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The Cretaceous Sverdrup Basin, Nunavut, Canada: A Boreal Ocean under Greenhouse Conditions

Claudia J. Schröder-Adams (1), Jens O. Herrle (2), Adam T. Pugh (1), Julie Andrews (1), and Jennifer Galloway (3)

(1) Dept. of Earth Sciences, Carleton University, Ottawa, Ontario, Canada, K1S 5B6, (2) Institute of Geosciences, Biodiversity and Climate Research Centre (BIK-F), Goethe University Frankfurt, D-60438 Frankfurt am Main, Germany, (3) Geological Survey of Canada, Calgary, T2L 2A7, Canada

The Arctic Boreal Sea and its paleoceanographic and paleoecological response to the Cretaceous Greenhouse climate remain enigmatic. This study takes a multi-fossil approach coupled with carbon isotope stratigraphy and geochemistry to address large-scale stratigraphic correlations, water column structure and paleoproductivity changes by comparing distal and proximal sedimentary records exposed on Ellef Ringnes and Axel Heiberg islands respectively, part of the Sverdrup Basin, Nunavut, Canada. A newly established carbon isotope record documents several δ13Corg excursions that tie well to precisely dated European carbon isotope records bringing an unprecedented stratigraphic accuracy to the Boreal Sea strata. This framework also allows for refinement of new and existing biostratigraphic data. Several OAEs are recognized including a prominent OAE 2 straddling the Cenomanian/Turonian boundary. This documents high latitude increased carbon burial during the Cenomanian/Turonian temperature maximum independent of different lithologies that mark this interval in our studied localities. As temperature cooled again primary productivity and carbon flux decreased and slight bottom oxygenation returned in the upper Santonian, where rare benthic foraminifera are observed. The Boreal Ocean is almost devoid of carbonate as it is predicted for a future Arctic Ocean under increasing levels of atmospheric greenhouse gases. Contrasting to distal basin settings benthic agglutinated foraminifera thrived in shelf areas where watermass stratification was disrupted. Changes in dinocyst assemblages responded to regressive/transgressive cycles that have not been previously recognized within the thick lithologically indistinct shale interval of the Upper Cenomanian to Campanian Kanguk Formation. Regressions triggered radiations in radiolarian assemblages due to reduced oxygen minimum zones (OMZ) and fertile shelf settings. In contrast, transgressive phases provided increased rates of organic matter deposition, in part due to terrestrial flooding coupled with humid conditions and input of Type III organic matter, but also high surface water productivity (Type II organic matter) which resulted in an expanded OMZ and reduced radiolarian species richness. Both proxies confirm stage boundaries as we compare these newly recognized Upper Cretaceous sea-level fluctuations within the Boreal Sea to global sea-level changes as established from well dated Atlantic records. The improved stratigraphic framework and regressive/transgressive history of the Cretaceous Boreal Sea allows for future refinement of paleogeographic reconstructions that among others address opening of paleoceanographic migration pathways.