

MOLECULAR MARKERS OF ORGANIC MATTER SOURCES AND FATE IN THE ARCTIC

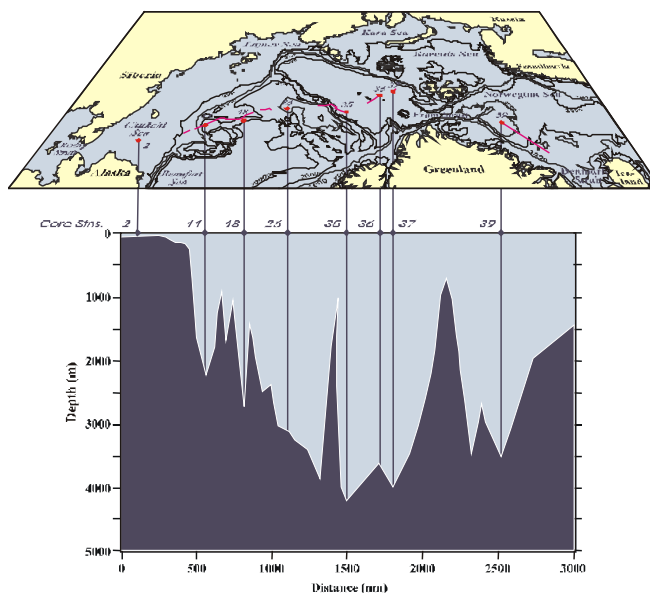
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Some of the highest global levels of primary production occur on the wide shelves of the Arctic Ocean, yet can be accompanied by large amounts of terrestrial material eroded from the land and transported by rivers and ice. In such complex system of multiple input, the carbon cycle is complicated by organic pools of vastly different recycling times under the influence of strong physical and temporal gradients. The use of molecular organic markers is well established as a means to understand the inputs and processes that occur in the oceans and underlying sediments, particularly the problem of differentiating organic sources and their degradative histories over geological time scales. Organic biomarkers are particularly useful in helping to understand how systems process, metabolize and sequester carbon in both the water column and sediments, a question central to understanding changes which might occur in the Arctic over decadal to geological time scales. This retrospective study is designed to examine the suite of potential organic markers that might be most useful to track the fate of primary production in the marine dominated the Chukchi Sea and compare it with the Beaufort Sea which receives more terrestrial material via rivers and ice transport. Multivariate approaches are being used to determine the suite of most appropriate molecular markers and to construct preliminary budgets for carbon export from the Chukchi and Beaufort shelves. In addition, core records are being studied to follow historical changes in community structure and productivity across the contrasting shelves.

We have focused on the analysis of a set of surface sediments (0-2cm) collected during the 1994 cruise that transected the Arctic Ocean (Fig 1-right). The molecular markers in these sediments provide a snapshot of material reaching the underlying shelf and basin sediments and thus a survey of the amount and distribution of organic matter either produced or transported into the Arctic Ocean. For most biomarkers examined, both the dry weight and organic carbon normalized concentrations are highest in the Chukchi Sea intermediate in the Eurasian Basin and Greenland Sea and lowest in the Canadian Basin. Arctic basin locations influenced by the Transpolar Drift have higher organic biomarker concentrations than locations influenced by the Beaufort Gyre. This implies that differences in both sources and/or transport mechanisms must occur, which in turn affect available nutrients and ultimately the amount of primary production reaching the underlying sediments. It also

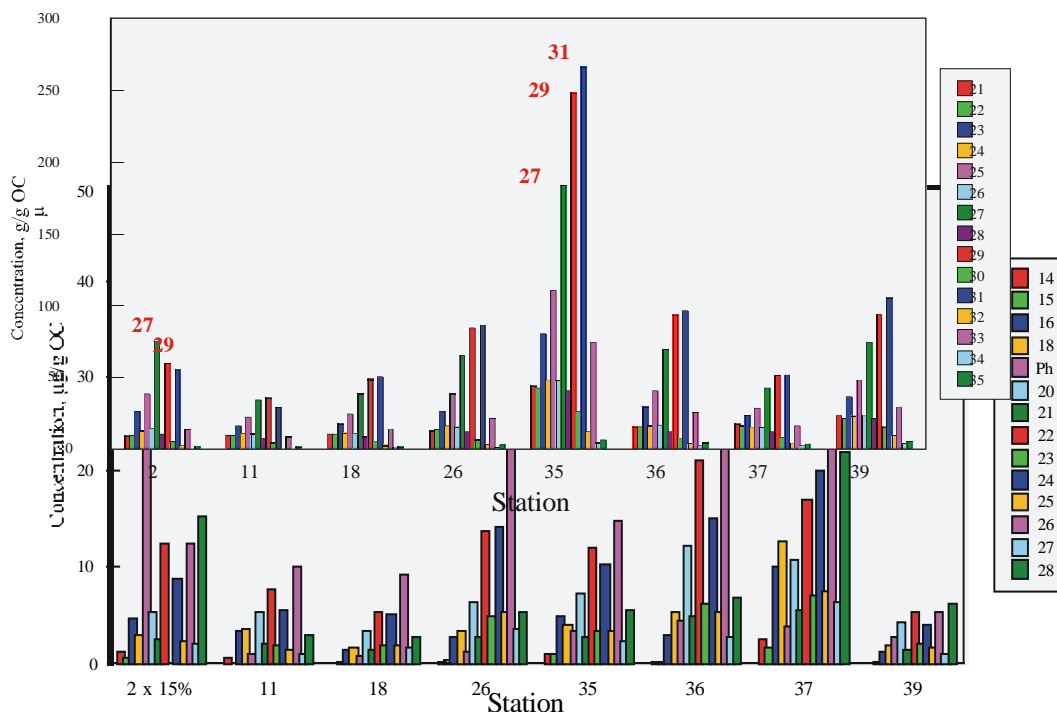


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highlights the need for close coordination of with physical and geochemical measures in any planned activities.

An example of the differences observed can be seen among the n-alkanes hydrocarbons which have a well-defined predominance of odd over even carbon chains which maximize at C27 or C29 in shelf samples (Fig. 2). Such distributions are very characteristic of input by higher plants. The shift to increased amounts of the C31 in the Arctic Basin may reflect the preferential transport offshore of low-density peat particles by nepheloid brines and drifting sea-ice (Yunker et al., 1993; Schubert and Stein, 1996; Fernandes and Sicre, 2000).

Figure 2 - n-Alkanes



As a marker of marine derived algal organic matter, the isoprenoid alcohol phytol is the major saturated alcohol in the Chukchi Sea, while other higher n-alcohols dominate in the basins (see Fig 3). Other higher n-alcohols (C22-C28) have a pronounced even-carbon predominance and overshadow the lower alcohols (C14-C20) at all locations, even on the Chukchi shelf.

While a dominance of higher carbon length alcohols is often considered indicative of a terrigenous origin, principal components analysis shows that the n-alcohols do not covary with the alkanes (unlike the Beaufort Sea; Yunker et al., 1995) and represent multiple sources. Other markers which show important differences and appear as important markers are the fatty acids (Harvey and Macko, 1997) and sterols which show complicated patterns and strong gradients among the transects.

Multiple regression models using principal components analysis has already shown a clear separation between a large number of autochthonous alcohols, sterols, and fatty acids that dominate on the Chukchi shelf and the allochthonous hydrocarbons and soil derived organic markers that predominate in the basin samples. It is apparent that physical processes which affect transport and nutrient cycling directly influence biogeochemical cycles over the shelf, slope, and deep basin, and this is reflected in the molecular distribution of organic preserved in

sediments. By integrating biomarker composition with biological and physical properties in the contrasting Chukchi and Beaufort Seas, field process studies may be able to follow the cycling of marine organic carbon, as well as compare its longevity in a system diluted by substantial terrestrial organic inputs.

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