | 1850.0 | 6070 | Kitson | 1868 | Dewing & Embry, 2007 | Orksut | 1929.4 | Miall, 1976 |
| STORKERSON BAY A-15 | 1971-12-10 | Blue Fiord | 1949.2 | 6395 | Blue Fiord | 1949.2 | Dewing & Embry, 2007 | Blue Fiord | 1944.6 | Miall, 1976 |
| NANUK D-76 | 1972-03-04 | Weatherall (bas sh) | 1126.0 | 3694 | Blackley | 1126 | Dewing & Embry, 2007 | Nanuk | 1126.2 | Miall, 1976 |
| NANUK D-76 | 1972-03-04 | Orksut, upper mb. | 1263.0 | 4144 | Kitson | 1263 | Dewing & Embry, 2007 | Orksut | 1261.9 | Miall, 1976 |
| NANUK D-76 | 1972-03-04 | Orksut, middle mb. | 1300.0 | 4265 | N/D | N/D | Dewing & Embry, 2007 | N/D | N/D | Miall, 1976 |
| KUSRHAAK D-16 | 1975-04-04 | Weatherall (Blck) | 3217.0 | 10554 | N/D | N/D | NEB | Eids | 3216.6 | PanArctic |
| KUSRHAAK D-16 | 1975-04-04 | Weatherall (bas sh) | 3300.0 | 10827 | N/D | N/D | NEB | N/D | N/D | PanArctic |
| KUSRHAAK D-16 | 1975-04-04 | Orksut, upper mb. | 3500.0 | 11483 | N/D | N/D | NEB | N/D | N/D | PanArctic |
| KUSRHAAK D-16 | 1975-04-04 | Orksut, middle mb. | 3545.0 | 11631 | N/D | N/D | NEB | N/D | N/D | PanArctic |
| KUSRHAAK D-16 | 1975-04-04 | Orksut, middle mb. | 3620.0 | 11877 | N/D | N/D | NEB | N/D | N/D | PanArctic |
| KUSRHAAK D-16 | 1975-04-04 | Blue Fiord | 3627.0 | 11900 | Blue Fiord | 3627 | NEB | Read Bay Group | 3626.6 | PanArctic |
| PARKER RIVER J-72 | 1979-06-01 | Weatherall (bas sh) | 484.0 | 1588 | Cape de Bray | 484 | Dewing & Embry, 2007 | Cape de Bray | 484 | NEB |
| PARKER RIVER J-72 | 1979-06-01 | Orksut | 875.0 | 2871 | Kitson | 855 | Dewing & Embry, 2007 | N/D | N/D | NEB |
| PARKER RIVER J-72 | 1979-06-01 | Blue Fiord | 917.0 | 3009 | Blue Fiord | 917 | Dewing & Embry, 2007 | Blue Fiord | 918 | NEB |
| MUSKOX D-87 | 1982-01-27 | Weatherall (bas sh) | 1380.0 | 4528 | Cape de Bray | 1380 | Dewing & Embry, 2007 | Cape de Bray | 1380.2 | PanArctic |
| MUSKOX D-87 | 1982-01-27 | Orksut, upper mb. | 1944.0 | 6378 | Kitson | 1795 | Dewing & Embry, 2007 | Eids | 1740.1 | PanArctic |
| MUSKOX D-87 | 1982-01-27 | Orksut, middle mb. | 1985.0 | 6512 | Blue Fd (u. mb.) | 1855 | Dewing & Embry, 2007 | N/D | N/D | PanArctic |
| MUSKOX D-87 | 1982-01-27 | Orksut, basal mb. | 2017.0 | 6617 | Eids | 1900 | Dewing & Embry, 2007 | N/D | N/D | PanArctic |
| MUSKOX D-87 | 1982-01-27 | Blue Fiord | 2022.0 | 6634 | Blue Fiord | 2018 | Dewing & Embry, 2007 | Blue Fiord | 2019.9 | PanArctic |

**Table 1. Tops of formations and members in Banks Island wells. Acronymy: N/D = not defined, Blue Fd (u.mb) = Blue Fiord upper member, Flue Fd. (bsh.mb.) = Blue Fiord black-shale member, Weatherall (bs sh) = basal shale member of Weatherall Fm., Weatherall (Blck) = Blackley Member of Weatherall Fm. More complete data are given in Appendix 2.**

The mainland subsurface materials and more cores are available for a larger number of wells (Fig. 1). The Imperial and Tuttle formations representing the southern tail of the Ellesmerian clastic wedge has received substantial study in recent years, and stratigraphy of this interval is considered up to date (Hadlari et al., 2009; Dixon, 2012). The Givetian-Frasnian Horn River Group below the Imperial siliciclastics is a subject of the Devonian Stratigraphic Framework study of GEM Mackenzie Project (Kabanov, 2017; Kabanov and Gouwy, 2017). The top of Hume Formation is corrected in this study in Crossley Lake S. K-60 based on new description of core (Appendix 1) and review of the original striplog and borehole logs. Correspondent change of this pick is also made in Horton River G-02 (Table 2).

| Well name | Date Rig Released | Lithostrat unit (this study) | Lithostrat unit (this study) MD, | Lithostrat unit (this study) MD | Lithostrat unit (reference 1) | Lithostrat unit (NEB), m | Reference1 | Lithostrat unit (reference2) | Lithostrat unit (reference2), m | Reference2 |
|---|---|---|---|---|---|---|---|---|---|---|
| GRANDVIEW HILLS 1(A-47) | 1960-04-02 | Canol | 234.7 | 770 | Canol | 234.7 | NEB | Canol | 233.5 | Hogue & Gal, 2008 |
| GRANDVIEW HILLS 1(A-47) | 1960-04-02 | Ramparts | 267.6 | 878 | Ramparts | 267.6 | NEB | Ramparts | 267.6 | Hogue & Gal, 2008 |
| GRANDVIEW HILLS 1(A-47) | 1960-04-02 | Hare Indian | 286.5 | 940 | Hare Indian | 286.5 | NEB | Hare Indian | 286.5 | Hogue & Gal, 2008 |
| GRANDVIEW HILLS 1(A-47) | 1960-04-02 | Bluefish | 469.4 | 1540 | Bluefish | 469.4 | NEB | Bluefish | 472.4 | Hogue & Gal, 2008 |
| GRANDVIEW HILLS 1(A-47) | 1960-04-02 | Hume | 481.0 | 1578 | Hume | 481 | NEB | Hume | 479.8 | Hogue & Gal, 2008 |
| GRANDVIEW HILLS 1(A-47) | 1960-04-02 | Headless | 559.3 | 1835 | Headless | 559.3 | NEB | Headless | N/D | Hogue & Gal, 2008 |
| GRANDVIEW HILLS 1(A-47) | 1960-04-02 | Landry | 571.5 | 1875 | Landry | 571.5 | NEB | Landry | 571.5 | Hogue & Gal, 2008 |
| ATTOE LK. I-06 | 1969-12-16 | Canol | 1086.3 | 3564 | Canol | 1086.3 | NEB | Canol | 1085.7 | Hogue & Gal, 2008 |
| ATTOE LK. I-06 | 1969-12-16 | Bluefish | 1139.3 | 3738 | Bluefish | 1139.3 | NEB | Bluefish | N/D | Hogue & Gal, 2008 |
| ATTOE LK. I-06 | 1969-12-16 | Hume | 1145.7 | 3759 | Hume | 1145.7 | NEB | Hume | 1144.9 | Hogue & Gal, 2008 |
| ATTOE LK. I-06 | 1969-12-16 | Headless | 1211.3 | 3974 | Headless | 1211.3 | NEB | Headless | N/D | Hogue & Gal, 2008 |
| ATTOE LK. I-06 | 1969-12-16 | Landry | 1226.8 | 4025 | Landry | 1226.8 | NEB | Landry | 1227.2 | Hogue & Gal, 2008 |
| CROSSLEY LK S K-60 | 1969-03-09 | Canol | 128.0 | 420 | Canol | 128 | NEB | Canol | 128 | Hogue & Gal, 2008 |
| CROSSLEY LK S K-60 | 1969-03-09 | Ramparts | 139.9 | 459 | Ramparts | N/D | NEB | Ramparts | N/D | Hogue & Gal, 2008 |
| CROSSLEY LK S K-60 | 1969-03-09 | Hare Indian | 213.7 | 701 | Hare Indian | 140 | NEB | Hare Indian | 140 | Hogue & Gal, 2008 |
| CROSSLEY LK S K-60 | 1969-03-09 | Bluefish | 365.8 | 1200 | Bluefish | 365.8 | NEB | Bluefish | 365.8 | Hogue & Gal, 2008 |
| CROSSLEY LK S K-60 | 1969-03-09 | Hume | 397.8 | 1305 | Hume | 387.1 | NEB | Hume | 387.1 | Hogue & Gal, 2008 |
| CROSSLEY LK S K-60 | 1969-03-09 | Headless | 427.0 | 1401 | Headless | N/D | NEB | Headless | N/D | Hogue & Gal, 2008 |
| CROSSLEY LK S K-60 | 1969-03-09 | Landry | 440.7 | 1446 | Landry | 442 | NEB | Landry | 442 | Hogue & Gal, 2008 |
| WOLVERINE H-34 | 1974-04-02 | Canol | 346.6 | 1137 | Canol | 346.6 | NEB | Canol | 278.0 | Hogue & Gal, 2008 |
| WOLVERINE H-34 | 1974-04-02 | Hare Indian | 408.1 | 1339 | Hare Indian | 406.6 | NEB | Hare Indian | 335.3 | Hogue & Gal, 2008 |
| WOLVERINE H-34 | 1974-04-02 | Bluefish | 451.1 | 1480 | Bluefish | 451.1 | NEB | Bluefish | 455.0 | Hogue & Gal, 2008 |
| WOLVERINE H-34 | 1974-04-02 | Hume | 458.4 | 1504 | Hume | 458.4 | NEB | Hume | 467.0 | Hogue & Gal, 2008 |
| WOLVERINE H-34 | 1974-04-02 | Headless | 500.2 | 1641 | Headless | N/D | NEB | Headless | N/D | Hogue & Gal, 2008 |
| WOLVERINE H-34 | 1974-04-02 | Landry | 521.2 | 1710 | Landry | 521.2 | NEB | Landry | 519.0 | Hogue & Gal, 2008 |
| KUGALUK N-02 | 1969-12-18 | Canol | 807.7 | 2650 | Canol | 807.7 | NEB | Canol | 814.4 | Hogue & Gal, 2008 |
| KUGALUK N-02 | 1969-12-18 | Bluefish | 884.8 | 2903 | Bluefish | N/D | NEB | Bluefish | N/D | Hogue & Gal, 2008 |
| KUGALUK N-02 | 1969-12-18 | Hume | 894.6 | 2935 | Hume | 890 | NEB | Hume | 895.2 | Hogue & Gal, 2008 |
| KUGALUK N-02 | 1969-12-18 | Headless | 930.6 | 3053 | Headless | N/D | NEB | Headless | N/D | Hogue & Gal, 2008 |
| KUGALUK N-02 | 1969-12-18 | Landry | 949.1 | 3114 | Landry | 944.9 | NEB | Landry | 951.0 | Hogue & Gal, 2008 |
| KILIGVAK I-29 | 1973-08-08 | Canol | 1244.8 | 4084 | Canol | 1244.8 | NEB | Canol | 1245.1 | Hogue & Gal, 2008 |
| KILIGVAK I-29 | 1973-08-08 | Bluefish | 1319.8 | 4330 | Bluefish | 1319.8 | NEB | Bluefish | N/D | Hogue & Gal, 2008 |
| KILIGVAK I-29 | 1973-08-08 | Hume | 1327.1 | 4354 | Hume | 1327.1 | NEB | Hume | 1327.1 | Hogue & Gal, 2008 |
| KILIGVAK I-29 | 1973-08-08 | Headless | 1365.8 | 4481 | Headless | N/D | NEB | Headless | N/D | Hogue & Gal, 2008 |
| KILIGVAK I-29 | 1973-08-08 | Landry | 1380.7 | 4530 | Landry | 1380.7 | NEB | Landry | 1380.7 | Hogue & Gal, 2008 |
| HORTON RIVER G-02 | 1970-01-22 | Hare Indian | 554.7 | 1820 | Hare Indian | 554.7 | NEB | Hare Indian | 553.2 | Hogue & Gal, 2008 |
| HORTON RIVER G-02 | 1970-01-22 | Bluefish | 677.6 | 2223 | Bluefish | N/D | NEB | Bluefish | 677.9 | Hogue & Gal, 2008 |
| HORTON RIVER G-02 | 1970-01-22 | Hume | 705.9 | 2316 | Hume | 691.9 | NEB | Hume | 705.6 | Hogue & Gal, 2008 |
| HORTON RIVER G-02 | 1970-01-22 | Headless | 735.5 | 2413 | Headless | N/D | NEB | Headless | N/D | Hogue & Gal, 2008 |
| HORTON RIVER G-02 | 1970-01-22 | Landry | 751.3 | 2465 | Gossage | 786.4 | NEB | Landry | 751.3 | Hogue & Gal, 2008 |
| ANGASAK L-03 | 1987-04-12 | Imperial + Hare Ind. | 914.5 | 3000 | Imperial | 914.5 | NEB | Imperial | 914.5 | Hogue & Gal, 2008 |
| ANGASAK L-03 | 1987-04-12 | Bluefish | 2044.0 | 6706 | Canol | 2044 | NEB | Canol | 2044 | Hogue & Gal, 2008 |
| ANGASAK L-03 | 1987-04-12 | Hume + Landry | 2047.5 | 6718 | Hume + Landry | 2047.5 | NEB | Hume + Landry | N/D | Hogue & Gal, 2008 |
| KILANNAK A-77 | 1980-07-09 | Imperial + Hare Ind. | 1266.9 | 4156 | Imperial | 1266.9 | NEB | Imperial | 1267 | Hogue & Gal, 2008 |
| KILANNAK A-77 | 1980-07-09 | Bluefish | 2077.5 | 6816 | Canol | 2077.5 | NEB | Canol | 2070 | Hogue & Gal, 2008 |
| KILANNAK A-77 | 1980-07-09 | Hume+Landry | 2086.5 | 6845 | Hume | 2086.5 | NEB | Hume | 2087 | Hogue & Gal, 2008 |
| KILANNAK A-77 | 1980-07-09 | Landry | N/D | N/D | Landry | 2159.4 | NEB | Landry | 2160 | Hogue & Gal, 2008 |

**Table 2. Tops of formations and members in N.W.T. mainland and offshore wells. More complete data are given in Appendix 2.**

# EMSIAN-GIVETIAN STRATIGRAPHY OF BANKS ISLAND

## Blue Fiord Formation

The Blue Fiord Formation is a succession of limestones, dolomitic limestones, and dolostones with benthic fauna originally defined by McLaren (1963) at Blue Fiord on Ellesmere Island. This is the youngest unit of the Franklinian carbonate shelf dated as Emsian to Eifelian across Arctic Islands (reviews in Embry and Klovan, 1976; Uyeno, 1990; Harrison, 1995). In the subsurface of Banks Island, the upper portion of Blue Fiord changes laterally from well to well. In Orksut I-44, a prominent high-gamma horizon at 25-34 m below the Blue Fiord top is matched to calcareous black shale cuttings described by Miall (1976) at 2249-2254 m. This shale is overlain by argillaceous limestones with tentaculitids and brachiopods. The high-gamma horizon, referred here as the informal black-shale member (Table 1), is traced in Ikkariktok M-64, but black shale at this depth is not reported in the cuttings descriptions. To the north and west of I-44 and M-64, the upper argillaceous limestone grades into dark-colored calcareous shales assigned to the Orksut Formation. This type of lateral Blue Fiord – Orksut transition was observed by Miall (1976) in outcrops on Princess Royal Islands in Prince of Wales Strait. However, these outcrops yielded middle Emsian conodonts and trilobites, which questions correlation with the Orksut Formation (biostratigraphic report # 624-22-10-79-06 of Raasch & Assoc., 1979, well file of Parker River J-72). The high-gamma horizon of the black-shale member seems to persist through facies transition into the basal member of Orksut Formation (Figs. 1 and 3), which makes possible to correlate the base of the Blue Fiord black-shale member with the top of Blue Fiord in Kusrhaak D-16, Muskox D-87, and Tiritchik M-48.

The core recovered from 16.2 m below the top of Blue Fiord in Storkerson Bay A-15 was dated by conodonts as Late Emsian (T.T. Uyeno, GSC paleontological report 6-TTU-1973). The latest Emsian or, possibly, Emsian/Eifelian boundary age is extrapolated to the top of Blue Fiord in Kusrhaak D-16, Muskox D-87, and Tiritchik M-48 wells.

The section of Parker River J-72 is quite different in both Blue Fiord and Orksut parts (Fig. 2). The upper Blue Fiord is a clean and very shallow-water limestone with at least one subaerial exposure surface intersected by core at around 957.3 m (Appendix 1; Wendte, 2012). This subaerial surface is overlain by a thin limestone and likely thin (0.1-0.3 m) grey shale matched to a distinct high-gamma spike. The upper part of this core (257-249 m) is dominated by fenestral micritic facies with abundant calcispheres and *Stromatactis* cavities characteristic of mud mounds (Lees and Miller, 1995). Panarctic microfossil age of “probably Givetian” seems too young for this core in comparison with the age of the Blue Fiord Formation elsewhere. Brice (1982) is the only one who based on brachiopods suggested a Givetian age for the upper Blue Fiord on Bathurst Island.

The younger age of the Blue Fiord carbonate shelf in Parker River J-72 seems overall reasonable based on complete absence of black shales that have Eifelian - lowermost Givetian age in other wells on Banks Island. Explanation of this significant facies transition occurring 50 km east of Muskox D-87 may lay in the involvement of Parker River J-72 area into the Middle Devonian forebulge with very shallow-water sedimentation, whereas other wells located west of this well penetrated the foredeep zone (cf. figure 57 in Embry and Klovan, 1976). Alternative explanation involves aggrading growth of the mud mound coevally with deposition of Orksut black shales.

In Muskox D-87 well, at least 140 m of the Blue Fiord between 2050 and 2200 m MD has very unusual high gamma response, which provides a warning about potential flaws of gamma-only correlations. This unusually high radioactivity in dolomitic limestones and dolostones has not yet been studied or explained. High gamma may result from burial fluids somehow linked to dolomitization processes which left highly altrered carbonate fabrics. Wendte (2012) describes alteration in core from 2073-2091 m as fractured coarse-crystalline dolostones, zebroid fabric, and saddle dolomite.

## Black shales of the Ellesmerian foredeep basin

Basinal siliceous, calcareous, and dolomitic mudrocks sandwiched between Silurian – Lower Devonian carbonates and base of the Devonian clastic wedge initially represented excellent source rocks, but likely reached limits of hydrocarbon generation during Late Devonian burial and at present are overmature (Dewing and Obermajer, 2009). Embry and Klovan (1976) correlated these mudrocks across the Acrtic Islands under the name ***Kitson Formation***. In its type area at Kitson River on northern Melville Island, the Kitson Formation is a poorly exposed unit of black carcareous mudrocks (Tozer and Thorstensson, 1964). The Kitson in the subsurface of Melville Island has characteristic high-gamma response, distinct interval velocity of 4.0-4.1 km/s, and thickness varying between 89 and 269 m depending on the irregular relief of underlying carbonates (Harrison, 1995). The conodont age in the type area ranges from middle Lochkovian to probably early Eifelian (reports of T.T. Uyeno collected in Harrison, 1995).

This study advocates using the local formation name Orksut instead of Kitson based on the significant age offset between the type Kitson of Melville Island and basinal mudrocks of Banks Island. Kitson Formation on Melville Island is dated as Lochkovian to early Eifelian, whereas on Banks Island these mudrocks include the upper part correlated with the latest Eifelian - Lower Givetian Bluefish Member of the northern mainland (Figs. 2 and 4). The base of these mudrocks is unlikely to be older than basal Eifelian as discussed further below, although Miall (1976) speculated that the Blue Fiord - Orksut contact may occur within the latest Emsian. This southward younging of black shales is consistent with migration of the starved foredeep in front of the prograding clastic wedge as reconstructed by Embry and Klovan (1976).

Miall (1976) proposed local names Orksut and Nanuk to be used in Banks Island stratigraphy. His ***Orksut Formation*** is a succession of calcareous shales with minor argillaceous limestones and siltstones. Orksut was defined in the 392 m thick interval of Orksut I-44 well, which is the entire preserved thickness of Devonian mudrocks in the type section. Miall (1976) recognized Orksut Formation in the lower part of mudrock section (below 1255 m) in Nanuk D-76 well and the basal few meters of mudrocks in Storkerson Bay A-1, although the log response in the latter well remains unknown. The Orksut Formation of Miall (1976) in its type section includes two parts that are unlikely to form one traceable unit: the basal high-gamma part between 2158.0 and 2220.5 m, where black calcareous mudrocks and argillaceous limestones are indeed dominant cutting lithologies, and the upper part with flat gamma response at 25-32 gAPI and low resistivity characteristic of grey shales and siltstones (Figure 2). This upper part (1828.8-2158.0 m) contains far less calcareous material and samples were originally logged as mostly grey to dark grey silty shales with rare limestones and dolomite-rich lithologies (NEB well file).

Miall (1976) defined the ***Nanuk Formation*** in the interval 1126-1262 m of Nanuk D-76 and 1732.8-1929.4 m of Storkerson Bay A-15. Diagnostic of the Nanuk was the dominance of siliceous shales with some chertstones, as opposed to calcareous shales of the Orksut. Only the type section of the Nanuk Formation was fully logged with geophysical tools, but the Nanuk top in that section is truncated at the sub-Mesozoic unconformity (Figs. 2 and 4). Miall (1976) interpreted Nanuk formation as an offshore and deeper-water equivalent of the Orksut Formation. An interval of light-colored chert was described at 1216-1242 m of the Nanuk D-76 (Figs. 2 and 4). However, borehole log signatures of this interval are very unusual: a very low gamma, thinly interbedded lithologies of contrasting sonic velocity, and high conductivity (ILD < 3 Ohm*m). The latter is more characteristic of clay-rich fine siliciclastics. This lithology is not yet understood as cuttings striplogs can hardly be considered sufficient today, but assignment to basinal cherts does not look correct. It thus appears that Nanuk Formation in its original definition is a valid unit only if (A) cherty and non-calcareous mudrock lithology is confirmed with new examination involving instrumental measurements of elemental composition and/or main mineral species, and has to show enough difference from mudrocks of the Orksut and basal Weatherall formations; and (B) log signatures show subsurface traceability of Nanuk facies. However, validity of the Nanuk Formation is also compromised by presence of cherty mudrocks within high-gamma intervals of Ikkariktok M-64 (859-882 m) and Tiritchik M-68 (1300-1340 m) that are correlated with the type Orksut in Orksut I-44 (Figure 2). The Nanuk Formation is thus not recommended for further use.

## Orksut Formation (new definition)

The Orksut Formation has to be redefined in order to become a traceable unit. This study assigns the type section of the Orksut Formation to an interval of 2158.0-2220.5 m in Orksut I-44 (Figure 2). This interval includes both black calcareous and dark grey weakly to non-calcareous shales as dominant lithologies with characteristic presence of argillaceous limestones through the interval. The high-gamma signature with strongest radioactivity at the base is considered diagnostic and helps trace Orksut Formation into Ikkariktok M-68 (previously assigned to Eids; Table 1).

The Orksut Formation changes further north and west as the underlying upper member of Blue Fiord grades into calcareous shales. The ***basal member*** of the Orksut is only 5-8 m thick and is traced by high gamma excursion in Tiritchik M-48, Muskox D-87, and Kusrhaak D-16. In the latter well this gamma signature is not well expressed making correlation less definative. The lower member is correlated to the black-shale member of the upper Blue Fiord in Ikkariktok M-68 and Orksut I-44. Lithologic distinction of the basal member from the overlying middle member remains below sample resolution.

The ***middle member*** is a 30-75 m thick succession of calcareous mudrocks with limestone interbeds characterized by depressed gamma signature in all wells except for unlogged Storkerson Bay A-15 and Kusrhaak D-16 where gamma stays at the level of basal and upper members. Mudrocks of the middle member experienced various degree of dolomitization, which is stronger in the basin center (Nanuk D-76 and Kusrhaak D-16). The core at 1354.8–1360.3 m of the type Nanuk section shows biotirbated dark grey shale with 10-46% of cryptocrystalline dolomite as calculated from CaO XRF values (Appendix 1). Siliceous shales are generally not dominant in the middle member but reported from the upper 25-30 m in Kusrhaak D-16 (Figure 3). In Tiritchik M-48 the upper 15 m were described as brittle siliceous shales and some cherts, but underlying part of the Orksut Formation (1368-1411.5 m) did not retrieve representative samples due to lost mud circulation at several levels.

The ***upper member*** is 37-62 m thick and defined by high gamma with strongest radioactivity in its basal part (Nanuk D-76 and Muskox D-87) or in the middle (Tiritchik M-48). The upper member correlates to the entire Orksut Formation in Ikkariktok M-68 and Orksut I-44 (Figure 2). In Muskox D-87, calcareous mudrocks are reported as dominant lithology from the thick interval of 1855-1944 m, and grey shales above (1785-1855 m) are also reportedly calcareous (Figures 2 and 3). This interval of uncertainty is tentatively moved out of Orksut into overlying Weatherall shales as suggested by gamma staying below values chactareristic of the upper member of the Orksut Formation. In Storkerson Bay A-15, the top of the upper member is picked at 1850 m around which dolomitic and calcareous mudrocks become prevalent over siliceous and micaceous mudrocks (Figure 3). Black basinal shales are totally absent in Parker River J-72, and the name Orksut there is tentatively assigned to the interval 875.0-917.0 m that includes interbeds of argillaceous limestone.

Age brackets of the Orksut Formation (new definition) are better for the top than for the base. Palynological identifications of D.C. McGregor (report Fl-7-1975-DCM) cap the top of the formation in Orksut I-44 at the early (or earliest) Givetian. The same report suggests that the interval in Storkerson Bay A-15 matching the middle member of Orksut cannot be older than Late Eifelian (report Fl-7-1975-DCM). The Emsian and/or Eifelian age of the Orksut is also suggested by Imperial Oil paleontological files. No credible biostratigraphic age seems to exist for the Blue Fiord/Orksut contact other than the late (latest) Emsian age of the limestone core in 16.2 m below this contact in Storkerson Bay A-15 (report 6-TTU-1973).

## Basal beds of the Devonian clastic wedge

Tozer and Thorsteinsson (1964) defined the Weatherall Formation of the Melville Island Group near Weatherall Bay of eastern Melville Island as interbedded very fine-grained sandstone, siltstone, and silty shale. The Weatherall Formation in its original definition was the basal unit of the Devonian clastic wedge and included a thick unit of shale with its upper 100 m (330 ft) exposed in the base of the type Weatherall section. This basal shale was correlated with the grey non-calcareous and bioturbated Cape de Bray shale defined in western Melville Island. Tozer and Thorsteinsson (1964) also defined the Blackley Member in the Weatherall Formation as an unfossiliferous unit of rhythmically bedded shales, siltstones and minor sandstones with the type section near Blackley Haven of the western Melville Island. This turbiditic unit with well-developed Bouma rhythmicity conformably overlies black shales assigned by Embry and Klovan (1976) to the Kitson Formation and is overlain conformably and gradationally by grey, more bioturbated shales of the Cape de Bray Formation. Embry and Klovan (1976) argued for the subsurface traceability of Blackley and Cape de Bray and escalated these units to formation status. At the same time, Miall (1976) opted to leave both members within the Weatherall Formation. The Blackley Formation occurs only in the westernmost portion of the Arctic Archipelago (western Banks, westernmost Melville, and Prince Patrick islands) and forms southward-converging clinoforms on seismic lines (Embry, 1988; Harrison, 1995). Eastward the Blackley grades into basal Cape de Bray and/or the upper part of basinal mudrocks assigned by Miall (1976) to Orksut and Nanuk.

Proposed correlation in the Banks Island (Table 1; Figures 2 and 3) follows formation tops of Embry and Klovan (1976) and Dewing and Embry (2007) in many details, but favors the local name Orksut over Kitson. Similarly, modifications are being proposed to the usage of the name Weatherall. Cross-section B-B' (Figure 3) clearly shows that the succession of mudrocks included by Miall (1976) in the Nanuk Formation forms the mudrock tongue wedging out from east to west and separating Orksut mudrocks from Blackley turbidites in Storkerson Bay A-15, Nanuk D-76, and Kusrhaak D-16. This wedge merges with the thick shale succession that in other wells of Banks Islands was previously assigned to Cape de Bray (Table 1; Dewing and Embry, 2007) and partly to Orksut (Miall, 1976). Therefore, Blackley in its typical facies does not appear to be the basal clastic wedge unit as it should by definition. On the other hand, the "real" Cape de Bray shale intervenes at 1945-2899 m of Kusrhaak D-16 where it separates Blackley from Weatherall (Dewing and Embry, 2007). Inability to adequately separate Cape de Bray and Blackley and trace these clinothemic units consistently compromises their independent formation status. With the present knowledge, it is deemed useful to revert to member status of the Blackley within the Weatherall Formation and stop applying the name Cape de Bray to the basal shale of the Devonian clastic wedge. A provisional name "basal shale member of the Weatherall Formation" is introduced until further clarification (Figures 2 and 3).

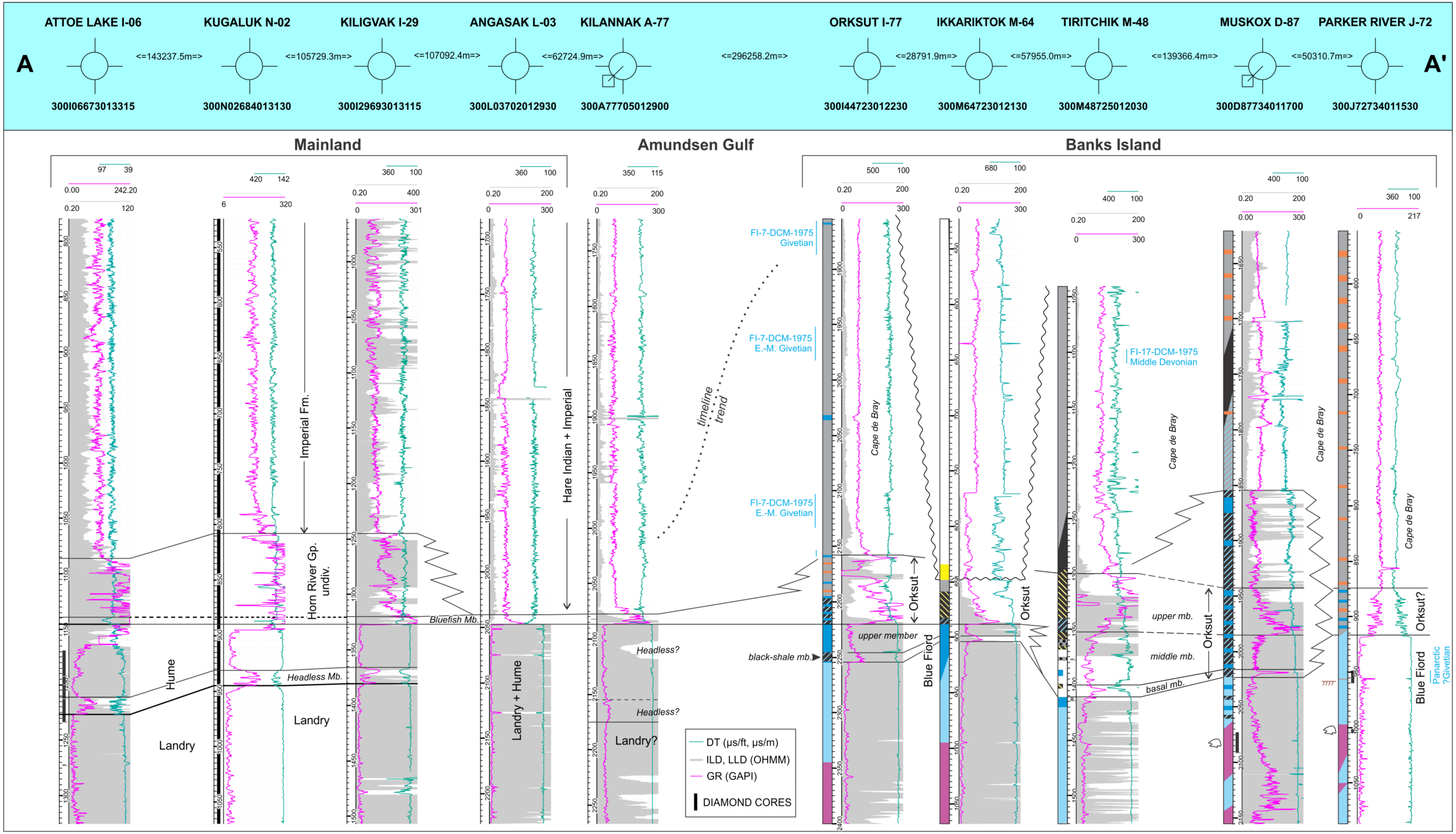


**Figure 2. Cross-section A-A'. Lithology is color-coded in Banks Island wells, see legend in Fig. 3.**

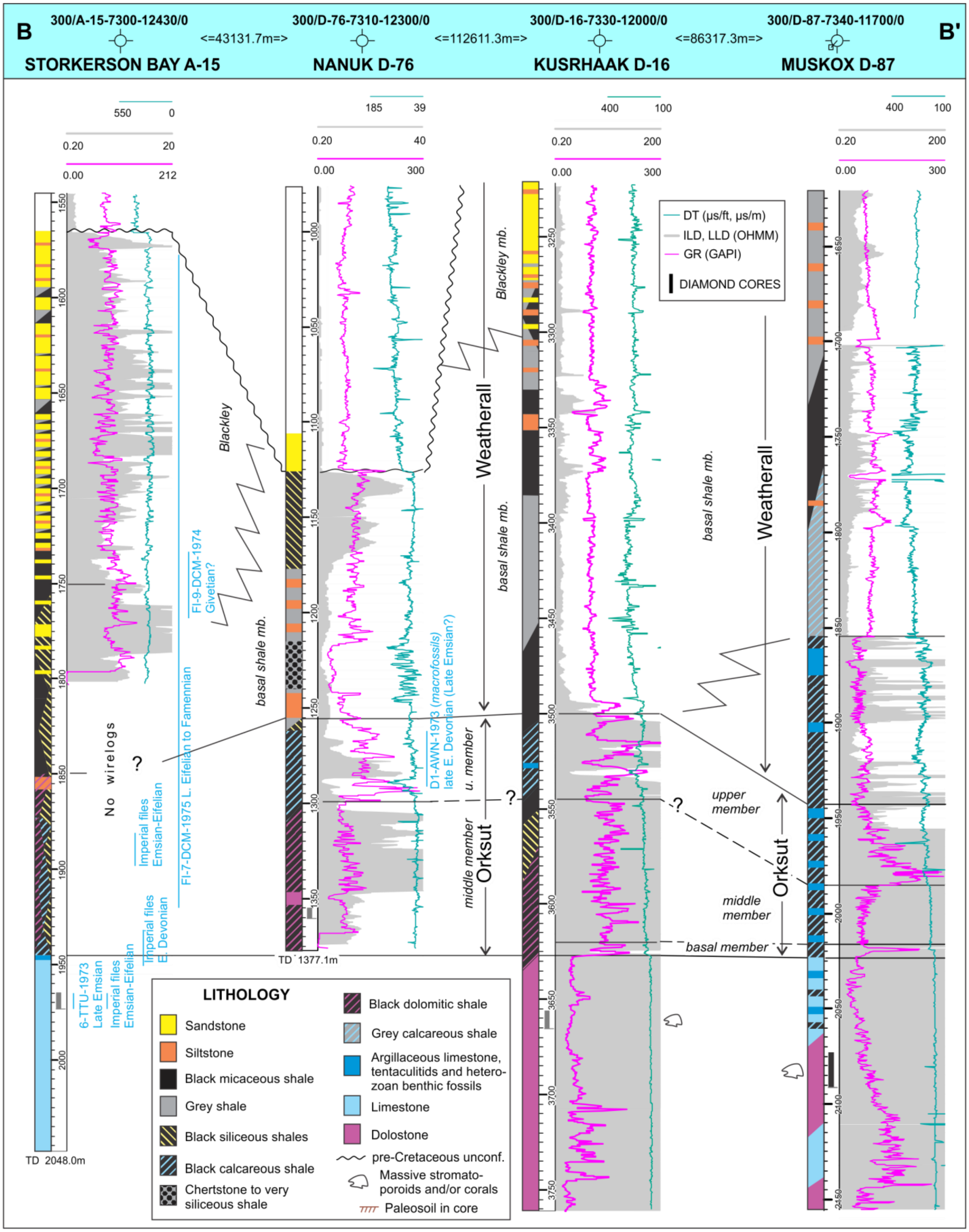


**Figure 3. Cross-section B-B'.**

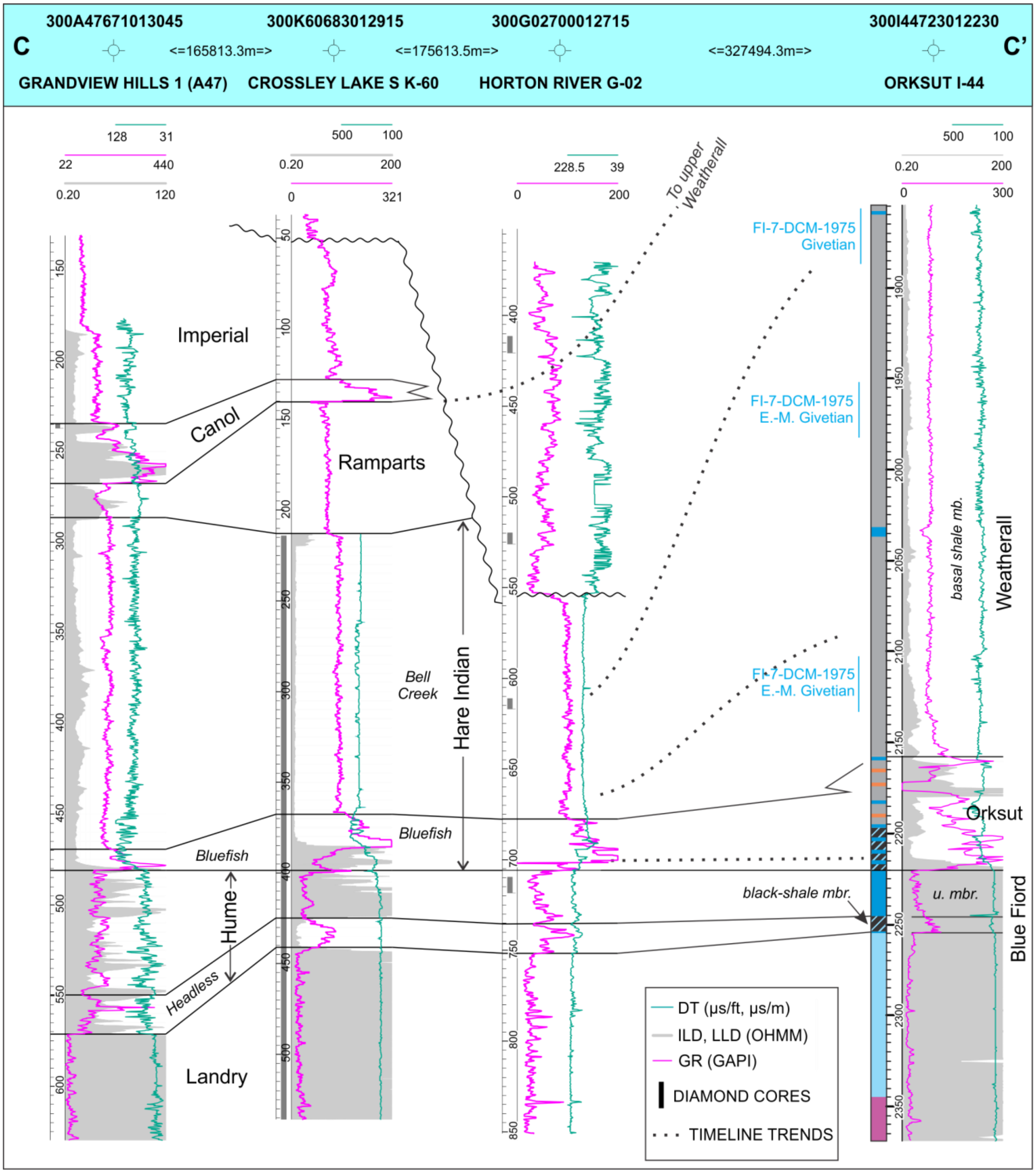


**Figure 4. Cross-section C-C'.**

# CORRELATION WITH NORTHERN MAINLAND

## Headless Member of Hume Formation

South of 68°N, the Hume Formation is a succession of medium-bedded variously argillaceous limestones and calcareous shales ranging between 90 and 140 m in thickness (Figure 5). The Hume is dominated by subtidal facies with rich assemblages of benthic fossils, as opposed to the underlying Landry Formation with peritidal cyclic facies association and generally poor fossil assemblages (Kabanov, 2014). Internal subdivisions of the Hume Formation were based on alternating strongly and weakly argillaceous intervals. Five informal members (three limestones and two intervening calcareous shales to limestones) have been traced in the subsurface by Tassonyi (1969) and Pugh (1983). Later Pugh (1993) concluded that the upper shaley unit does not show wide traceability and proposed a three-fold subdivision with the lower prominently argillaceous and thin-bedded unit named Headless, after its assumed formation-rank equivalent in the southern Mackenzie Mountains and the subsurface of the Great Slave Plain (Mejer-Drees, 1993). In outcrops, the two-fold subdivision into lower more argillaceous, recessive member and upper somewhat cleaner and more resistant limestone was found most reliable (Morrow, 1991; Gal et al., 2009).

Subsurface traceability of the Headless Member in the Mackenzie Valley and southern Peel Area is usually masked by development of marlstones with similar log response in the upper Hume, but traceability greatly improves northward across 67°. In some seismic transects, the Headless Member matches with a reflection marker separating Hume Formation from underlying shallow-water peritidal carbonates (MacLean et al., 2012). Minor black shale occurrences within Headless were reported from outcrops (Gal et al., 2009) and wells (Tassonyi, 1969; Pugh, 1983), including a distinct tongue of black pyritic shale in the basal part of Hume Formation intersected by Cranswick A-42 (Pugh, 1983). In core from Kugaluk N-02, the Headless features enhanced dolomite content, suppressed bioturbation as opposed to thoroughly bioturbated limestones of the upper Hume, and distal tempestite facies character (Kabanov, 2014). This character is retained in other cored sections (e.g., Clare F-79, Crossley Lake S. K-60) and indicates a "Headless highstand". In Kugaluk N-02, elemental data with flat logs of Al-normalized Mo, V, Pb, Zn, Cu, Ni, and U indicates that the seafloor remained oxic during the Headless highstand (Kabanov, 2015). This lack of anoxia can be extrapolated to most other sections where black shales are absent. Few sections with known occurrence of black shales probably refer to lows or shelf-margin ramps with depleted bottom oxygen.

The Landry/ Headless contact is a conformity described as sharp (Gal et al., 2009) or gradational with deepening-upward facies succession (Appendix 1; Kabanov, 2014; Kabanov et al., 2016a). Biostratigraphic summaries used to place this contact at or close to the Emsian/Eifelian boundary, but recent developments suggest possible younger Eifelian age in the *costatus* Zone (Gouwy, 2017b; Uyeno et al., 2017).

## Hume traceability north of 68° and correlation with Banks Island

The Headless Member is traced in most wells to the north of 68° (Figures 2 and 4) except for Angasak L-03 and Kilannak A-77 where the Landry-Hume succession does not retain diagnostic log responses (Figure 2). However, on Cross-section C-C' the log signature of the Headless is very distinct in all three mainland wells indicating that Hume thins consistently northward from 90 meters in Grandview Hills #1 to 46 m in Horton River G-02 (Figure 4). This is why a low-resistivity excursion at 2103.0-2117.0 m of Kilannak A-77 more likely matches Headless, and the top of Landry occurs at 2117 m (Table 2). Without age constraints for the Hume top in these wells, it is not clear if northward tapering of the Hume formation is caused by the backstepping of the Hume carbonate shelf in front of the advancing foreland basin or less accommodation space within the same age bracket.

In the Mackenzie Plain and Peel area, the Hume top is a “drowning unconformity” not recording any significant gap in sedimentation (Kabanov and Gouwy, 2017) and occurring within the *ensensis* Zone of the uppermost Eifelian (Gouwy, 2017b). This drowning surface may become progressively older northward as the Ellesmerian foredeep migrated south and less time allocated for Hume deposition, but available chronostratigraphic brackets on both sides of Amundsen Gulf are currently far from adequate for a definative answer.

The black-shale member of the Blue Fiord Formation of Banks Island shows an apparent match to the Headless member of the northern mainland (Figures 2 and 4). If this is correct, the Landry/Hume contact approximates to the Blue Fiord top of the northern and western Banks Island where the non-conclusive age constraint is only available in Storkerson Bay A-15 (Figure 3). It is also possible that in this well the top of Blue Fiord is older than in the mainland and occurs within the late Emsian, which seems consistent with the downwarp of the carbonate platform under the strain from the encroaching Ellesmerian Orogen (Embry and Klovan, 1976). To add further uncertainty, both the Headless of the northern Mainland and its correlatives on Banks Island match the timing of the Romanzov deformation of northern Yukon and Alaska (Lane, 2007).

## Horn River Group

The Givetian-Frasnian Horn River Group occurs across the vast area in the Northwest Territories and is traced in Northern Yukon as the Canol Formation (Figure 5A). Thick (150-400 m) Hare Indian and Ramparts formations developed in NTS map sheets 96E,L,M and 106H,I,P define the bank-and-trough paleogeographic area or BAT (Figure. 5B; Kabanov and Gouwy, 2017). This succession of fossiliferous grey shales, siltstones, and limestones conformably overlies the basal black-shale unit (called the Bluefish Member) of the Hare Indian Formation. In the central Mackenzie Valley south of Norman Wells, the Hare Indian-Ramparts thins into the black shale dominated package that is only 20-50 m thick. Kabanov and Gouwy (2017) referred to this basinal area between Norman Wells and the axis of the Keele tectonic zone as the southern off-bank area or SOB. Immediately west of 130° meridian in the Peel Plain and Plateau and adjacent Mackenzie Mountains, the thick Hare Indian - Ramparts succession grades into thin black shales similar to those of the SOB defining the western off-bank paleogeographic area (WOB on Figure 5). The entire Hare Indian Formation including its basal Bluefish Member merges into the Canol Formation as the well log marker for the upper Hare Indian fades approximately westward of 132° meridian. The overlying Canol Formation is composed of siliceous pyritic shales. This main unit of the “Canol shale hydrocarbon play” imprints the thickness variations of the Hare Indian and Ramparts. The Canol Formation is 60-120 m thick in off-bank areas but thins to a few meters above Ramparts carbonate banks (Fig. 2), up to its disappearance on tops of tallest carbonate banks intersected by wells in the subsurface of NTS map area 106H.

Conodont-based biostratigraphic age of the Horn River Group has been recently summarized by Pyle and Gal (2016) and Kabanov and Gouwy (2017). The Hare Indian Formation is mostly Givetian (Fig. 6A). Most recent conodont identifications place lower one-half of the Bluefish Member in the latest Eifelian *ensensis* Zone (Gouwy, 2017b), and the Eifelian/Givetian boundary has yet to be found in the middle of Bluefish or closer to its top. The base of Canol occurs in the latest Eifelian in thicker Canol sections where the Ramparts is thin or absent. In places where thick Kee Scarp carbonate banks aggrade on the Bell Creek Member, the Kee Scarp – Canol contact is found within the *transitans* Zone (Early Frasnian) and *punctata* Zone (early Middle Frasnian). The main part of the Dodo Canyon Member and basal beds of the Imperial Formation remained undated until the recent discovery of the early Late Frasnian conodont assemblage in the top of Canol at Powell Creek

(Fig. 6A; Gouwy, 2017b).

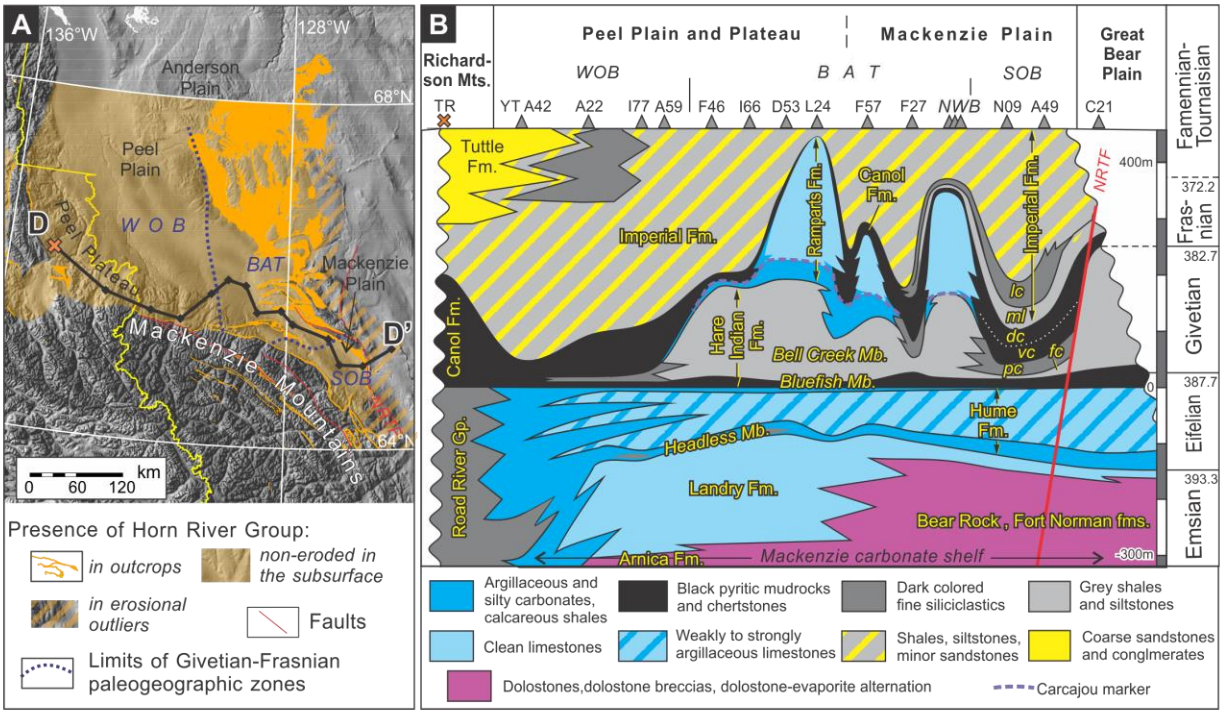


**Figure 5. Hume Formation and Horn River Group of central-northern Mackenzie Corridor (modified from Kabanov, 2017): (A) geographic spread of Horn River Group between 64° and 68°N; (B) Cross-section D-D' leveled at Hume top. NRTF is Norman Range thrust fault (other tectonic elements are not shown). Sections from left to right: Trail River outcrop (TR), Cranswick YTA-42, Cranswick A-22, S. Ramparts I-77, N. Ramparts A-59, Ramparts River F-46, Hume River I-66, Hume River D-53, Carcajou L-24, Maida Creek F-57, Hoosier F-27, NWB is Norman Wells bank with over a hundred of well sections, Little Bear N-09, Bluefish A-49, and Bracket Lake C-21. Stratigraphic members in SOB: (fc) Francis Creek; (ps) Prohibition Creek; (vs) Vermillion Creek; (dc) Dodo Canyon; (ml) Mirror Lake; (lc) Loon Creek.**

## Horn River Group north of 68° and correlation with Banks Island

In the continuously cored section Kugaluk N-02, the Horn River Group is entirely composed of laminated black shales, and borehole logs do not offer their ready subdivision into Hare Indian and Canol parts, which relates this section to the WOB paleogeographic area. The Bluefish facies occurs in the basal 7 m (23 ft) as indicated by mass tentaculitids and overall increase in calcareousness (Appendix 2). In top of this basal horizon, a dark grey slickensided shale with previously reported *Phycosyphon* or *Chondrites* trace fossils at 883.3-885.4 m (2898.0-2905 ft) is assumed to be the offshore tail of the Bell Creek Member (Kabanov et al., 2016b). In the Mackenzie Delta area to the west of Kugaluk N-02, the Middle-Upper Devonian strata are eroded. An increase in thickness of the Hare Indian and correspondent thinning of Canol is traced in Wolverine H-34 well located in 40 km to the east of Kugaluk N-02, and the typical BAT succession of the thick Bell Creek - Ramparts and thin Canol is developed further east in Crossley Lake K-60 (Figure 4).

Reassignment of the thin black-shale unit onlapping Hume top in Angasak L-03 and Kilannak A-77 from Canol to the Bluefish Member (Table 2) adds a lot of consistency to the mainland – Banks Island correlation (Figures 2, 4, and 6). It is concluded that:

(1) Sections Kugaluk N-02 and Kiligvak I-29 (Figure 2) penetrate the Horn River Group in the

northern (modern coordinates) closure of the latest Eifelian – Frasnian starved black-shale basin. The Canol phase of this basin (latest Givetian – Frasnian) records the strongest stratification and bottom anoxia in the northern mainland and accounted for the backstepping and ultimate demise of Ramparts carbonate banks. However, being suppressed by prograding siliciclastics of the Devonian clastic wedge, the Canol basin did not extend north of 70°. The Canol Formation in this correlation merges into the undivided Hare Indian and Imperial formations of the mainland nomenclature or the Weatherall Formation of the Arctic Islands nomenclature.

(2) The latest Eifelian – earliest Givetian Bluefish Member likely represents the same anoxic event as the Orksut Formation (new definition) in the Orksut I-44 and Ikkariktok M-64 wells of the southern-central Banks Island. These two wells penetrate the marginal area of the Hume – upper Blue Fiord carbonate platform. Immediately north and west, this carbonate platform shales into black calcareous mudrocks of the basal and muddle members of the Orksut Formation (Figure 6) as this area became involved in the Ellesmerian foredeep already by the latest Emsian – earliest Eifelian. It is very likely that the Bluefish anoxic event retains its characteristic high-gamma response in this foredeep basin and traces as the upper member of the Orksut Formation in its new definition.

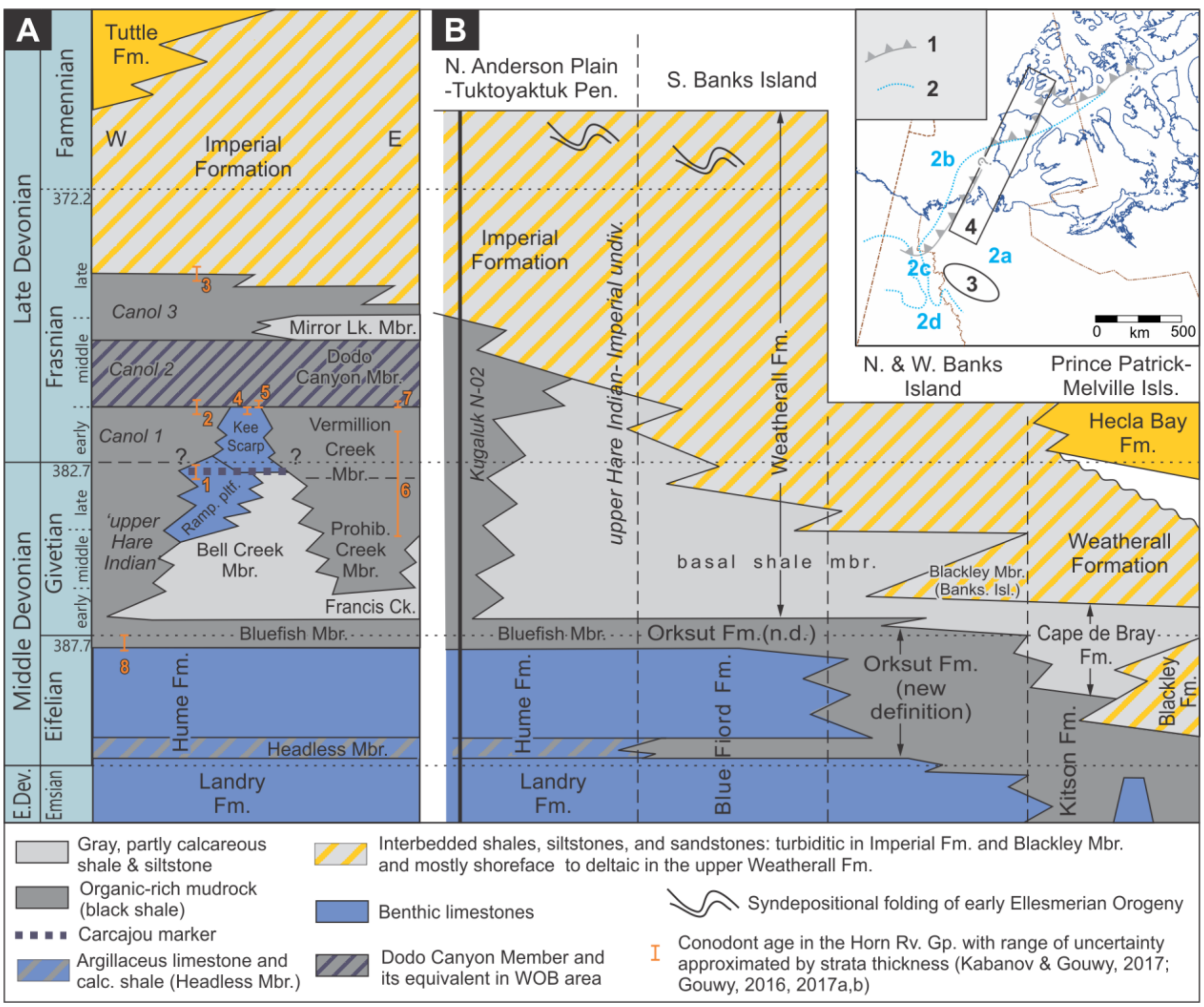


**Figure 6. Late Emsian - Frasnian chronostratigraphy of Mackenzie Corridor (A) and coeval strata of southwestern Arctic Islands (B). Conodont ages of the Horn River Group: (1-3) Powell Creek: (1) *norrisi* (lowermost *falsiovalis*) Zone; (2) base of punctata zone; (3) lower *rhenana* Zone; (4) *transitans* Zone, Kee Scarp quarry at Norman Wells; (5) *punctata* Zone, base of Canol Fm., Mackenzie River # 4 (E-27) well; (6, 7) Prohibition Creek: (6) Givetian-Frasnian boundary; (7) *transitans-punctata* transitional assemblage and lower *punctata* Zone; (8) *ensensis* Zone at Rumbly**

**Creek Tributary. Stratigraphy of southern Prince Patrick and Melville islands is interpreted from Embry and Klovan (1076), Harrison (1995), and Harrison and Brent (2005). Numbered in the inset map are (1) Ellesmerian deformation front (Lane, 2007); (2) limits of late Franklinian (Early Devonian-Eifelian) megafacies (Lane, 2007): (2a) Mackenzie Platform; (2b) Franklinian Basin; (2c) Richardson Trough; (2d) Selwyn Basin; (3) area assessed in Fig. 6A; (4) area assessed in Fig. 6B.**


## ACKNOWLEDGEMENTS

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## LIST OF APPENDICES

***Appendix 1. Illustrated descriptions of cores from Nanuk D-76, Parker River J-72, and Crossley Lake S. K-60***

***Appendix 2. Full table of formations***

***Appendix 3. ED-XRF data from Nanuk D-76 core***

# APPENDIX 1. ILLUSTRATED CORE DESCRIPTIONS

## METHODOLOGY

***ED-XRF geochemistry:*** The Bruker Tracer IV-SD Turbo tool with serial # T4S1325 was used on core from 1354.8-1360.3 m of Nanuk D-76. XRF measurement areas were flagged with red sticky circles (Fig. A1-1). The tool was operated in non-vacuum mode using the Mining Light Elements factory calibration (single excitation at 25kV), which is suitable for qualitative to semi-quantitative assessment of light elements (Mg, Al, Si, P, S, Ca, K, Ti) and, to various degree, elements with larger atomic numbers. Acquisition of spectra was conducted for ca. 90 seconds (Table A1-1).

***Core photographs:*** Subtle textures in Nanuk D-76 core that previously could not be clearly seen were revealed by smoothing rough core face with grit 400 abrasive on the rotary lap surface. Under water spray, this enhances core imaging resolution to the level comparable to polished-slab photomicrographs (Figs. A1-2 and A1-3).

## ELF NANUK D-76

| | |
|---|---|
| **UWID: 300D76731012300 [NT]** | |
| **NT WID#:** | **N686** |
| **SPUD: 1972/01/17** | |
| **WELL CONFIDENTIAL UNTIL 1977/03/04** | |
| **GOVT KB:** | **327 ft** |

Core at 1354.8-1360.3 m was measured by Pavel Kabanov, GSCC, December 2017.

### ORKSUT FORMATION

### 1354.8-1360.3 m (4445-4463 ft), Figures A1-1 to A1-3.

Boxes 1-4: Dolomitic marlstone: pelitomorphic, pyritic, hard, dark bluish grey, homogeneous, with 20-40% dolomite content (XRF data; Table A1-1) but non-calcareous (no HCl fizzing). Pyrite is abundant, in the form of thick, frequently distorted pyritic streaks, lenticles, and laminae with diffuse margins, and as "pyrite dust" dispersed in the rock matrix. The "pyrite dust" describes common hand-lens expression of pyrite framboids. No skeletal fossils. Lamination is vague and discontinuous, dipping at 12-20°, displaced by minor fracture planes. Lamination is better preserved in some horizons like Radiolaria-rich interval in the bottom of Box 1 (Fig. A1-2B). Bioturbation is present with BI ranging from 2 to 4. Extensive veining of white crystalline calcite in top of Box 4.

Boxes 5-6: Dolomitic marlstone: similar to the above but slightly darker *colored* and with less altered lamination seen as 5 to 10 mm thick sedimentary rhythms. Occasional disruption of laminae indicate bioturbation at BI 1-2.


**Figure A1-1. Nanuk D-76, boxed core at 1354.8-1360.3 m. Top (right) and bottom (left) of the core are labelled; arrows indicate drilling direction. Red circles mark XRF reading areas (Table A1-1).**

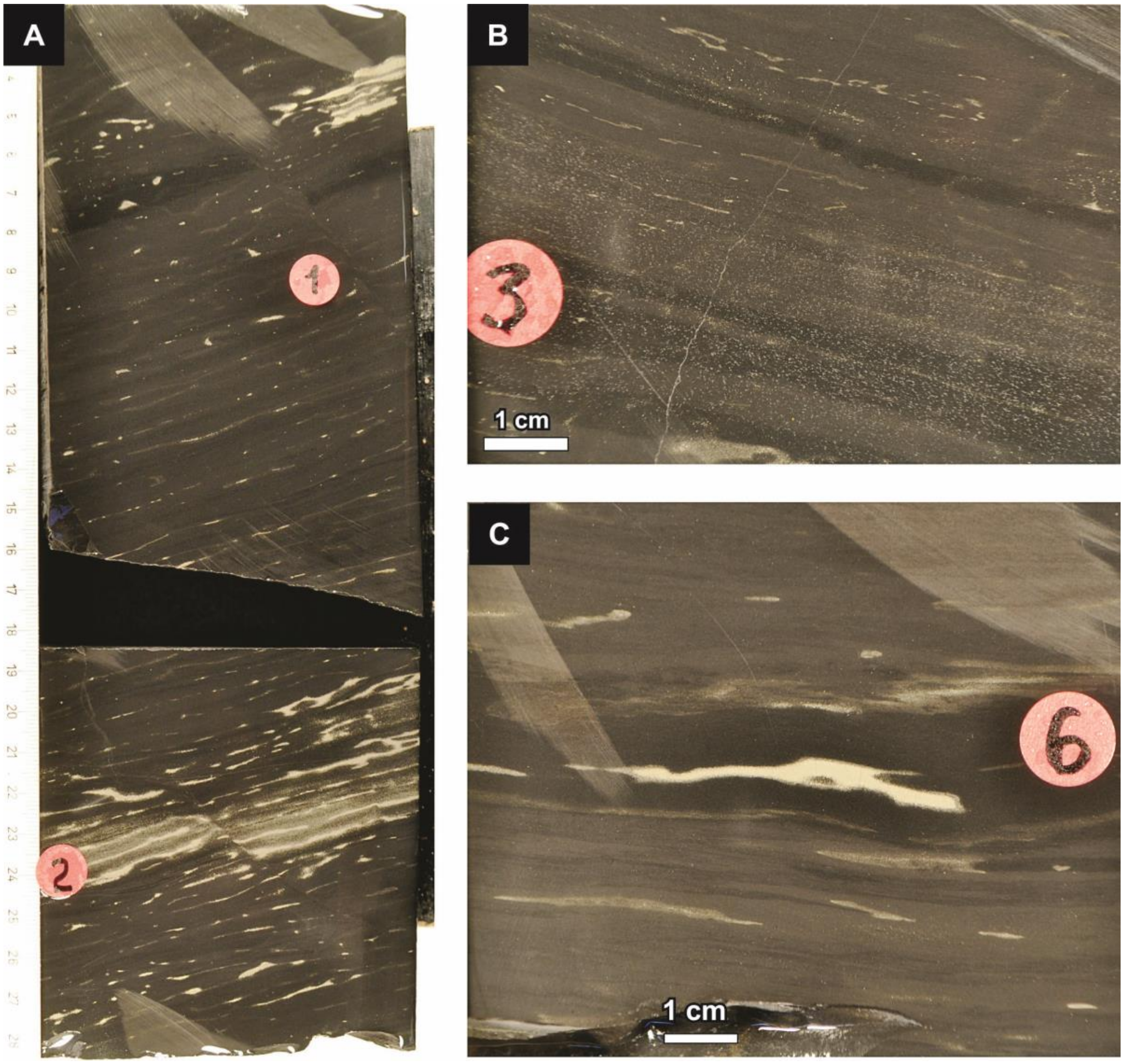


**Figure A1-2. Close-ups at textures of Nanuk D-76 core. Yellow are pyrite streaks and laminae. Red circles (XRF reading points) locate views on Figure A1-1. Ruler in (A) in cm and mm. Mass Radiolaria tests are seen in (B) as white specks. (C) shows collapsed bioturbation pattern masking the leftovers of sedimentary lamination.**

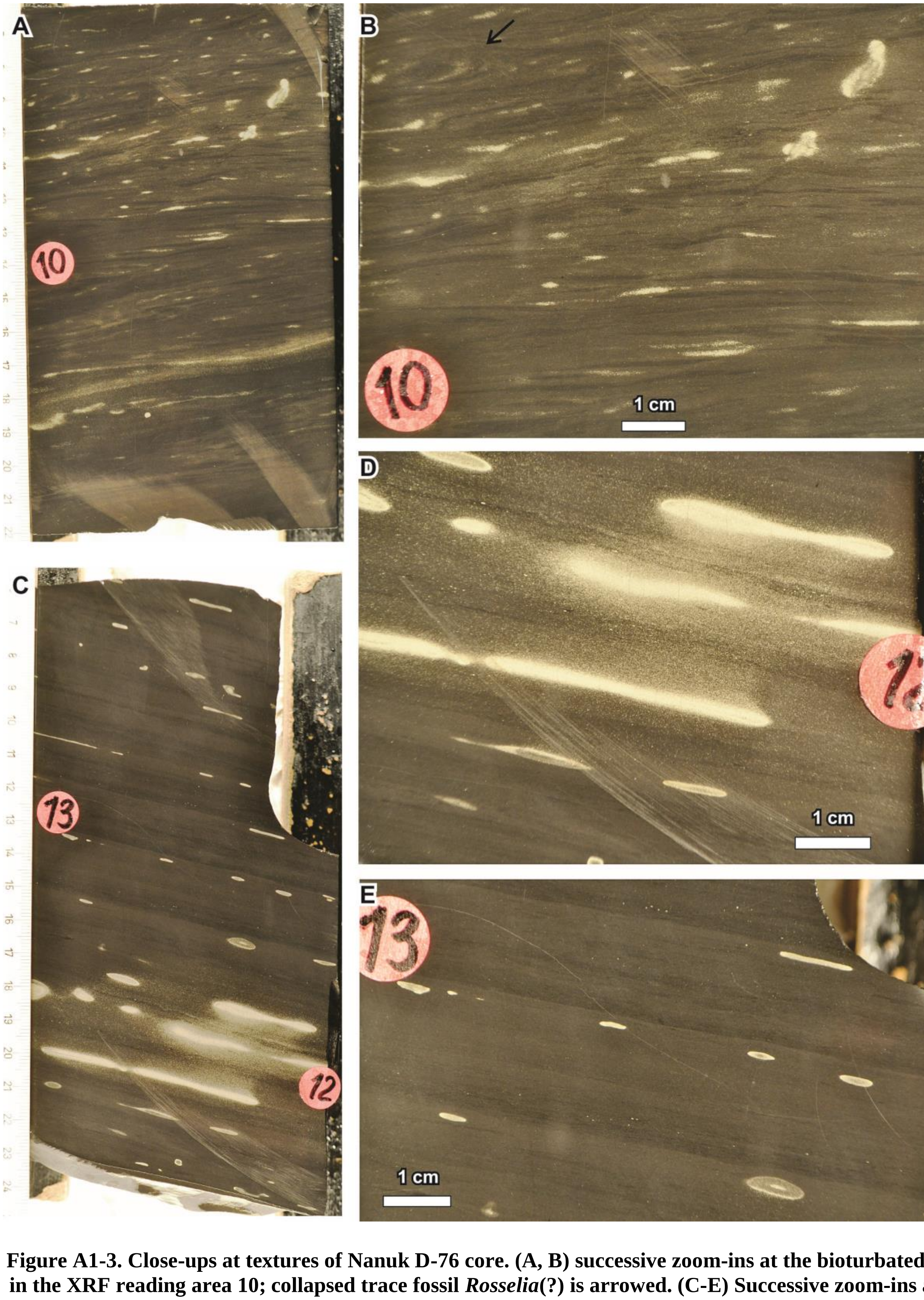


**Figure A1-3. Close-ups at textures of Nanuk D-76 core. (A, B) successive zoom-ins at the bioturbated shale in the XRF reading area 10; collapsed trace fossil *Rosselia*(?) is arrowed. (C-E) Successive zoom-ins at the core with preserved lamination in XRF reading areas 12 and 13.**

| Reading ID | MgO | CaO | CaMg(CO3)2 | Al2O3 | SiO2 | P2O5 | Fe2O3 | S | K2O | TiO2 | MnO | Co3O4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SRG1* | 9.31 | 13.30 | | 7.44 | 36.80 | 0.59 | 3.66 | 1.63 | 2.20 | 0.38 | 0.06 | 0.04 |
| SARM41* | 7.75 | 1.28 | | 8.95 | 45.20 | 0.04 | 3.66 | 0.15 | 1.31 | 0.49 | 0.07 | 0.04 |
| **1** | 21.30 | 28.00 | 45.85 | 12.60 | 30.70 | 0.88 | 1.53 | 0.60 | 3.37 | 0.56 | 0.07 | 0.03 |
| **2** | 3.46 | 14.70 | 24.07 | 12.10 | 26.60 | 0.50 | 21.20 | 16.60 | 3.68 | 0.61 | 0.10 | 0.29 |
| SRG1* | 8.63 | 13.10 | | 6.90 | 35.30 | 0.57 | 3.55 | 1.54 | 2.10 | 0.36 | 0.06 | 0.04 |
| **3** | 21.00 | 26.30 | 43.07 | 12.10 | 32.60 | 0.81 | 1.72 | 0.89 | 3.31 | 0.80 | 0.07 | 0.03 |
| **4** | 10.50 | 21.90 | 35.86 | 18.40 | 39.70 | 0.56 | 2.24 | 1.24 | 4.50 | 0.64 | 0.06 | 0.03 |
| **5** | 12.50 | 24.20 | 39.63 | 17.70 | 37.80 | 0.69 | 1.36 | 0.67 | 4.12 | 0.54 | 0.06 | 0.03 |
| **6** | 11.30 | 19.20 | 31.44 | 19.70 | 41.20 | 0.55 | 1.66 | 0.81 | 4.72 | 0.63 | 0.05 | 0.03 |
| **7** | 12.80 | 21.30 | 34.88 | 19.10 | 37.90 | 0.62 | 1.86 | 0.81 | 4.72 | 0.68 | 0.06 | 0.02 |
| **8** | 19.90 | 28.50 | 46.67 | 12.00 | 26.60 | 0.91 | 5.13 | 2.99 | 3.02 | 0.44 | 0.08 | 0.08 |
| **9** | 21.60 | 25.90 | 42.41 | 13.00 | 27.70 | 0.80 | 4.07 | 2.56 | 3.35 | 0.47 | 0.07 | 0.06 |
| **10** | 15.50 | 25.50 | 41.76 | 14.50 | 32.20 | 0.79 | 4.30 | 2.50 | 3.85 | 0.56 | 0.08 | 0.06 |
| **11** | 18.10 | 26.40 | 43.23 | 15.10 | 32.20 | 0.83 | 1.89 | 0.72 | 3.94 | 0.56 | 0.07 | 0.03 |
| **12** | 0.05 | 6.33 | 10.37 | 5.24 | 10.80 | 0.37 | 40.40 | 33.70 | 1.47 | 0.45 | 0.13 | 0.62 |
| **13** | 22.10 | 25.30 | 41.43 | 15.10 | 29.20 | 0.80 | 1.94 | 0.72 | 3.89 | 0.56 | 0.07 | 0.03 |
| SRG1* | 7.40 | 12.90 | | 7.63 | 37.50 | 0.59 | 3.57 | 1.69 | 2.19 | 0.37 | 0.06 | 0.05 |
| * Shale standards are excluded from calculation of data departure parameters | | | | | | | | | | | | |
| **Maximum** | **22.10** | **28.50** | **46.67** | **19.70** | **41.20** | **0.91** | **40.40** | **33.70** | **4.72** | **0.80** | **0.13** | **0.62** |
| **Median** | **15.50** | **25.30** | **41.43** | **14.50** | **32.20** | **0.79** | **1.94** | **0.89** | **3.85** | **0.56** | **0.07** | **0.03** |
| **Minimum** | **0.05** | **6.33** | **10.37** | **5.24** | **10.80** | **0.37** | **1.36** | **0.60** | **1.47** | **0.44** | **0.05** | **0.02** |
| **StDev** | **7.09** | **6.21** | **10.16** | **3.91** | **7.85** | **0.17** | **11.38** | **9.64** | **0.86** | **0.10** | **0.02** | **0.17** |

**Table A1-1. ED-XRF quantifications for elements exceeding 0.1 wt.% in core at 1354.8-1360.3 m of Nanuk D-76. Calculation of dolomite is made from CaO on assumption that $Ca^{2+}$ is entirely bound in dolomite, likely an overestimation. Reading IDs correspond to red circles on core face (Figs. A1-1 to A1-3). Quantification errors, autodetected trace elements, and spectra are given in Appendix 3.**

# CPOG CROSSLEY LK S K-60

| |
|---|
| **UWID: 300K606830129150 [NT]** |
| **NT WID#: N407** |
| **SPUD: 1968/08/28** |
| **WELL CONFIDENTIAL UNTIL 1974/03/09** |
| **GOVT KB: 503ft** |

Core section measured by Pavel Kabanov, GSCC, December 2017.

## BELL CREEK MEMBER OF HARE INDIAN FORMATION

**242.3-262.1 m (795-860 ft)** Shale: with alternating silty and pelitomorphic intervals, pale bluish grey, non-calcareous, fissile but slightly harder than below; non to weakly calcareous. Sideritic nodules are rare, small and very poorly formed, disappear in the upper one-half. Burrowing patters preserve on some bedding planes. No macrofossils. Common tiny (0.1-0.5 mm) dark-colored fragments on bedding planes – acritarch cuticles and/or coaly detritus.

**262.1-305.4 m (860-1002 ft)** Shale: pale grey, very fissile, soft, soapy, mostly pelitomorphic with frequent rusty weathering poorly formed flattened sideritic nodules. Occasionally preserved burrowing patterns. Weakly to non calcareous.

**305.4-318.5 m (1002-1045 ft)** Shale: pale gray, fissile, bioturbated and vaguely laminated, with rare to frequent flattened sideritic nodules; distinguished from shale above and below only by enhanced calcite content in the shale matrix. Rare laminae of silty shale and siltstone.

**318.5-335.9 m (1045-1102 ft)** Shale: pale grey, soft, soapy, fissile, pelitomorphic as below; mostly homogenous with rare flakey fabrics and rare vague burrowing patterns on fissility planes. Distinct from shale below by frequent horizons (or flattened nodules) of rusty weathering siderite which are especially numerous in basal 2-3 m. This interval is weakly to non-calcareous. Degree of bioturbation cannot be assessed. No skeletal fossils encountered.


**Figure A1-2. Crossley Lake S. K-60: light grey fissile shale of Bell Creek Member at 325.5-332.2 m (1068-1090 ft); siderite nodules are arrowed.**

**335.9-365.8 m (1102-1200 ft)** Shale: grey to pale grey, soft, fissile, readily expandable in water, with rare finely crystalline and poorly formed sideritic nodules. Most of these nodules appear are flattened and appear as 0.5-1.5 cm thick intervals. She shale matrix is non to weakly calcareous, with very rare harder intervals of increased calcite content. Lamination is obscure. Almost no fossils or distinct trace fossils, One finding of thin shell about 5 mm in size of unknown affinity. Occasionally preserved acritarchs. Flakey fabric on bedding planes is distinct in the lower part and fades toward the top.

## BLUEFISH MEMBER OF HARE INDIAN FORMATION

**365.8-374.3 m (1200-1228 ft)** Shale: dark grey to grey, fissile, moderately expanding in water, rarely splitting with conchoid surfaces. Non-disturbed lamination is emphasized with poorly preserved dark-colored flakes and sometimes with collapsed acritarchs. No visible pyrite development. Flaky fabric on some bedding planes.

**374.3-381.3 m (1228-1251 ft)** Shale: fissile, dark grey but paler than below, non-calcareous; semi-hard, breaking in chips with some conchoidal surfaces. Many bedding planes are littered with acritarchs. Tentaculitids preserve sporadically as decalcified impressions.

**381.3-383.7 m (1251-1259 ft)** Shale: dark grey, fissile and subfissile, non-calcareous, with rare harder and less fissile calcareous intervals bearing mass tentaculitids. Acritarchs are preserved on some fissility planes.

**383.7-387.7 m (1259-1272 ft)** Mudrock: calcareous, black to very dark grey, hard, subfissile. Massing tentaculitids emphasize non-disturbed lamination. Several limestone intervals composed of matrix-poor tentaculitid concentrates in bases grading upward to mudrock; the thickest graded limestone at 1269 ft is 10 cm thick. Pyritic streaks are conspicuous in finer-grained mudrocks with fewer tentaculitids. Calcareous content in matrix decreases in top. Hard monolithic intervals at 1268 and 1263-1264 ft are impregnated with micritic non-calcareous mineral, probably dolomite. Top very gradational.

**387.7-389.2 m (1272-1277 ft)** Mudrock: hard, calcareous, silty shales to siltstones with collapsed variously pyritized tentaculitids; very similar to 1278-1301 ft. “Clam” shell and fragment of another bivalve is spotted in the middle.

**389.2-389.5 m (1277-1278 ft)** Mudrock: fissile grey non-calcareous shale with enhanced imbibition, massing acritarchs, and dark rubbly particles on fissility planes imparting characteristic flaky appearance. This horizon is mostly preserved as rubble and loose flakes.


**Figure A1-2. Crossley Lake S. K-60: interval 363.3-381.9 m (1192-1253 ft) showing hard black mudrocks of Bluefish Member (right end) grading into grey fissile shales of Bell Creek Member (left end).**

**389.5-396.5 m (1278-1301 ft)** Mudrock: black, very homogeneous and evenly calcareous, silty, with rare pyritic streaks and some pyrite dust. Alternation of slightly harder and slightly more fissile intervals. Harder intervals produce 1-10 cm long core cylinders with conchoid fracturing. Calcareous is moderate and HCl fizzing dies in 10-20 secs leaving non-calcareous (siliceous?) matrix on the surface. Scattered collapsed tentaculitids; acritarchs were spotted on bedding planes in lower 1 m.

**396.5-397.8 m (1301-1305 ft)** Mudrock: hard, black, very calcareous and grading to limestone; fissile, evenly laminated; lamination is emphasized by collapsed, rarely non-collapsed horizontally lying tentaculitids. Calcareousness increases to base. No benthic fossils.

**397.8-398.4 m (1306-1307 ft)** Mudrock: very calcareous, micaceous, laminated, degree of bioturbation masked by fissility, BI 2-3 in the basal 10-20 cm and declines to 0-1 in top. The lamination is defined by collapsed tentaculitids and generally more disrupted than at 1301-1305 ft, which is accounted for minor burrowing disturbance. Rare thin brachiopod valves.

## HUME FORMATION

**398.4-398.7 m (1307-1308 ft)** Limestone: brownish black, argillaceous, thoroughly bioturbated (BI 4-5); Three-five cm thick bioclastic-brachiopod coquina in top underlain by thicker calcimudstone with rare brachiopod bioclasts and very rare tentaculitids. Strong pyrite replacement of many brachiopod shells. Lingulid brachiopods are common. Only about 50% of core is preserved.

**398.7-399.3 m (1308-1310 ft)** Limestone: very dark brownish gray, rich in brachiopods. Most brachiopods are disarticulated and tiled in coquinas; some are bivalve and in situ, occasionally with geopetally filled interiors. BI 5-6. The texture varies from coarse bioclastic wackestones to floatstone and rudstone with imbricated whole brachiopod valves and tight micritic matrix. Crushed chips and flakes of fissile calcareous interbeds. Mass lingulids are encountered on one fissility plane,.

**399.3-401.7 m (1310-1318 ft)** Limestone: tight bioclastic brachiopod wackestones, floatstones, and matrix-rich packstones with brownish gray matrix (paler colored than above), prominently nodular, with thick dissolution seams; crushed chips and flakes of fissile calcareous interbeds. Many large *in situ* brachiopods; rare to common echinoderm fragments; no corals or stromatoporotids. A few levels with flakes of grey calcareous shale indicate argillaceous interbeds.

**401.7-402.0 m (1318-1319 ft)** Shale: calcareous, brownish grey, very fissile, with collapsed impression of brachiopods.

**402.0-404.2 m (1319-1326 ft)** Limestone: brownish grey, nodular, similar to 1310-1380 but with rare favositid corals. Rugged erosional surface in base.

**404.2-411.8 m (1325-1351 ft)** Limestone: brownish grey, bioturbated, moderately nodular bioclastic wackestones with diverse macrofossils. Erosional surface in top is not associated with subaerial exposure or very shallow-water signatures. Common and diverse favositid and ?colonial rugose corals; rare massive bryozoans; brachiopod debris does not dominate like above, but echinoderms and other bioclast types make nearly equal proportion with brachiopods. Crumbled flakes of steel grey shale indicate argillaceous solution seams and shale interbeds. Large massive calcisponge at 1340 ft. Gastropods and other mollusks preserved as moulds. Weak dispersed dolomitization alomng argillaceous partings and solution seams.


**Figure A1-3. Crossley Lake S. K-60: interval 395.0-403.6 m (1296-1324 ft) with Hume-Bluefish contact at orange arrow.**

**411.8-416.7 m (1351-1367 ft)** Limestone: weakly argillaceous, medium-bedded and nodular, lighter colored than above; coarse brachiopod packstones, floatstones, and minor rudstones; distinct from 1325-1351 by lack of corals, admixture of tentaculitid tubes and ?trilobites, and dominance of brachiopods in the bioclastic material that locally make coquinas; moderate dolomitization as above.

**416.7-422.8 m (1367-1387 ft)** Limestone: brownish grey, well bioturbated (BI 5), similar to 1325-1351 but finer-grained. Homogeneous bioclastic packstone deviating into wackestone. Rare solitary rugose corals and favositids.  Bioclastic material diverse, whole shells rare. Rare thick solution seams and disintegrated flakes of calcareous shale.

**(1387-1397 ft)** Limestone: grey, paler colored than above; alternation of clean and argillaceous limestones and thin interbeds of fissile calcareous shale. Clean limestones are massive well bioturbated bioclastic packstones similar to 1367-1387 ft. Argillaceous tend to be brachiopod and mollusk coquinas. Bactritid cephalopods are found in top. Proportion of massive packstones decreases downward in favor of coquina textures. BI 4-5. No obvious sedimentary lamination.

Box 96 contains 11 ft interval (1396-1407 ft) implying core recovery less than 65%.

**422.8-425.8 m (1397-1401 ft)** Limestone-shale alternation: monolithic argillaceous limestones form 5-20 m thick competent beds alternation with fissile pale grey micaceous calcareous shales. BI is 4-5 in limestones and 3 in shales.

## HEADLESS MEMBER OF HUME FORMATION

**427.0-434.3 m (1401-1425 ft)** Calcareous shale: pale beige and greenish grey, pelitomorphic with relatively few micaceous flakes. Lamination is rhythmic, defined by more calcareous and lighter colored calcisiltitic laminae forming starved ripples. Lamination is disrupted by discrete backfilled burrows and simple plunging burrows. Bioturbation weak (BI 2). Bioclastic coquinas are rare, composed of fenestellid bryozoans, ostracods, and brachiopod fragments. Such coquinas are distorted by loading and occur in bases of 1-2 cm thick fining-upward rhythms. The central part of the interval is most argillaceous, most fissile, and contains less fossils. Limestones mostly comply to calcimudstone texture.

**434.3-440.7 m (1425-1446 ft)** Limestone: argillaceous, in the upper part interbedded with fissile calcareous shale and in the lower one-half grading into finely nodular limestone with thinner shale intercalations. Bioclastic wackestones with minor mollusk-brachiopod coquinas. Distinct from 1425-1440 my more significant bioturbation (BI 3-4). The upper one half retains remnants of heterolithic lamination (BI3-4), the lower part does not keep distinct sedimentary laminae (BI4). Rare *in situ* brachiopods.


**Figure A1-4. Crossley Lake S. K-60: Headless Member at 423.4.0-443.5 m (1389-1455 ft) with arrowed top and base.**

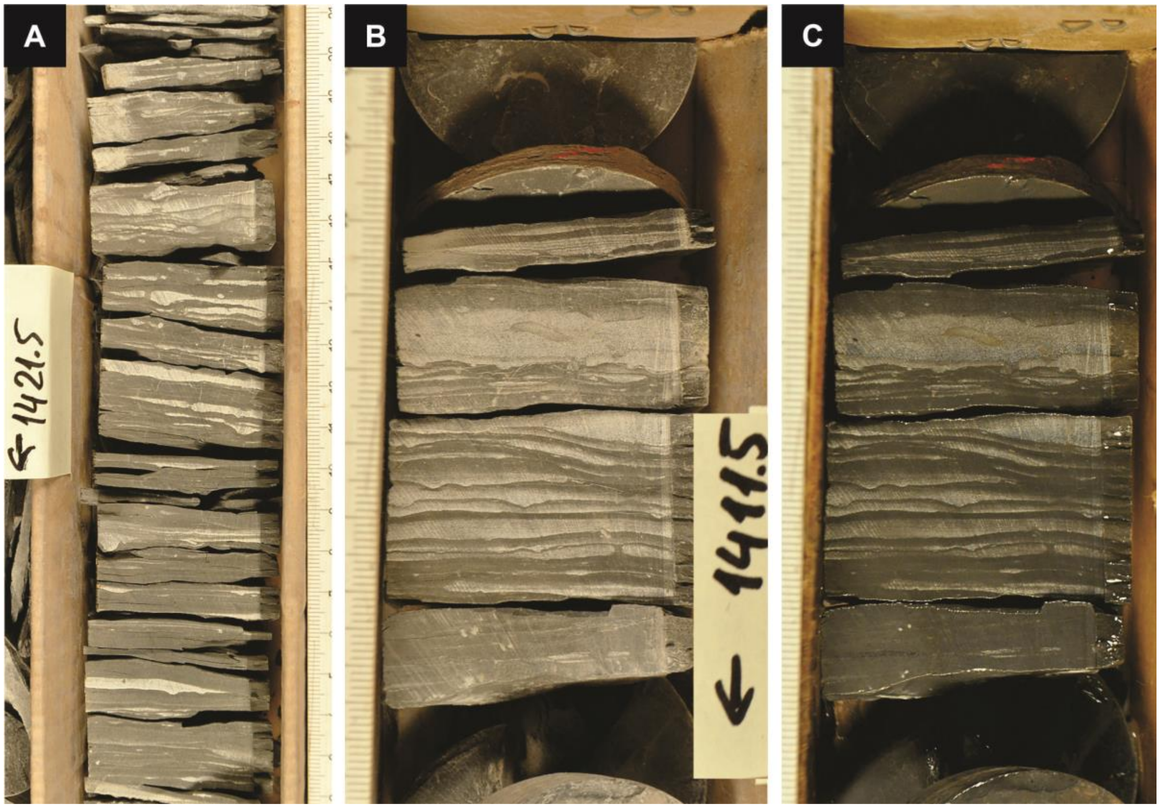


**Figure A1-5. Crossley Lake S. K-60: Close-ups of rhythmic lamination in Headless Member, arrow points down drilling direction; (B and C) are dry (B) and water-spayed (C) view of the same core. Ruler in cm and mm.**

## LANDRY FORMATION

**440.7-444.1 m (1446-1457 ft)** Limestone: brownish grey, distinctly nodular and with extensive solution seams, thoroughly bioturbated (BI 5), with bioclastic calcimudstone and wackestone texture; tentaculitids, thin-shelled brachiopods, echinoderm sclerites.

**444.1-447.4 m (1457-1468 ft)** Limestone: brownish grey, massive and moderately nodular, alternation of bioclastic wackestones, packstones, and minor poorly sorted peloidal-bioclatic grainstones. BI 4-5. Minor streak of dolomitization.

**447.4-448.7 m (1468-1472 ft)** Limestone: brownish grey, massive to vaguely laminar, alternation of rounded-grain (peloidal?) fine-grained grainstones, packstones, and wackestones. Planar stylolites are common; nodularity is developed only in wackestones.

**448.7-453.2 m (1472-1487 ft)** Limestone: brownish dark grey, calcimudstones and bioclastic wackestones with minor packstones and ?grainstones; thick argillaceous solution seams; the limestone is moderately dolomitic in the middle with finely crystalline dolostone bands crudely following stratification. BI ≥ 4. Fossil assemblage poor, with thin-shelled mollusks, ostracods, and ?brachiopods.

**453.2-454.2 m (1487-1490 ft)** Shale and argillaceous limestone: beige grey, strongly compacted, bioturbated to laminar (BI 2-3), with an interval in the middle showing no bioturbation and even starved-ripple braided lamination with very small-scale (mm-scale) ripples made of calcareous silt. An interval with gently buckled lamination in the base.

**454.2-459.0 m (1490-1506 ft)** Limestone: dark brownish grey, clean to weakly argillaceous. Massive nodular and vaguely laminated calcimudstones, minor fine-grained peloidal-calcispheral grainstones. Local minor development of finely crystalline dolomite in micritic limestone matrix. Only one horizon with macrofossil assemblage at 1499 ft: small brachiopods, *Amphipora*, calcisponges. Fissile argillaceous limestone with shale interbeds at 1501-1502 ft. Base disconformable.

**459.0-460.2 m (1506-1510 ft)** Limestone: fossiliferous, rubbly and nodular. A rugged erosional surface in top underlain by stylolitized breccia of pale greenish grey, vaguely mottled calcimudstone. Fragments of breccia are intermixed with argillaceous rubble in the core tray. This subaerially altered zone occupies only about 1 ft in the core box and does not show downward gradation to unaltered fossiliferous limestone probably due to lost or non-recovered core. Limestone below: nodular fossilifeous floatstones and boundstones with Amphipora, massive stromatoporoids, and tabulate corals. Matrix is ranging from bioclastic wackestone to poorly sorted grainstone. The lower 50 cm is massive calcimudstone and poorly sorted peloidal grainstone lacking massive forms and containing only mollusk biomolds. Base disconformable.

Thickness below is not measured: brecciated pale brownish grey calcimudstone with solution vugs and argillaceous partings, mixed with loose argillaceous flakes with half-dissolved limestone crumbles.

Core description stops at 1512 ft.

# CHEVRON ET AL PARKER RIVER J-72

**UWID: 300J72734011530 [NT]**

**NT WID#: N1113**

**SPUD: 1979/01/13**

**WELL CONFIDENTIAL UNTIL 1984/06/01**

**GOVT KB: 191.6 m**

Core at 949-960 m MD was measured by Pavel Kabanov, GSCC, January 2018. This description amends the description of Wendte (2012) by reporting “microbial fenestral micrites” and *Stromatactis* fabrics (Figures A1-6 through A1-10).

## BLUE FIORD FORMATION

High-amplitude stylolites throughout the core. Original units are meters.

**949.0-949.5** Limestone: brownish grey, tight, vaguely mottled birds-eye dismicrite with rare larger (up to 4 cm) *Stromatactis* cavities filled with geopetal sediments (also micritic limestone) and sparry calcite. Rare *in situ* brachiopods.

**949.5-950.0** Limestone: mottled calcispheral very fine-grained packstones with several internal discontinuities. These surfaces are rugged with high relief and overhands. Distinct from the above and below by lack of fenestrae and presence of numerous macrofossils: brachiopods, mollusks, solitary rugose corals.

**950.0-952.0** Limestone: brownish grey, fenestral dismicrites (packstones and wackestones) variously enriched in calcispheres and brachiopods. Some spheres are parathuramminid foraminifers. Cm-sized *Stromatactis* are rare to common. Non-deformed in situ fossils, some in micritic envelopes: brachiopods, gastropods, thin-shelled forms (ostracods?).

**952.0-952.5** Limestone: mottled, argillaceous, showing “polymud fabric” polyphase bluish grey argillaceous sediment (cavity-infiltrating facies) hosting angular fragments of brownish grey calcispheral birds-eye wackestone (framework facies). These partly laminar sediments probably floor the larger (meter scale) collapsed Stromatactis cavity, and fragments of framework limestone originate from Stromatactis roof collapse. This fabric resembles a paleosol but is different by lack of an unconformity surface and profile developed underneath, as well as good preservation of thin-shelled fossils in the cavity-infiltrating sediment. In a pedogenic claystone these shells would be corroded up to complete obliteration. Definition of the polymud fabric originates from Waulsortian mud mounds (Lese and Miller, 1995; Devyust and Lees, 2001) and mechanisms of formation are discussed elsewhere (e.g. Hladil, 2005).

**952.5-955.5** Limestone: brownish grey ostracodal dismicrites with cm-sized *Stromatactis* chambers, similar to 950.0-952.0 m. Geopetal sediments in *Stromatactis* cavities are partly bluish grey argillaceous limestone and partly clean limestone.

**955.5-956.6** Limestone: pale brownish grey, tight, vaguely laminar fenestral dismicrites and grainstones. The lamination is uneven and buckled, cryptocrystalline microbial crusts are common. Fossils: primitive parathuramminids and smaller calcispheres, ostracods and other thin-shelled mm-sized fossils, are lamellar stromatoporoids, brachiopods. Many grains are coated with micrite. The lower one-half is slightly more argillaceous, with thick shale-lined pressure solution sutures.

**956.6-957.0** Limestone: fenestral dismicrite similar to 952.5-955.5 but with crudely laminar fabric in the lower part. The basal 5 cm is very argillaceous, with anastomosing shale laminae (thick solution seams) encasing lenticular nodules of lacy (very fenestral) dismicrite.

**957.0-957.2** Shale: steel grey, fissile, weakly calcareous, pyritic (with partings and clusters of idiotopic pyrite crystals). This core interval is disintegrated into flaky rubble. No fossils noted.

**957.2-957.3** Limestone: dark brown, weakly argillaceous, massive fine-grained peloidal-calcispheral subrounded-grain grainstone with clasts of limestone and pyritized claystone. Large *Amphipora* is the only noted macrofossil. The core is preserved as rubble of stylolitized breccia and the basal 1.5 cm attached to the unconformable top of underlying limestone.

**957.3-957.4** Limestone: pale brownish grey massive ostracodal wackestone with overprint of dark pyritized mottles. Penetrated by branching channels with dark laminar haloes (pedogenic coatings) interpreted as rhizocretions (Wendte, 2012). The top is stylolitic: overcompacted blebs (lenticles) of grey claystone are squeezed between the top of 957.3-957.4 m and the base of the grainstone of 957.2-957.3 m.

**957.4-957.7** Limestone: dark brownish grey crudely laminar grainstone with coated grains and diverse fossils: amphiporas, algal nodules, oncoids, brachiopod valves, mollusk framents.

**957.7-961.0** Limestone: darker colored stromatoporoid floatstones with an interval of *Euryamphipora* (lamellar stromatoporoid) rudstone (more details on p. D2 of Wendte, 2012).

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Lees, A. and Miller, J. 1995. Waulsortian banks. In: Monty, C.L.V., Bosence, D.W.J., Bridges, P.H., and Pratt, B.R. (eds.) Carbonate Mud-Mounds: Their Origin and Evolution. International Association of Sedimentologists, Special Publication 23: 191-271.

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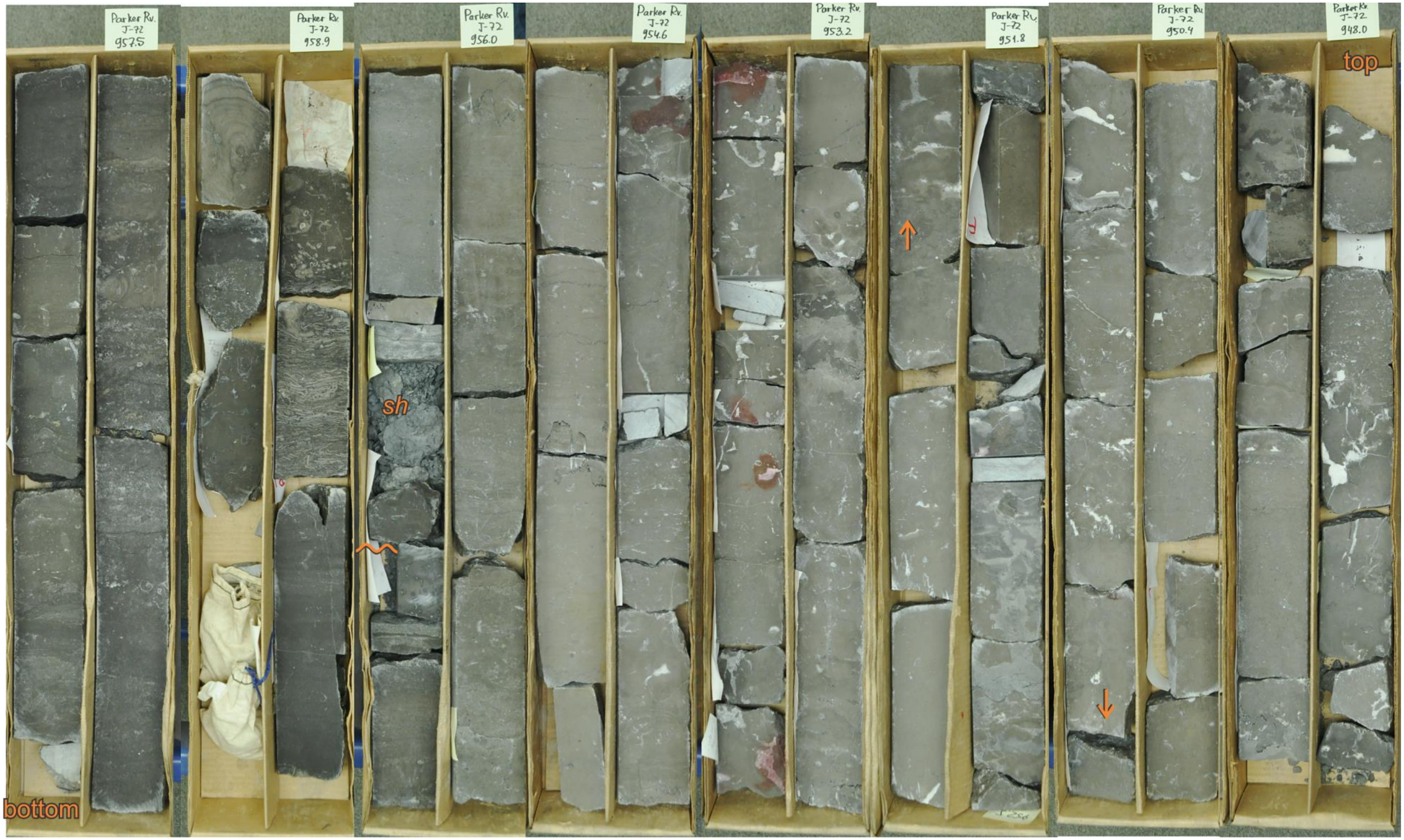


**Figure A1-6. Parker River J-72, core at 949.0-960.0 m. Wavy line shows subaerial surface; (*sh*) is shale at 957.0-957.2 m; arrows bracket an interval with collapsed limestone and multiphase marly sediments filling early diagenetic cavities (large-scale polymud fabric).**

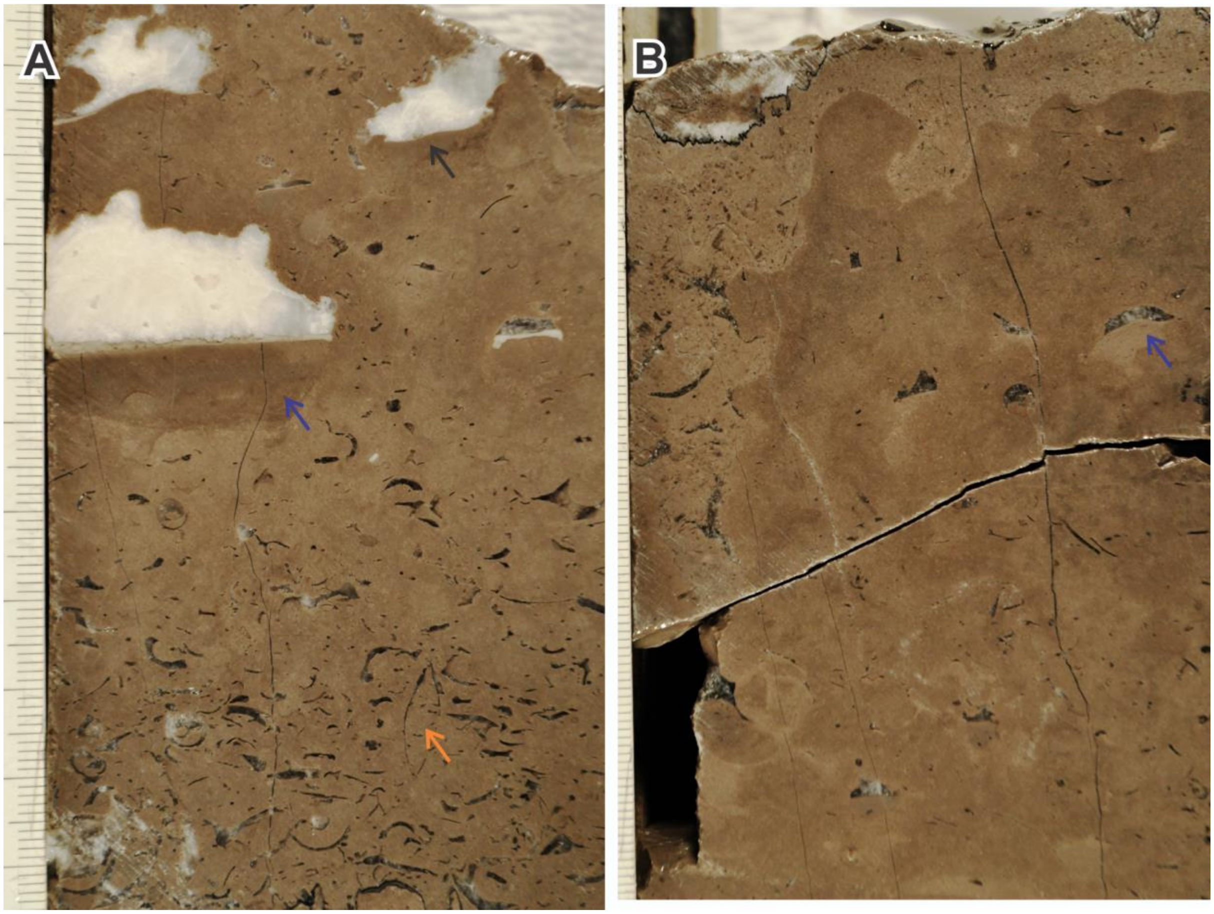


**Figure A1-7. Parker River J-72, core at 949.0-960.0 m. Close-ups at 949.1 m (A) 949.9 m (B). Geopetal lime mud sediments in small Stromatactis fenestrae are blue-arrowed). A bivalve entombed in life position by syngenetically lithified micrite is orange-arrowed. Note a rugged discontinuity surface with protuberances and deep pockets in (B).**

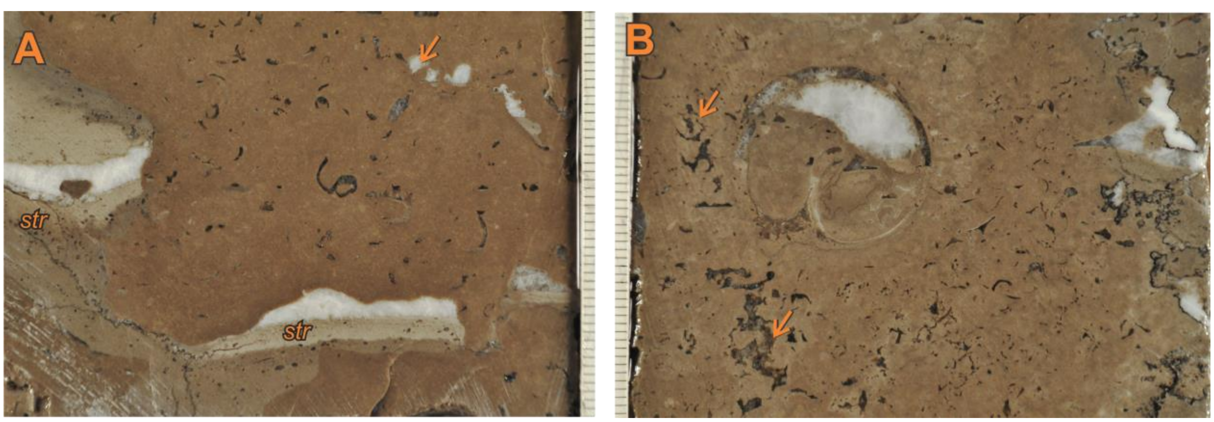


**Figure A1-8. Parker River J-72, core at 949.0-960.0 m. "Birds-eye" fenestral network (arrowed) grading to Stromatactis (*str*) in larger cavities floored with geopetal sediments. Note gastropod in (B). (A) 951.3 m, (B) 950.6 m.**

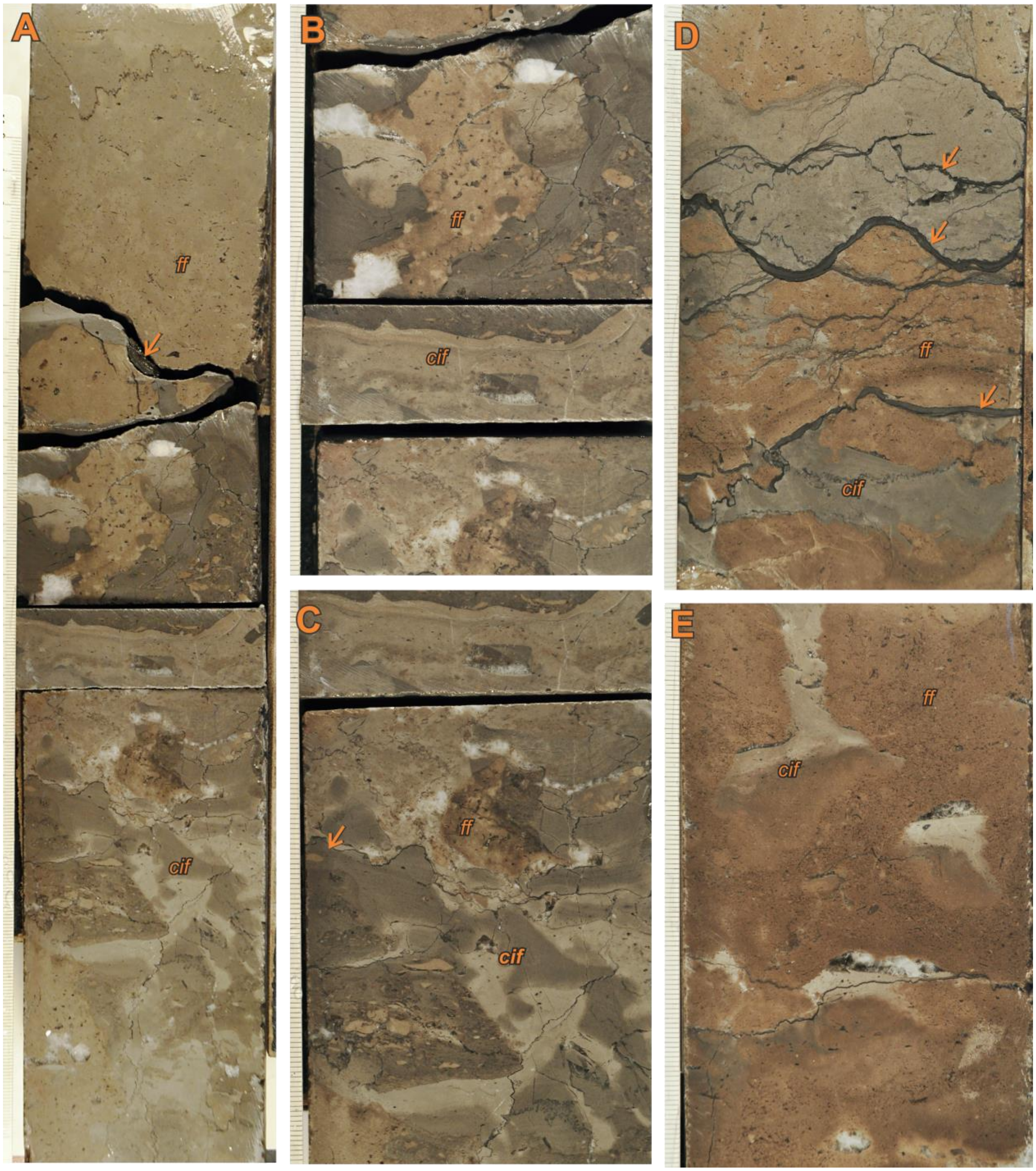


**Figure A1-9. Parker River J-72, core at 949.0-960.0 m. Overlapping close-ups of large-scale brecciated and polymud fabrics at 952.0-952.8 m; (*ff*) is framework facies, often in displaced clasts, and (*cif*) is multiphase cavity-infilling facies or polymuds. Large portion of this interval has been consumed by pressure solution leading to loss of large cavities, as indicated by stylolites and thick solution seams (arrowed).**

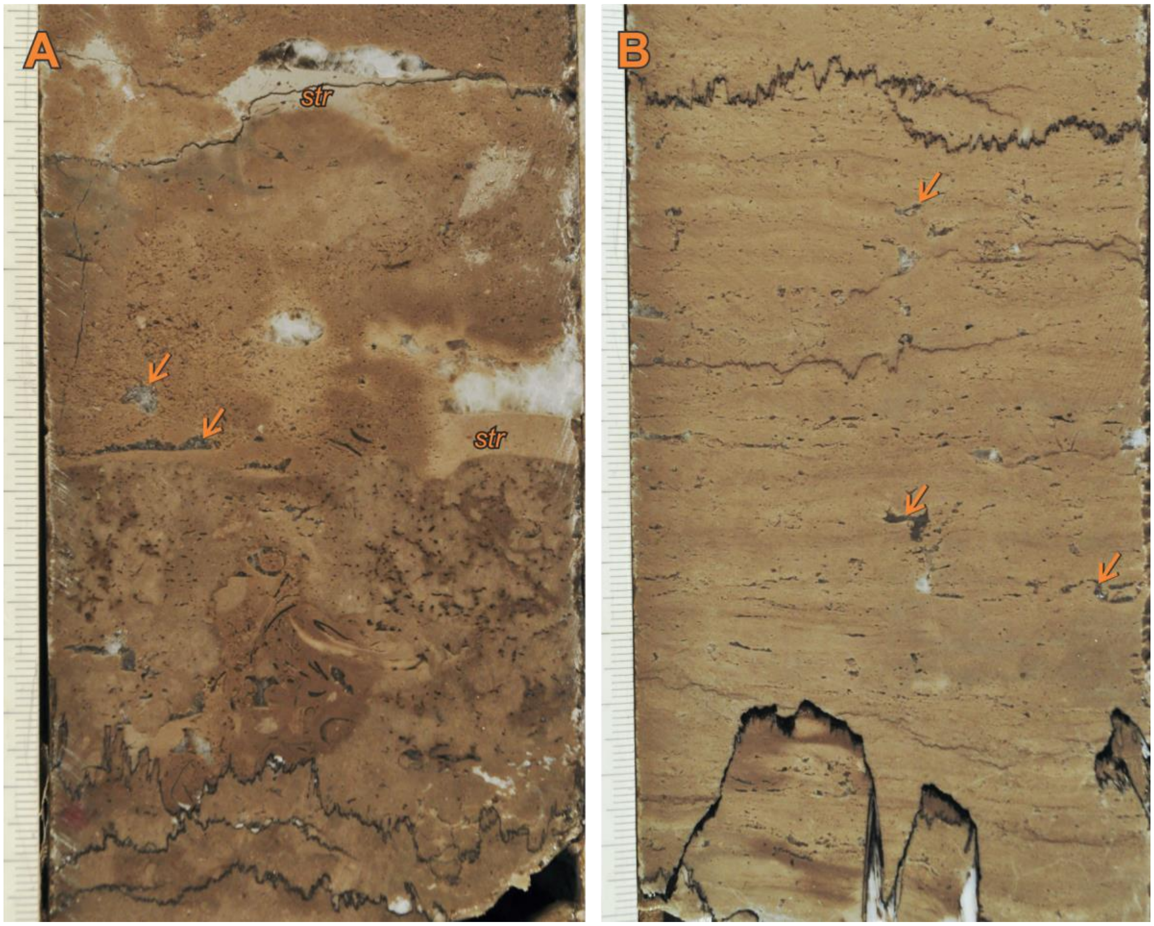


**Figure A1-10. Parker River J-72, core at 949.0-960.0 m; "birds-eye" fenestrae are arrowed. (A) Rudimentary *Stromatactis* (*str*) at 952.7 m; note excellent preservation of mollusk biomolds in a micritic matrix. (B) Laminar fenestral facies at 955.5-956.6 m.**