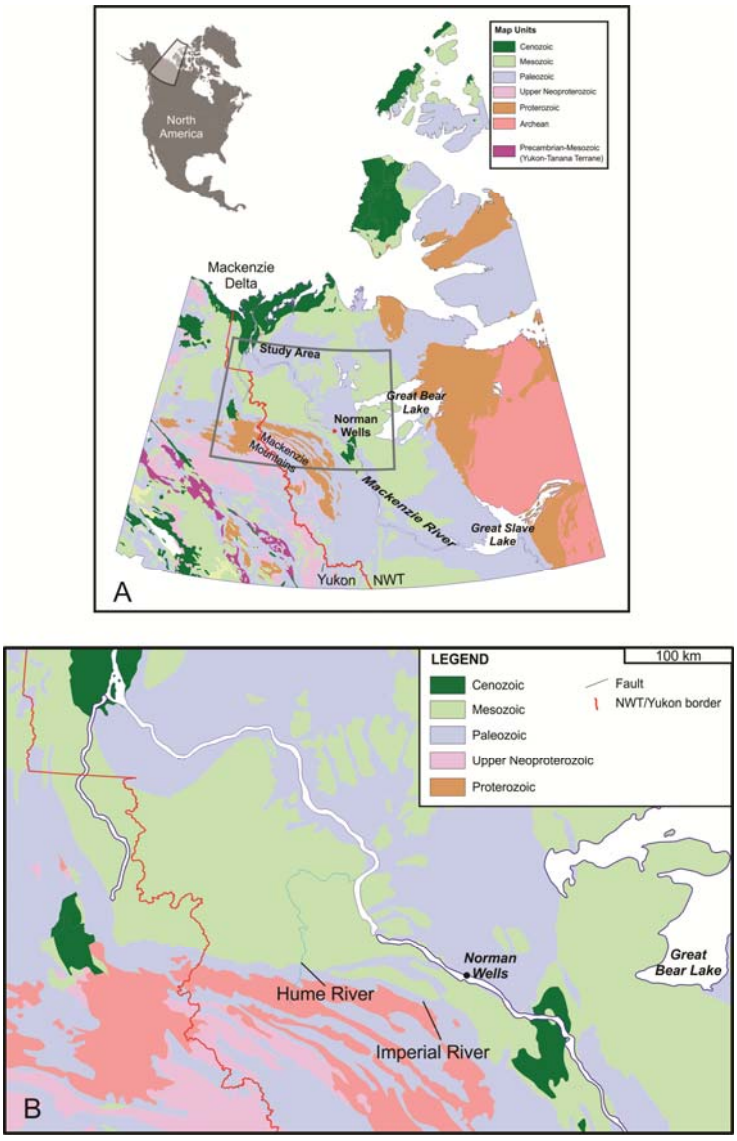
Supplemental data

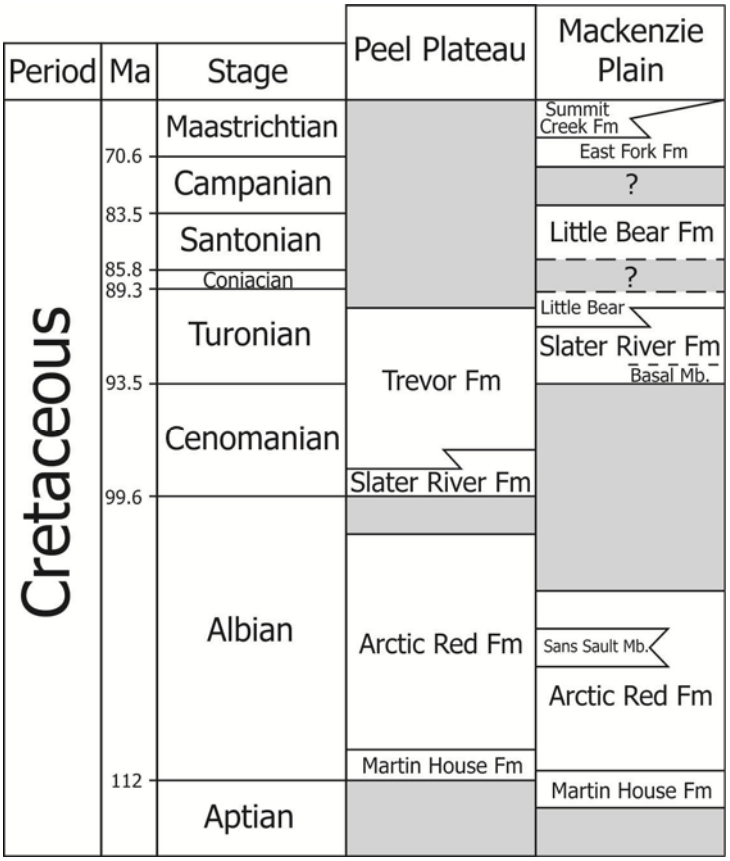
The new material used in this study was drawn from the following sources: the Hume River and Imperial River outcrop sections in the Mackenzie Plain – Peel Plateau area of the Northwest Territories, Canada; the Glacier Fiord surface section, Axel Heiberg Island, Nunavut, Canada; exploration wells in offshore southeastern Canada (Argo F-38, Demascota G-32, Onondaga E-84 and Wenonah J-75); and exploration wells in the Labrador–Baffin Seaway (Roberval K-92 and Skolp E-07). Sections on each of these four areas follow.



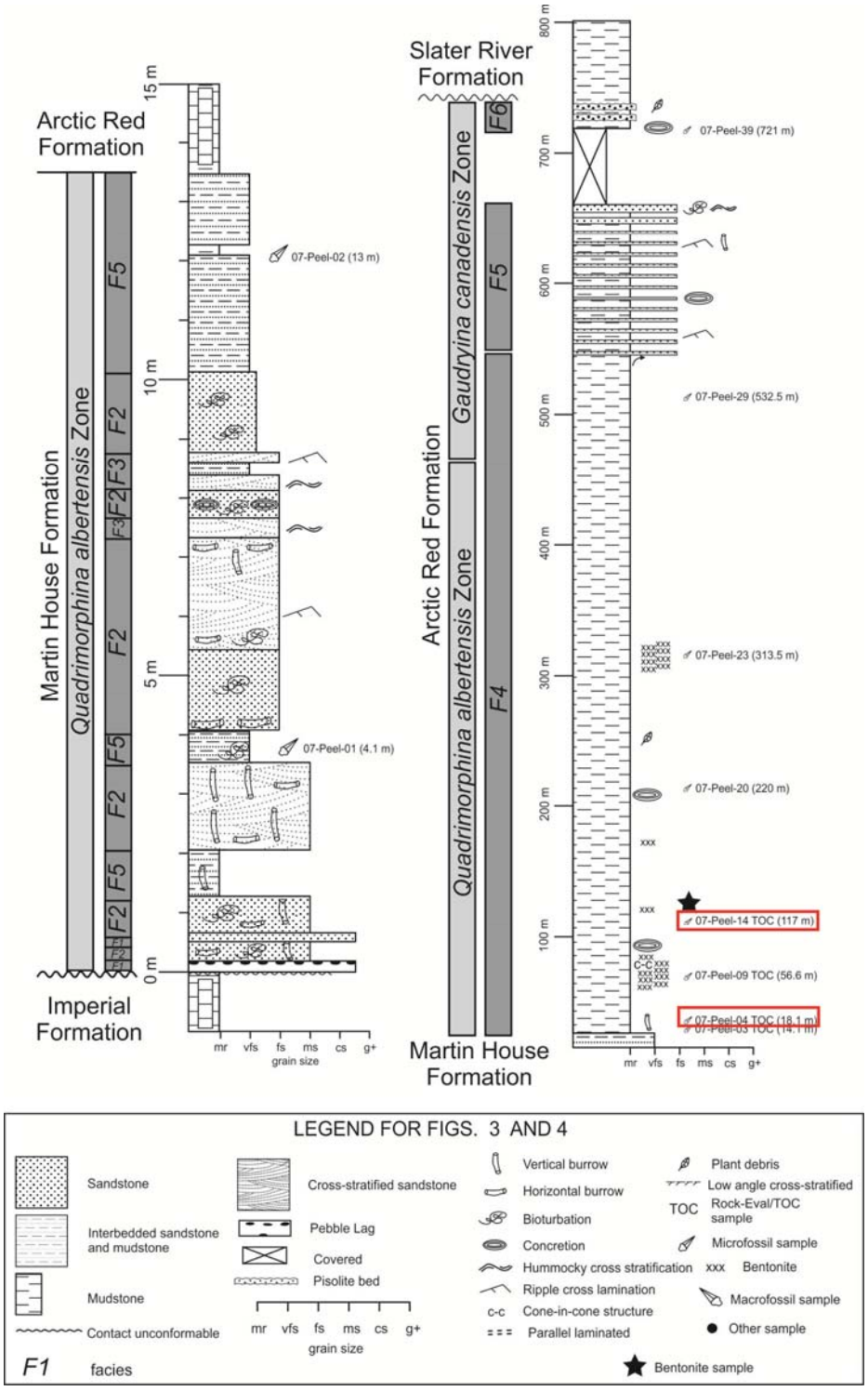
Supplemental data Figure 1. *Map of the Mackenzie Plain–Peel area showing locations of the Hume River and Imperial River surface sections. Adapted from Hadlari et al. (2014, figs 1–2).*

Mackenzie Plain – Peel Plateau area

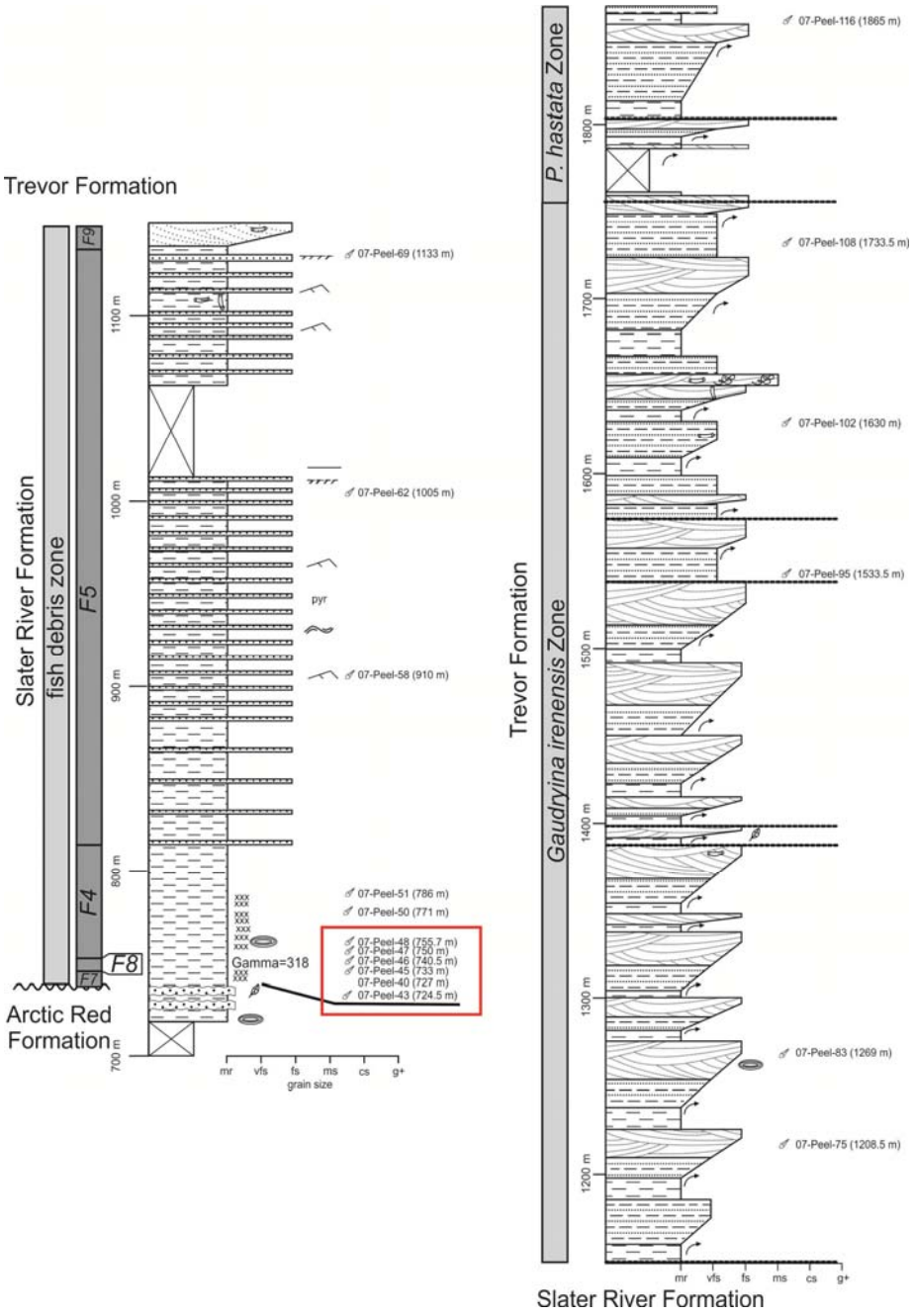
Material from this area is from two surface sections, the Hume River and Imperial River (Supplemental data Fig. 1). Samples from the Hume River section were collected by Thomas Hadlari of the Geological Survey of Canada (Calgary), and Danielle Thomson and Claudia Schröder-Adams of Carleton University, Ottawa, Canada; samples from the Imperial River section were collected by Thomas Hadlari. Information on the samples and specimens from this section used in this study is presented as part of Appendix 3. The basic stratigraphy is shown in Supplemental data Fig. 2 after Thomson et al. (2011), and a commentary to possible variation on this can be found in Fensome (2016). Details of sample occurrence in the Hume River section is shown in Supplemental data Figs 3–4. Details of sample occurrence in the Imperial River section is shown in Supplemental data Fig. 5.



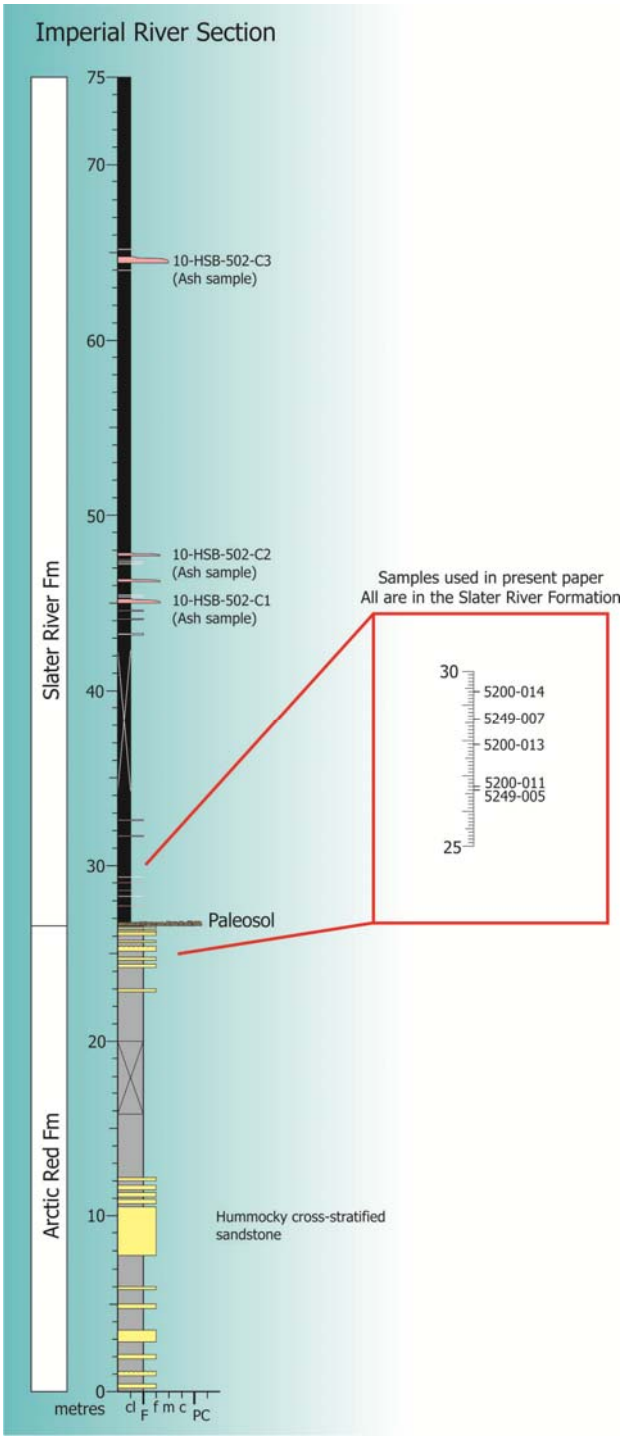
Supplemental data Figure 2. *Chronostratigraphy and formations according to Thomson et al. (2011). Adapted from Thomson et al. (2011, fig. 3).*



Supplemental data Figure 3. *Sample locations in the Hume River section — Martin House and Arctic Red formations. Samples with specimens illustrated in this study are framed by a red box. Adapted from Thomson et al. (2011, figs 6–7).*



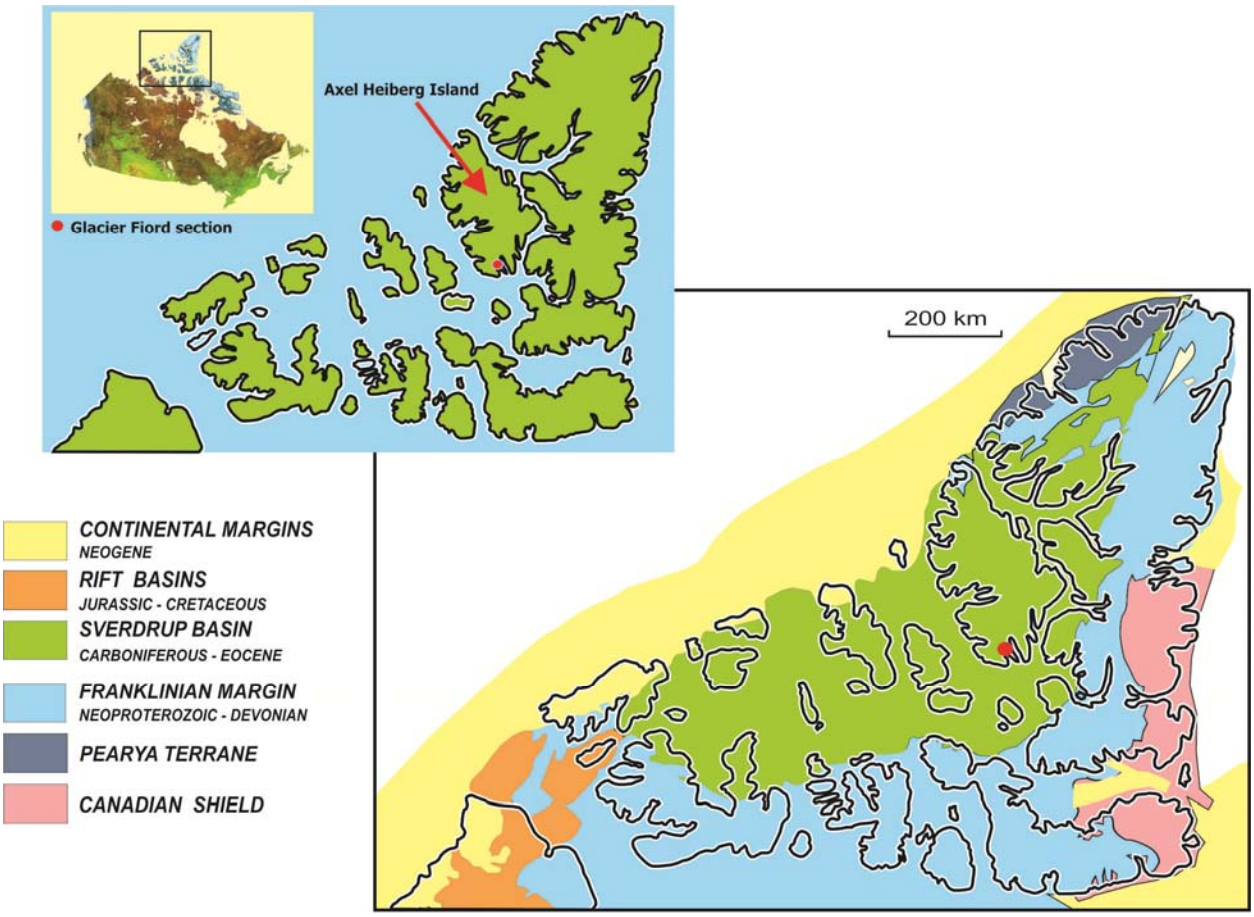
Supplemental data Figure 4. *Sample locations in the Hume River section — Slater River and Trevor formations. Samples with specimens illustrated in this study are framed by a red box. For legend, see Supplemantal data Fig. 3. Adapted from Thomson et al. (2011, figs 6, 8–9).*



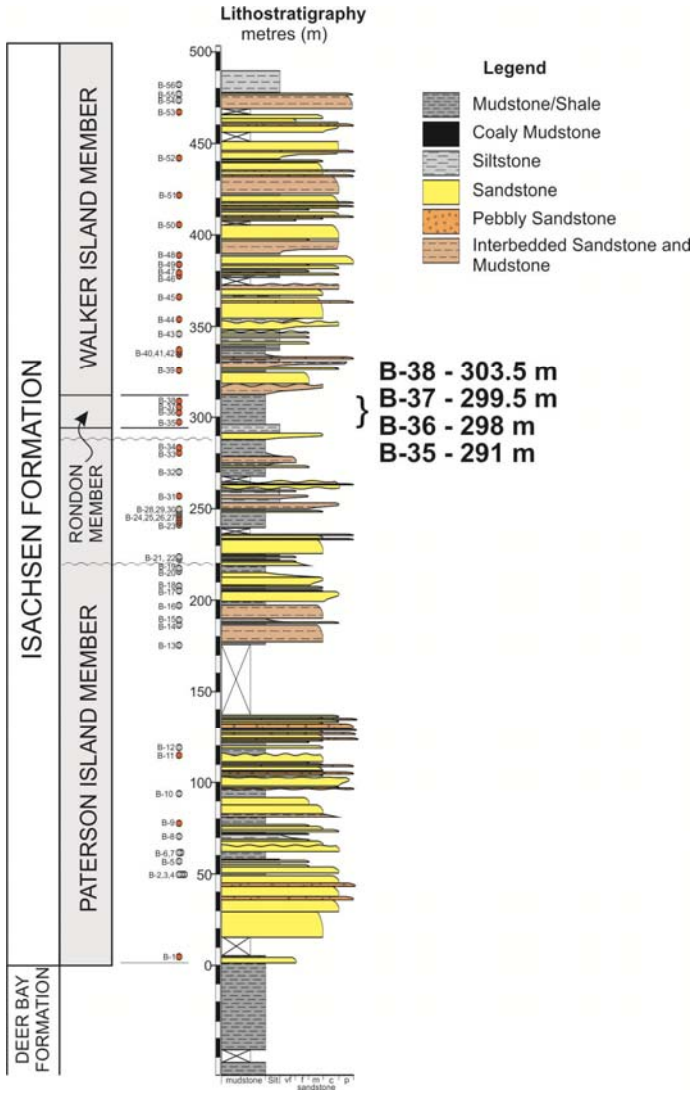
Supplemental data Figure 5. *Sample locations in the Imperial River section. Samples with specimens illustrated in this study are indicated in the inset red box. Adapted from a figure provided by Thomas Hadlari.*

Glacier Fiord section, Axel Heiberg Island

This is a single section collected by Jennifer Galloway of Geological Survey of Canada (Calgary). The location of the section is shown in Supplemental data Fig. 6. Information on the samples and specimens from this section used in this study is presented as part of Appendix 3. Details of sample occurrence in the Isachsen Formation in the Glacier Fiord section are shown in Supplemental data Fig 7. A similar chart for samples from the younger Christopher Formation is not available, but details of this part of the section can be found in Schröder-Adams et al. (2014).



Supplemental data Figure 6. *Map of part of the Canadian Arctic Archipelago showing the location and general geological setting of the Glacier Fiord section on Axel Heiberg Island. Adapted from a figure provided by Jennifer Galloway (Galloway et al. 2013).*

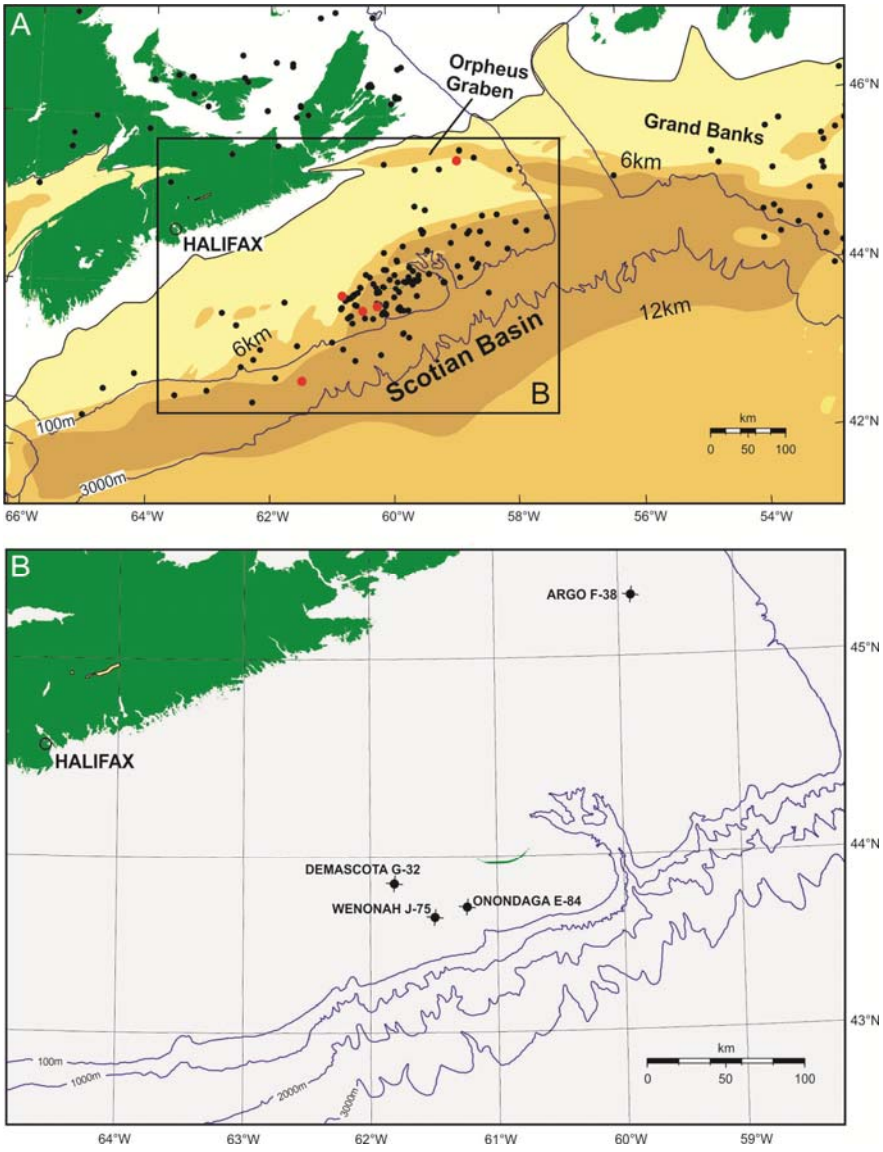


Supplemental data Figure 7. *Sample locations in the Glacier Fiord section — Isachsen Formation. Samples with specimens illustrated in this study are framed by a red box. Adapted from a figure provided by Jennifer Galloway.*

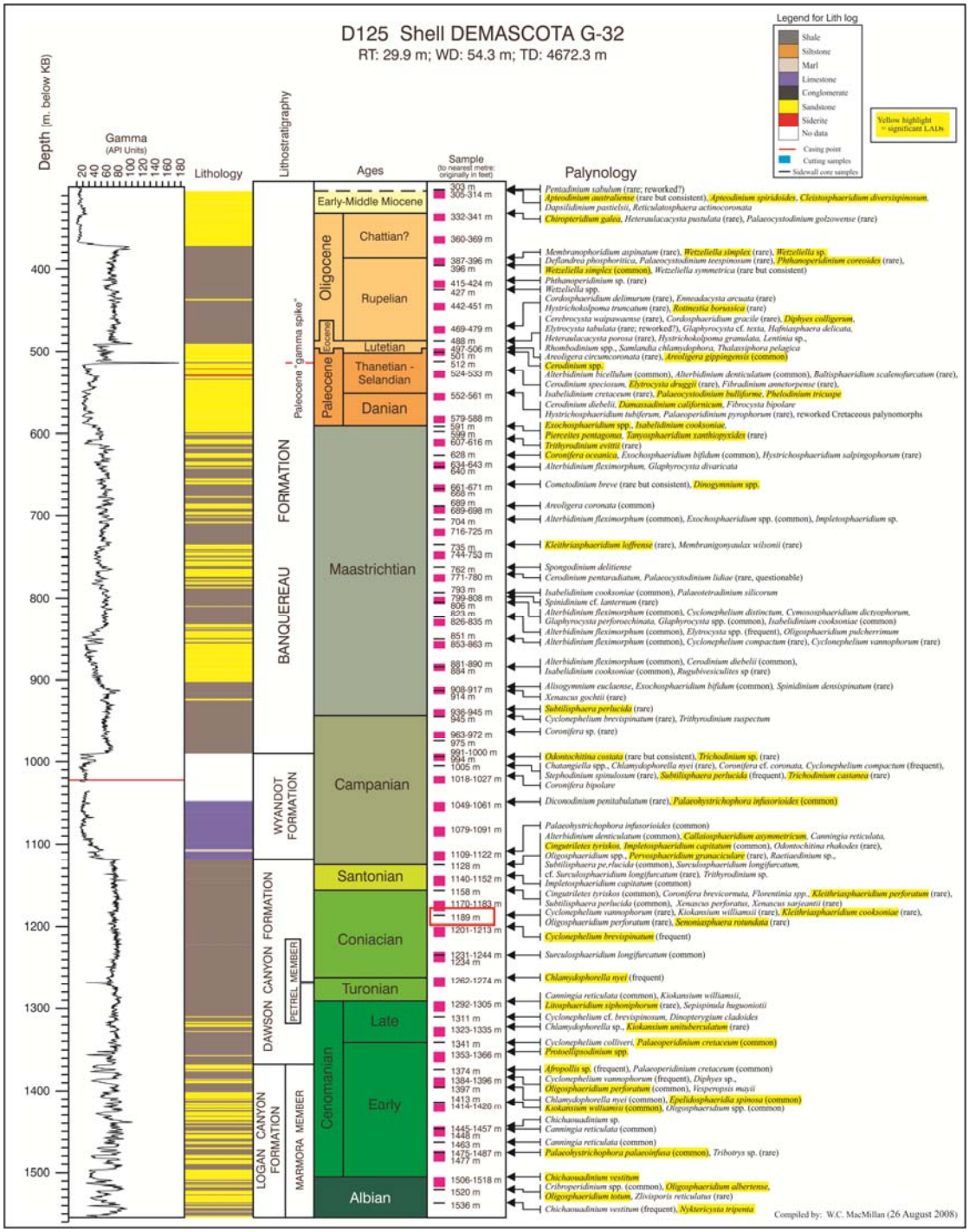
Scotian Margin

Material from four Scotian Margin wells was used in this study (Supplementary data Fig. 8). Information on the samples and specimens from this section used in this study is presented as part of Appendix 3. Biostratigraphical analyses of Demascota G-32, Onondaga E-84 and Wenonah J-75 were recorded in detail by Fensome et al. (2008, 2009). Charts for each of these

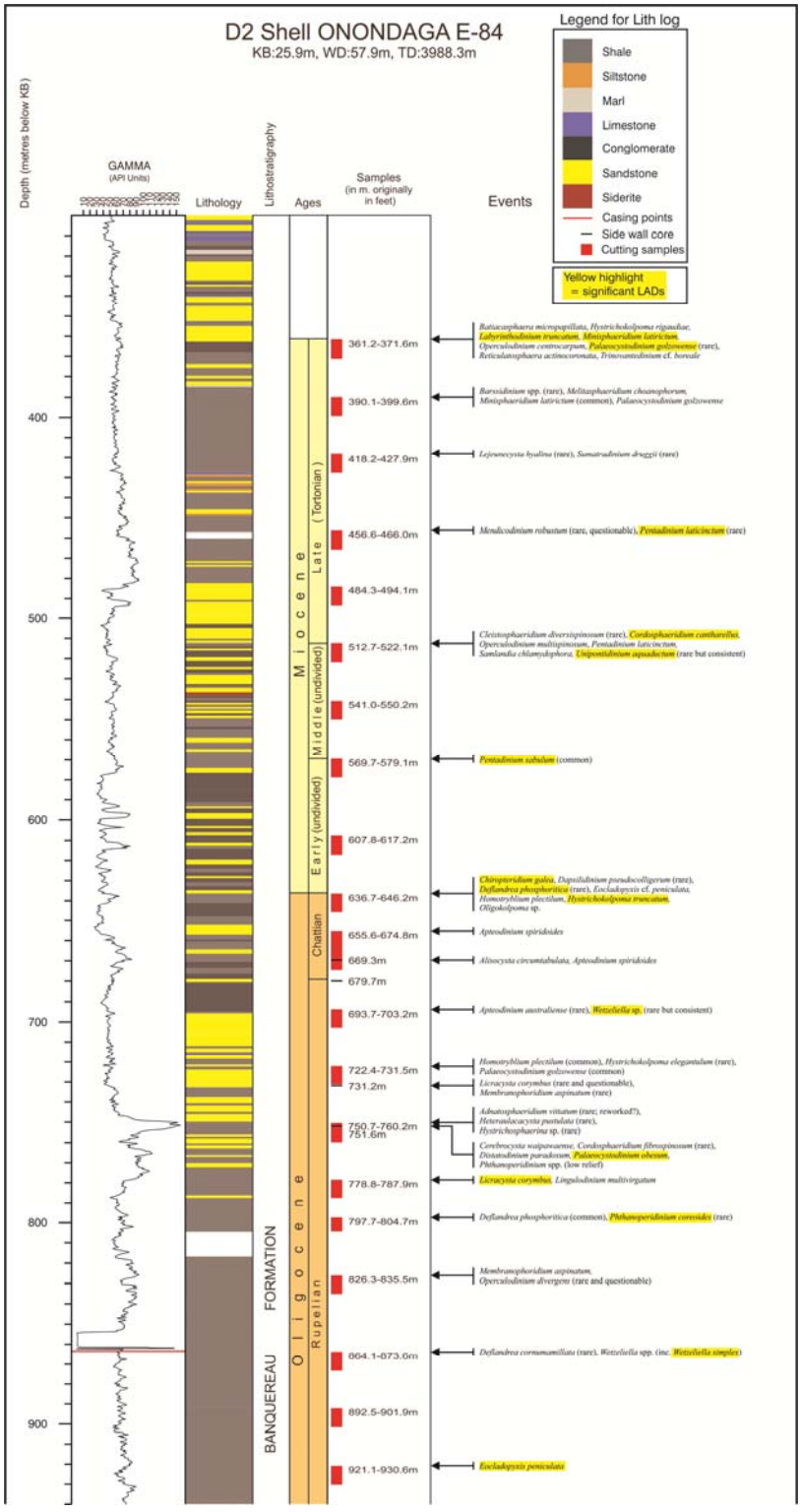
wells are reproduced here as Supplemental data Figs 9–11, with samples used in the present study indicated by red boxes. The material from Argo F-38 used in the present study is based on new reconnaissance analyses, although no new stratigraphy has been developed; a chart for this well is provided here as Supplemental data Figs 9–12.

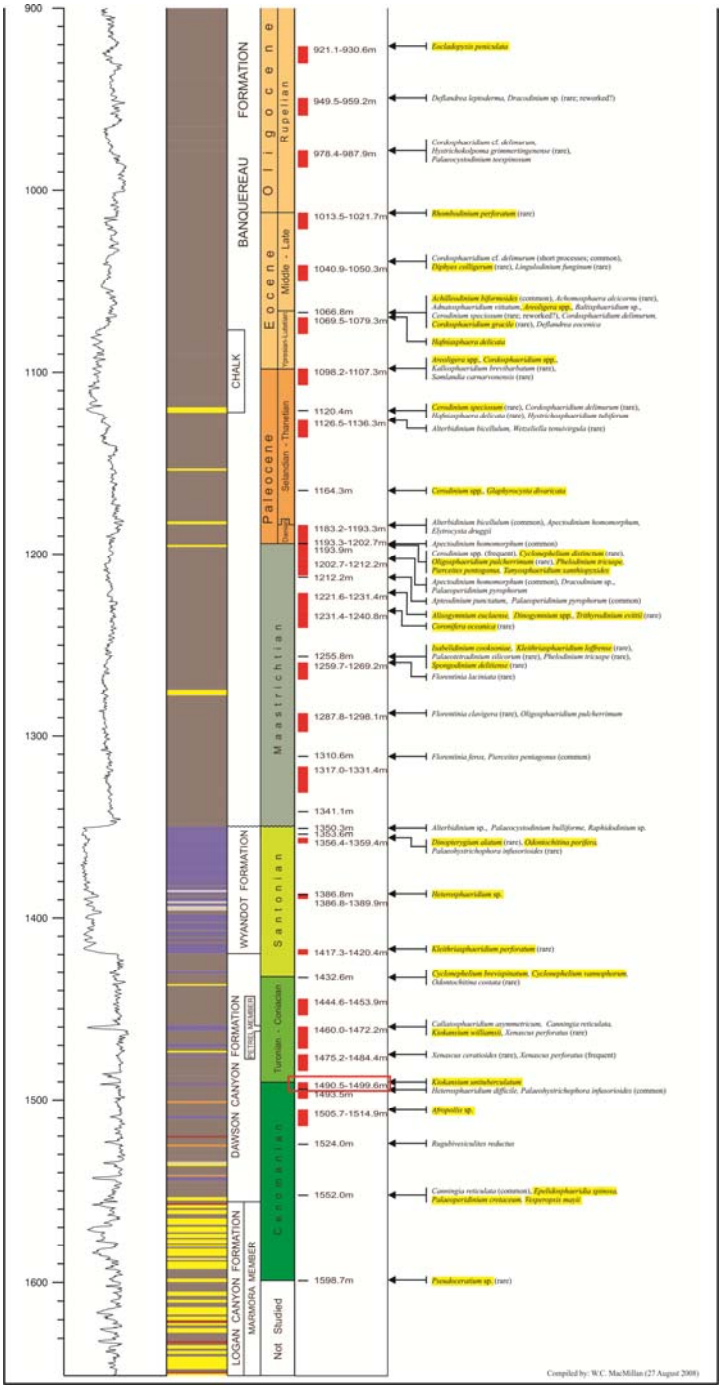


Supplemental data Figure 8. *Map of the Scotian Margin, offshore eastern Canada, showing the location of the wells from which specimens illustrated in the present paper derive. Adapted from a figure provided by Andrew MacRae; see also Fensome et al. (2008) and Weston et al. (2012).*

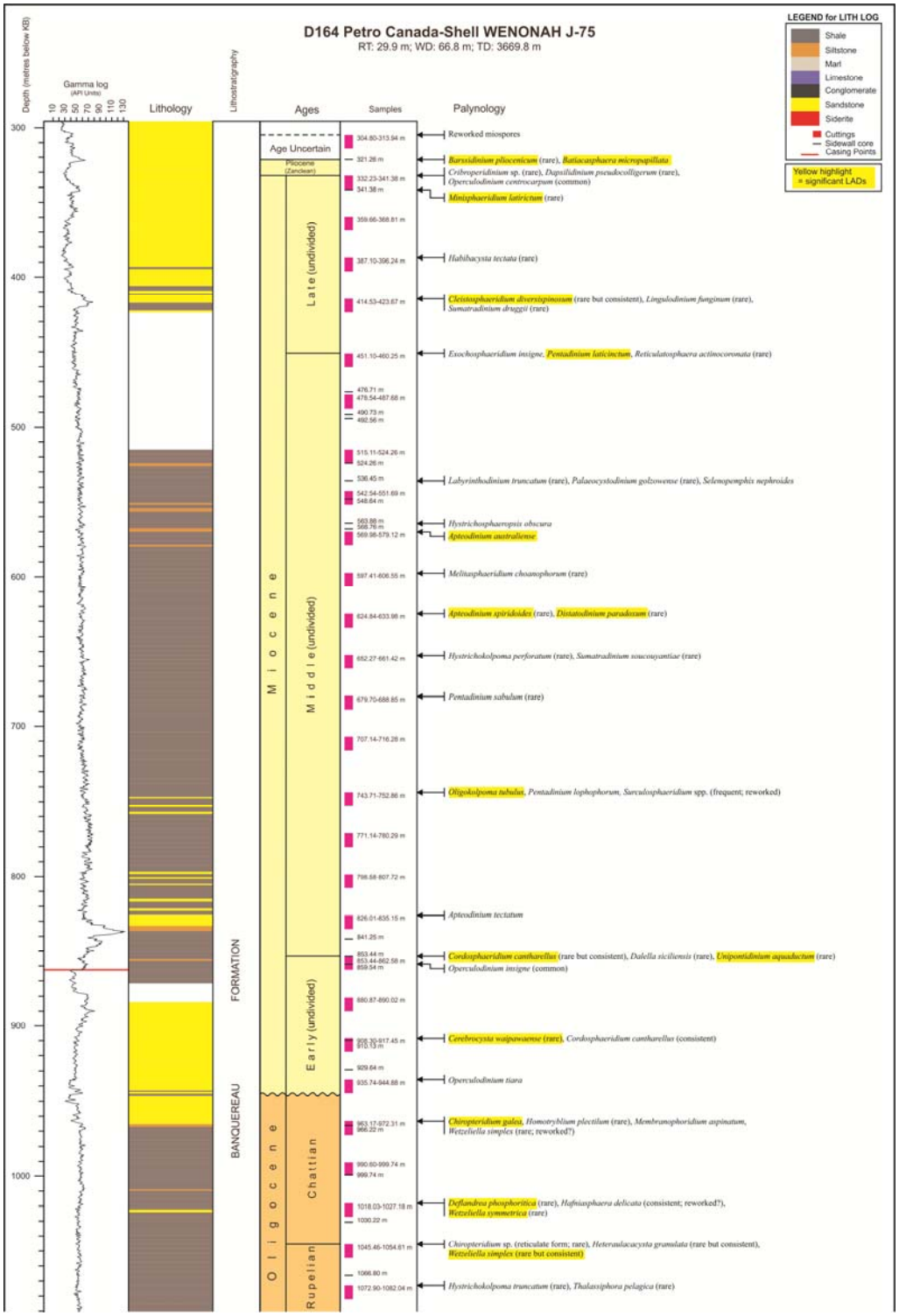


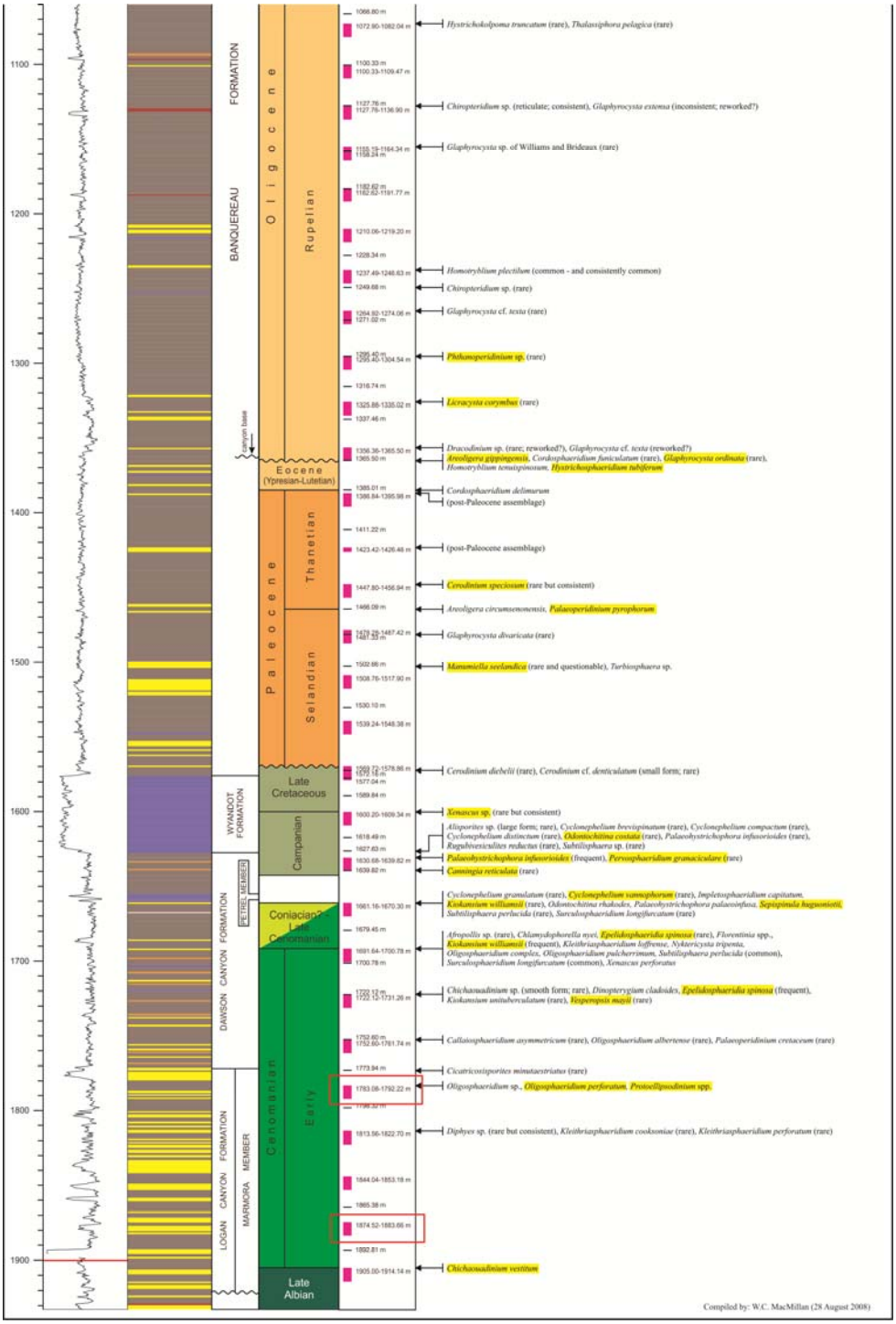
Supplemental data Figure 9. *Chart showing biostratigraphical, chronostratigraphical, lithostratigraphical, sample and well-log data from the Demascota G-32 well. For location, see Supplemental data Figure 8. Samples with specimens illustrated in this study are framed by a red box. Adapted from Fensome et al. (2008).*


D2 Shell ONONDAGA E-84
KB:25.9m, WD:57.9m, TD:3988.3m
Legend for Lith log
Shale
Siltstone
Marl
Limestone
Conglomerate
Sandstone
Siderite
Casing points
Side wall core
Cutting samples
Yellow highlight = significant LADs
Depth (metres below KB)
GAMMA (API Units)
Lithology
Lithostratigraphy
Ages
Samples (in m. originally in feet)
Events
BANQUEREAU FORMATION
Miocene
Late (Tortonian)
Middle (undivided)
Early (undivided)
Oligocene
Chattian
Rupelian
361.2-371.6m
390.1-399.6m
418.2-427.9m
456.6-466.0m
484.3-494.1m
512.7-522.1m
541.0-550.2m
569.7-579.1m
607.8-617.2m
636.7-646.2m
655.6-674.8m
669.3m
679.7m
693.7-703.2m
722.4-731.5m
731.2m
750.7-760.2m
751.6m
778.8-787.9m
797.7-804.7m
826.3-835.5m
864.1-873.6m
892.5-901.9m
921.1-930.6m
400
500
600
700
800
900

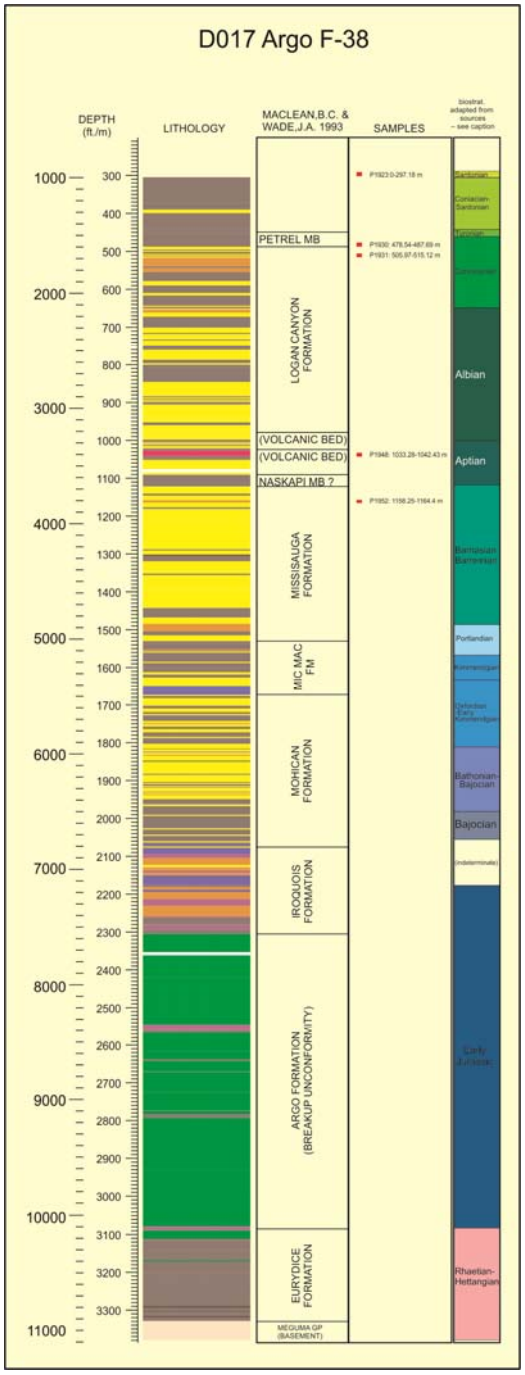


Supplemental data Figure 10. *Chart (arranged in two columns) showing biostratigraphical, chronostratigraphical, lithostratigraphical, sample and well-log data from the Onondaga E-84 well. For location, see Supplemental data Figure 8. Samples with specimens illustrated in this study are framed by a red box. Adapted from Fensome et al. (2008).*


D164 Petro Canada-Shell WENONAH J-75
RT: 29.9 m; WD: 66.8 m; TD: 3669.8 m
LEGEND for LITH LOG
Shale
Siltstone
Marl
Limestone
Conglomerate
Sandstone
Siderite
Cuttings
Sidewall core
Casing Points
Yellow highlight = significant LADs
Depth (metres below KB)
Gamma log (API Units)
Lithology
Lithostratigraphy
Ages
Samples
Palynology
BANQUEREAU FORMATION
Age Uncertain
Pliocene (Zanclean)
Miocene
Late (undivided)
Middle (undivided)
Early (undivided)
Oligocene
Chattian
Rupelian
304.80-313.94 m
321.26 m
332.23-341.38 m
341.38 m
359.66-368.81 m
387.10-396.24 m
414.53-423.67 m
451.10-460.25 m
476.71 m
478.54-487.68 m
490.73 m
492.56 m
515.11-524.26 m
524.26 m
536.45 m
542.54-551.69 m
548.64 m
563.88 m
568.76 m
569.98-579.12 m
597.41-606.55 m
624.84-633.98 m
652.27-661.42 m
679.70-688.85 m
707.14-716.28 m
743.71-752.86 m
771.14-780.29 m
798.58-807.72 m
826.01-835.15 m
841.25 m
853.44 m
853.44-862.58 m
859.54 m
880.87-890.02 m
908.30-917.45 m
910.13 m
929.64 m
935.74-944.88 m
963.17-972.31 m
966.22 m
990.60-999.74 m
999.74 m
1018.03-1027.18 m
1030.22 m
1045.46-1054.61 m
1066.80 m
1072.90-1082.04 m
Reworked miospores
Barssidinium pliocenicum (rare), Batiacasphaera micropapillata
Cribroperidinium sp. (rare), Dapsilidinium pseudocolligerum (rare), Operculodinium centrocarpum (common)
Minisphaeridium latirictum (rare)
Habibacysta tectata (rare)
Cleistosphaeridium diversispinosum (rare but consistent), Lingulodinium funginum (rare), Sumatradinium druggii (rare)
Exochosphaeridium insigne, Pentadinium laticinctum, Reticulatosphaera actinocoronata (rare)
Labyrinthodinium truncatum (rare), Palaeocystodinium golzowense (rare), Selenopemphix nephroides
Hystrichosphaeropsis obscura
Apteodinium australiense
Melitasphaeridium choanophorum (rare)
Apteodinium spiridoides (rare), Distatodinium paradoxum (rare)
Hystrichokolpoma perforatum (rare), Sumatradinium soucouyantiae (rare)
Pentadinium sabulum (rare)
Oligokolpoma tubulus, Pentadinium lophophorum, Surculosphaeridium spp. (frequent; reworked)
Apteodinium tectatum
Cordosphaeridium cantharellus (rare but consistent), Dalella siciliensis (rare), Unipontidinium aquaductum (rare)
Operculodinium insigne (common)
Cerebrocysta waipawaense (rare), Cordosphaeridium cantharellus (consistent)
Operculodinium tiara
Chiropteridium galea, Homotryblium plectilum (rare), Membranophoridium aspinatum, Wetzeliella simplex (rare; reworked?)
Deflandrea phosphoritica (rare), Hafniasphaera delicata (consistent; reworked?), Wetzeliella symmetrica (rare)
Chiropteridium sp. (reticulate form; rare), Heteraulacacysta granulata (rare but consistent), Wetzeliella simplex (rare but consistent)
Hystrichokolpoma truncatum (rare), Thalassiphora pelagica (rare)



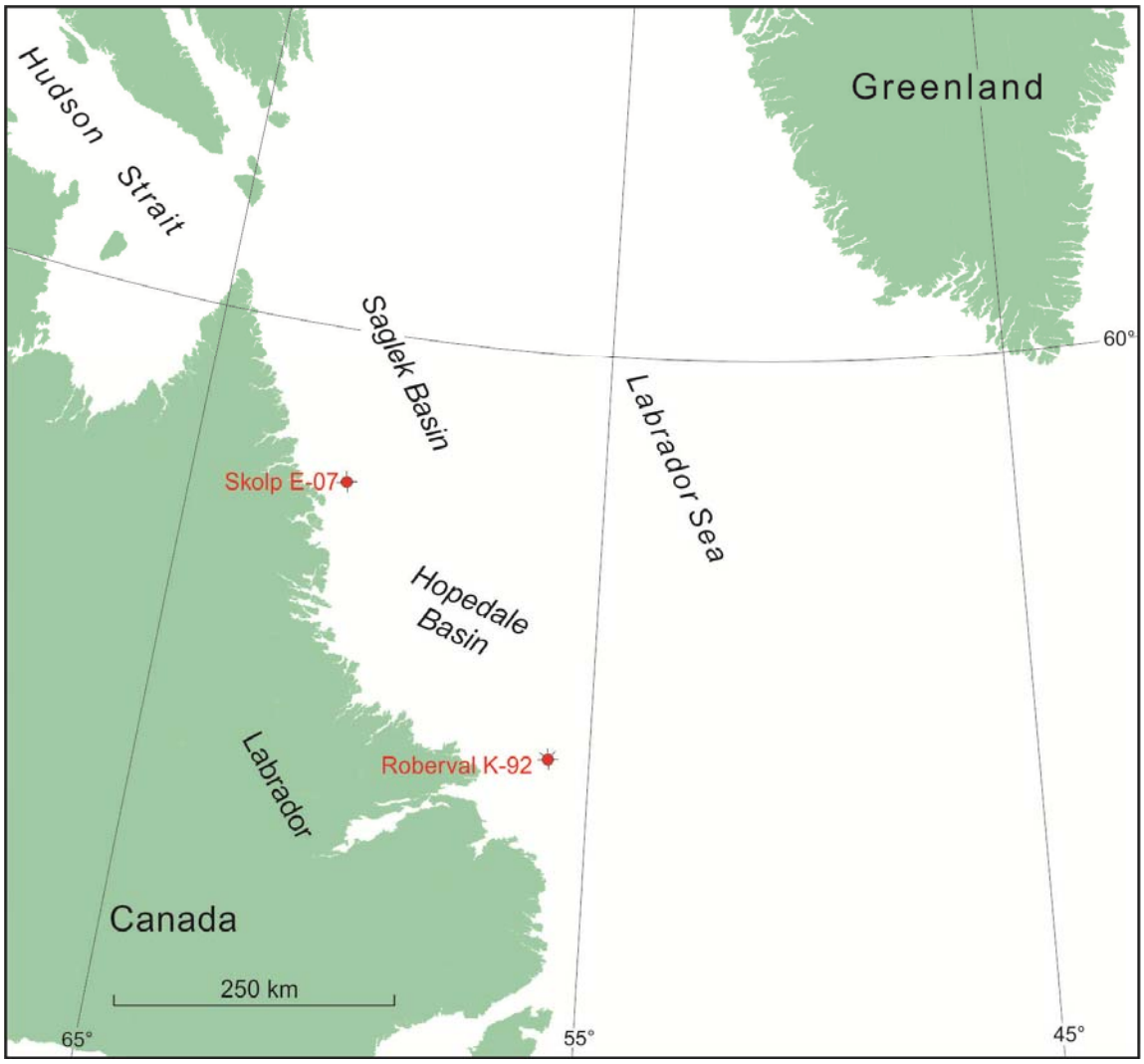
Supplemental data Figure 11. *Chart (in two columns) showing biostratigraphical, chronostratigraphical, lithostratigraphical, sample and well-log data from the Wenonah J-75 well. For location, see Supplemental data Figure 8. Samples with specimens illustrated in this study are framed by a red box. Adapted from Fensome et al. (2008).*



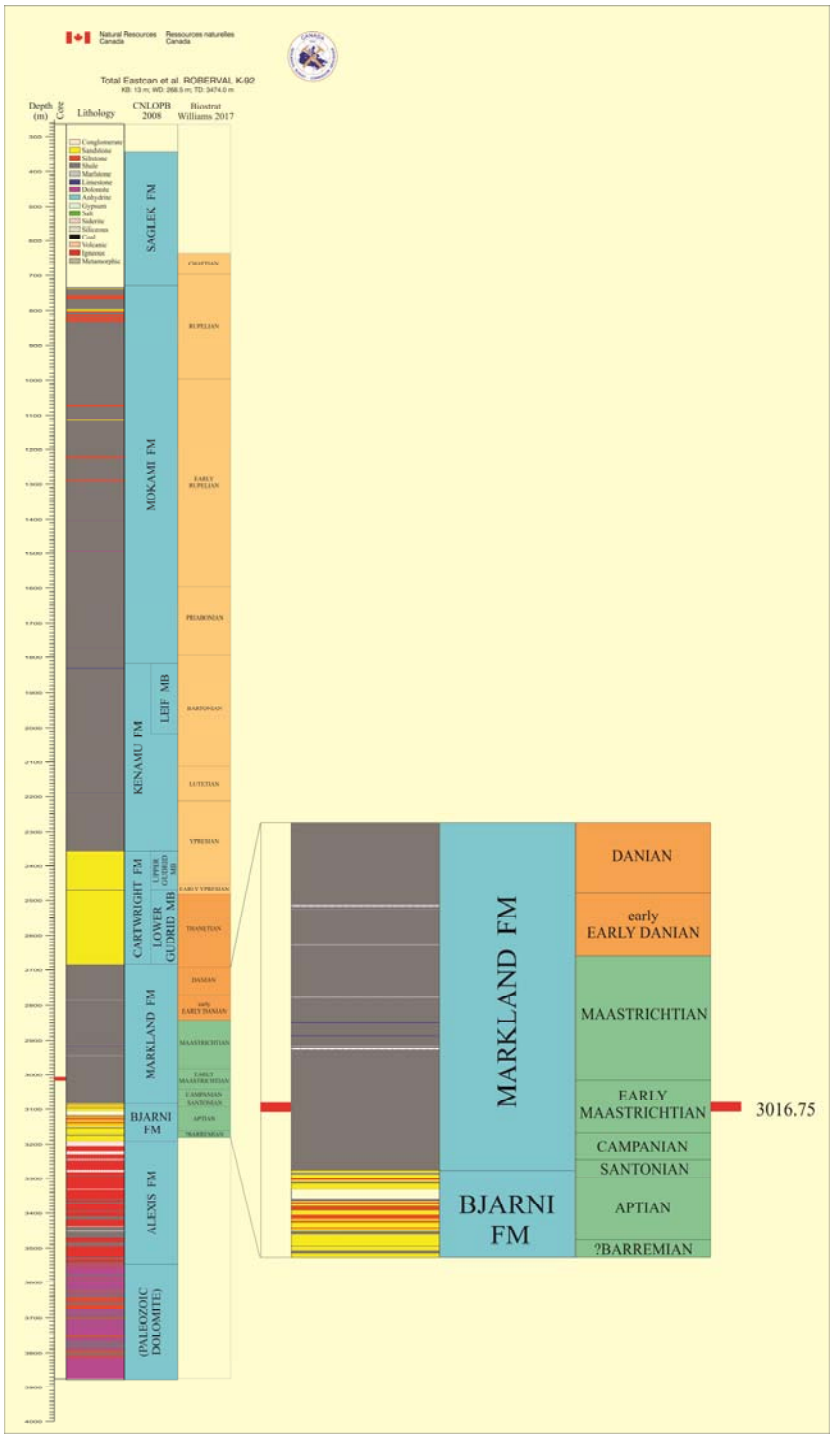
Supplemental data Figure 12. *Chart showing biostratigraphical, chronostratigraphical, lithostratigraphical and sample data from the Argo F-38 well. For location, see Supplemental data Figure 8. Samples with specimens illustrated in this study are those shown. Adapted from a figure provided by Andrew MacRae; lithostratigraphy from McLean and Wade (1993); biostratigraphy adapted from Bujak in Barss et al. (1979).*

Labrador Margin

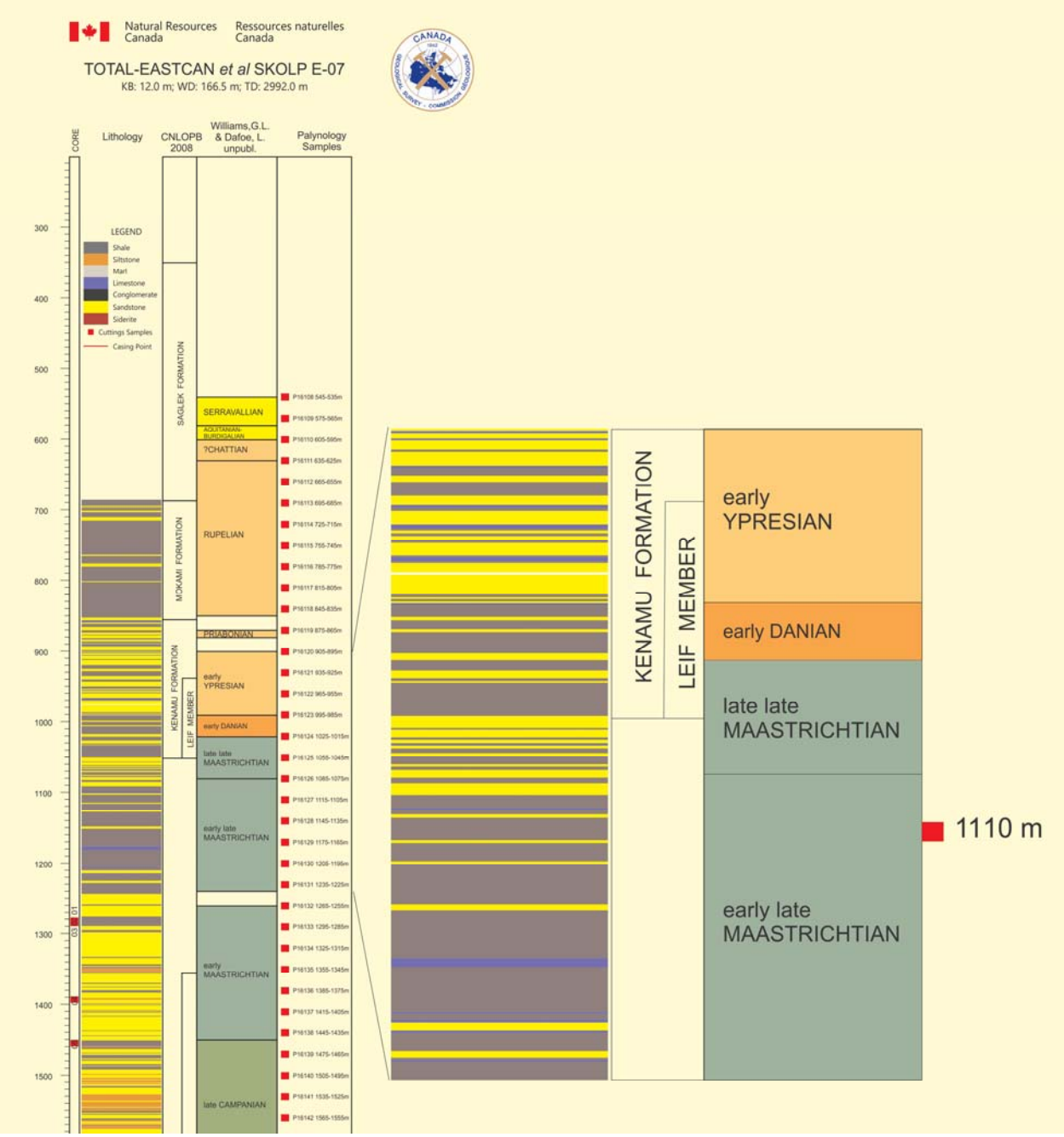
Material from two Labrador Margin wells was used in this study (Supplementary data Fig. 13). Information on the samples and specimens from this section used in this study is presented as part of Appendix 3. Biostratigraphical analyses of Roberval K-92 were recorded in detail by Williams (2017). Biostratigraphical scheme for Skolp E-07 has been provided by one of us (GLW) and L. Dafoe (unpublished data). Charts for each of these wells are reproduced here as Supplemental data Figs 14–15, with samples used in the present study indicated by red boxes.



Supplemental data Figure 13. *Map of the Labrador Margin, offshore eastern Canada, showing the location of the wells from which specimens illustrated in the present paper derive. Adapted from Nøhr-Hansen et al. (2017).*



Supplemental data Figure 14. *Chart showing biostratigraphical and lithostratigraphical data from the Roberval K-92 well, and the location of the sample used in this study from this well. For location, see Supplemental data Figure 13. Lithostratigraphy from Canada–Newfoundland-Labrador Offshore Petroleum Board (2008); biostratigraphy from Williams (2017).*



Supplemental data Figure 15. *Chart showing biostratigraphical and lithostratigraphical data from the Skolp E-07 well, and the location of the sample used in this study. For location, see Supplemental data Figure 13. Lithostratigraphy from Canada–Newfoundland-Labrador Offshore Petroleum Board (2008); biostratigraphy from L. Dafoe and G.L. Williams (personal communication March 2018).*

References

Barss MS, Bujak JP, Williams GL. 1979. Palynological zonation and correlation of sixty-seven wells, eastern Canada. Geological Survey of Canada Paper 78-24, 117 p.

Canada–Newfoundland and Labrador Offshore Petroleum Board. 2008. Schedule of Wells: Newfoundland and Labrador Offshore Area. October 2008. http://www.cnlopb.ca/wells/.

Fensome RA. 2016. A palynological analysis of middle Cretaceous strata in the Hume River section, Northwest Territories, Canada. Geological Survey of Canada Open File 8073, 132 p. (not formally published).

Fensome RA, Crux JA, Gard IG, MacRae RA, Williams GL, Thomas FC, Fiorini F, Wach G. 2008. The last 100 million years on the Scotian Margin, offshore eastern Canada: an event-stratigraphic scheme emphasizing biostratigraphic data. Atlantic Geology 44:93–126.

Fensome RA, Williams GL, MacRae RA. 2009. Late Cretaceous and Cenozoic fossil dinoflagellates and other palynomorphs from the Scotian Margin, offshore eastern Canada. Journal of Systematic Palaeontology 7:1–79.

Galloway JM, Sweet A, Sanei H, Dewing K, Hadlari T, Embry AF, Swindles GT. 2013. Middle Jurassic to Lower Cretaceous paleoclimate of Sverdrup Basin, Canadian Arctic Archipelago inferred from the palynostratigraphy. Marine and Petroleum Geology 44:240–255.

Hadlari T, MacLean BC, Galloway JM, Sweet AR, White JM, Thomson D, Gabites J, Schröder-Adams CJ. 2014. The flexural margin, the foredeep, and the orogenic margin of a northern Cordilleran foreland basin: Cretaceous tectonostratigraphy and detrital zircon provenance, northwestern Canada. Marine and Petroleum Geology 57:173–176.

MacLean BC, Wade JA. 1993. Seismic markers and stratigraphic picks in the Scotian Basin

wells. East Coast Basin Atlas Series, Energy, Mines and Resources Canada, 276 p.

Nøhr-Hansen H, Williams GL, Fensome RA. 2017. Biostratigraphic correlation of the western and eastern margins of the Labrador–Baffin Seaway and implications for the regional geology. Geological Survey of Greenland and Denmark Bulletin 37, 74 p.

Schröder-Adams CJ, Herrle JO, Embry AF, Haggart JW, Galloway JM, Pugh AT, Harwood DM. 2014. Aptian to Santonian foraminiferal biostratigraphy and paleoenvironmental change in the Sverdrup Basin as revealed at Glacier Fiord, Axel Heiberg Island, Canadian Arctic Archipelago. Palaeogeography, Palaeoclimatology, Palaeoecology 413:81–100.

Thomson D, Schröder-Adams CJ, Hadlari T, Dix G, Davis WJ. 2011. Albian to Turonian stratigraphy and palaeoenvironmental history of the northern Western Interior Sea in the Peel Plateau region, Northwest Territories, Canada. Palaeogeography, Palaeoecology, Palaeoclimatology 302:270–300.

Weston JF, MacRae RA, Ascoli P, Cooper MKE, Fensome RA, Shaw D, Williams GL. 2012. A revised biostratigraphic and well-log sequence-stratigraphic framework for the Scotian Margin, offshore eastern Canada. Canadian Journal of Earth Sciences 49:1417–1462.

Williams GL. 2017. Palynological Analysis of the Two Labrador Shelf Wells, Petro-Canada et al. Roberval C-02 and Total Eastcan et al. Roberval K-92, offshore Newfoundland and Labrador. Geological Survey of Canada Open File 8183, 63 p. (not formally published).