Episodes of ice rafted debris and their effects on primary productivity in the Labrador Sea for the past 31,000 years

A.N.N. Muzuka

GEOTOP, Université du Québec à Montréal, C.P. 8888, Montréal, Québec, Canada H3C 3P8.

Introduction

The Pleistocene has undergone abrupt climatic changes from cold to warm periods within short time intervals as revealed by ice core records (e.g. Dansgaard *et al.*, 1993). These climatic changes have been associated with growth and decay of the Laurentide and Greenland ice sheets as well as changes in the magnitude of deep water formation (Hay, 1993). During disintegration of the Laurentide ice sheet, enormous amounts of fresh meltwater and ice rafted debris were introduced to the northern Atlantic through the Gulf of St. Lawrence and the Hudson Strait (Teller, 1990; Bond *et al.*, 1992).

Although episodes of high input of ice rafted debris have been reported based on grain size distributions and calcium carbonate contents (Hillaire-Marcel *et al.*, 1994 and references therein), the stable isotopic compositions of organic carbon and nitrogen have not been used as a tool to characterize these episodes. Furthermore, detailed documentation of primary productivity response to the episodes of iceberg and meltwater input to the Labrador Sea using stable isotopes is lacking. Therefore, the stable isotopic compositions of organic carbon and nitrogen in conjunction with content of organic carbon and $CaCO_3$ for piston core HU-91-045-94 (50°12.26'N, 45°41.14'W and 3440 m water depth) in the southern Labrador Sea, are used to document changes in the type and source of organic matter input, variation in primary productivity and episodes of ice rafted debris deposition for the last 31 kyrs. The chronology of the core has been obtained using both ^{14}C AMS dating and oxygen isotopes (Hillaire-Marcel *et al.*, 1994).

Results and discussion

The $\delta^{13}C$ and $\delta^{15}N$ values for the analyzed upper 640 cm, which averages -23.6 ± 1.1‰ and 6.8 ± 0.8‰ respectively, indicate signifiacant input of terrestrial organic matter in the area especially during glacial and transition periods. Transport of allochthonous material by icebergs and turbidity currents can be invoked as the causes of high proportion of terrestrial organic matter in the area.

Intervals of massive deposition of ice rafted debris, which are characterized by low values of $\delta^{13}C$ and $\delta^{15}N$, high content of $CaCO_3$ and low content of organic carbon, occurs at depths of 238-246 cm (H1), 340–390 cm (H2) and 550–600 cm (H3). These episodes of ice rafted debris deposition now known as Heinrich events (Bond *et al.*, 1992), is further supported by high content of coarse fraction >150 microns, and low abundances of planktonic foraminiferas at this site (Bilodeau *et al.*, 1994; Hillaire-Marcel *et al.*, 1994). Owing to high $CaCO_3$ content, the ice rafted debris were derived from the eastern Canada, especially Hudson Bay, where extensive palaeozoic carbonate deposits exist. During deposition of ice rafted debris, primary productivity in the Labrador Sea was depressed or completely shut down since all Heinrich events are marked by high proportion of terrestrial materials as well as low abundance of benthic and planktonic foraminifers (Bilodeau *et al.*, 1994).

The stable isotopic compositions of organic carbon and nitrogen indicate two other major events namely: the Young Dryas (170–180 cm) and turbidite or Heinrich event? (460–470 cm). Based on inverted ^{14}C AMS ages, the event at 460–470 cm depth interval has been interpreted as turbiditic (Hillaire-Marcel *et al.*, 1994). However, this event could as well correlate with Heinrich event H2a inferred from ice core records by Mayewski *et al.* (1994).

Results of this work also show relatively low $\delta^{13}C$ and $\delta^{15}N$ values of organic matter around 8.4 kyrs (120–135 cm), an indication either of massive input of freshwater or initiation of the western boundary undercurrent. The slightly low $\delta^{18}O$ values around 8.4 kyrs may be an indication of input of freshwater resulting from the final stages of disintegration of the Greenland and Laurentide ice sheets.

The organic carbon content which averages 0.35%, do not show significant differences in organic carbon content between glacial and interglacial periods. However, using a two component mixing equation, (−21‰ and −26‰ as end-members) the core section above 100 cm, which corresponds to the interglacial period contains high proportion of marine organic matter. The $CaCO_3$ content which average 20.74% is higher in the interglacial core section than during glacial period. High proportion of marine organic matter and high content of $CaCO_3$ in Holocene is an indication of increased primary productivity owing to improvement in climatic condition and high nutrient input.

Conclusion

This study highlighs the usefulness of stable isotopes of organic carbon and nitrogen in identifying Heinrich events in the Labrador Sea. The glacial sediments are dominated by high proportion of terrestrial material and primary productivity was greatly reduced during massive input of meltwater and ice rafted debris.

References

Bilodeau, G. *et al.* (1994) *Canad. J. Earth Sci.*
Bond, G. *et al.* (1992) *Nature*, **360**, 245–9.
Dansgaard, W. *et al.* (1993) *Nature*, **364**, 218–20.
Hay, W. W. (1993) *Ann. Rev. Earth Planet. Sci.*, **21**, 227–54.
Hillaire-Marcel, C. (1994) *Canad. J. Earth Sci.*
Mayewski, P. A. (1994) *Science*, **263**, 1747–51.
Teller, J. T. (1990) *Quaternary Res.*, **34**, 12–23.