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Evaluating environmental changes in the southern extent of the Arctic Ocean during the Late Cretaceous using biomarkers and microfossils

JUAN F DIAZ TAMAYO[1], LORENZ SCHWARK[2], JENNIFER GALLOWAY[3], MANUEL BRINGUE[3], STEVE GRASBY[3] AND PER PEDERSEN[1]

[1]University of Calgary
[2]Kiel University
[3]Geological Survey of Canada

Presenting Author: juanfdiazt@gmail.com

During the Late Cretaceous, the proto-Arctic Ocean was warmer, fresher and more isolated from the world's oceans than today. Ocean productivity in coastal and offshore areas was relatively high and controlled mainly by high nutrient influx from fluvial run-off and probably wind-driven upwelling. The landmasses surrounding the main Arctic water body were characterized by the presence of extensive forests that resemble those found in modern temperate regions. Most of the data used to construct the environmental models of the proto-Arctic Ocean during the Cretaceous have been collected from cores and outcrops from the Alpha Ridge, the Sverdrup Basin and the Northern Slope of Alaska. However, limited paleoenvironmental studies have been developed further south at the mainland coast of Arctic Canada, an area that allows critical insight into the oceanographic and ecological interactions between the proto-Arctic Ocean and the Western Interior Seaway.

Here, we use micropaleontological and geochemical data recovered from the Santonian to Maastrichtian Smoking Hills (SHF) and Mason River (MRF) formations in the Anderson Plains (Northwest Territories, Canada) to analyze how local and probably global environmental changes affected marine ecosystems in the southern extent of the proto-Arctic Ocean near the end of the Cretaceous Period. The SHF is dominated by marine organic matter as evidenced by low Terrigenous-Aquatic biomarker ratios, the presence of aromatic norhopanes and low concentrations of plant-derived cyclic biomarkers. In contrast, the MRF exhibits abundant terrigenous organic matter with a high input of aromatic compounds derived from soil microbes. Biomarkers also inform on oxygenation, secondary productivity, intensity of wildfires and the relative input of organic matter derived from gymnosperm versus angiosperm plants. Paleoecosystems evolved in four stages: the SHF has a dominance of gymnosperms over angiosperms; the lower MRF experienced enhanced soil, and vegetation influx and a slight increase in gymnosperms content; the middle MRF had more terrigenous influx dominated by angiosperm-derived compounds; and the upper MRF is characterized by dominantly soil-derived organic matter and a paleovegetation with low angiosperms content. Radiolarians and dinoflagellates were predominant during the deposition of the SHF but were gradually replaced by diatoms and silicoflagellates during the deposition of the MRF.