

Organic Matter in Sediments from the North American Arctic Margin

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Abstract

To better understand the nature and distribution of the sedimentary organic matter in margin sediments off the North American Arctic, we analyzed thirty cores collected from all its major basins, including Baffin Bay/Davis Strait, the Canadian Archipelago, three regions of the Beaufort Sea (Mackenzie River Shelf, East Alaskan and West Alaskan Shelves), as well as the Chukchi and Bering Seas. Measurements included organic and inorganic carbon contents, mineral surface area, stable carbon and radiocarbon compositions of organic matter and a variety of CuO oxidation products derived from both terrigenous vascular plant and non-vascular plant sources. Our analyses showed major differences in the compositions of surface sediments along the North American Arctic margin. For example, while organic carbon contents were relatively uniform in all regions, ranging between 1 and 2 wt%, inorganic carbon contents were extremely elevated in the Canadian Archipelago sites (up to 8 wt%). Based on their depleted ¹⁴C signatures, the elevated carbonate contents in these latter sediments reflect inputs from erosion of limestone bedrock in the adjacent terrain. Marked contrasts in the distribution of terrigenous-specific biomarkers indicated significant differences in the inputs of land-derived materials. For example, the highest carbon-normalized yields of lignin phenols were found in sites along the shelf portion of the Beaufort Sea, including off Barrow Canyon and Mackenzie Shelf. In contrast, sediments from Baffin Bay and the Archipelago were relatively devoid of these terrigenous markers. Compositional contrasts among biomarker classes indicated differences in provenance of land-derived organic matter among regions. Inputs from coastal erosion appear to be more important in the western parts of the Beaufort, Chukchi and Bering Seas, whereas export from the Mackenzie River dominate the eastern Beaufort sea.

Is the deuterium isotope composition of amber a reliable inland paleoclimatic indicator?

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Hydrous deuterium-exchange experiments have shown that a significant fraction of the original D/H composition of bulk kerogens, bitumens and expelled oils may participate in isotopic exchange reactions during burial diagenesis. However, it is unknown to what extent resins and their fossil counterpart amber, exchange hydrogen isotopes following their biosynthesis. This situation hinders the application of resin D/H measurements in paleoenvironmental reconstruction. As compared with other plant-derived compounds resins seem to preserve most of the chemical and isotopic features during their transformation to amber [1,2]. Yet, in fossil resinoids the number of hydrogen-containing functional groups seems to decrease, whereas the number of aromatized groups apparently increases with increasing age [3,5,6]. Accordingly, the possibility of a significant D-isotopic exchange with meteoric waters during burial cannot be ruled out. By using a series of immersion experiments in deuterated (D-enriched) waters over a period of several months at several temperatures, here we investigate whether significant D-isotopic exchange occurs during early thermal maturation and polymerization of conifer and angiosperm resins. At 90 °C, equivalent to ~3 km of burial, modern conifer and angiosperm resins have an average post-metabolic D exchange of 4.63%, compared to only 1.08% for mature, polymerized ambers. At 55 °C the degree of exchange is considerably lower: 1.9% for resins and 0.6% for ambers. Our results indicate that most D/H isotopic exchange occurs prior to polymerization reactions of resins, thereby confirming that D/H measurements from amber constitute a potentially sensitive proxy for environmental reconstructions of past climates, ecologies, and hydrological regimes.

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