Oxygen consumption rates in the shelf and slope sediments of the western Arctic

BONNIE CHANG[1], ALLAN DEVOL[1] AND JOHN CHRISTENSEN[2]

[1]Sch. of Oceaongraphy, Univ. of Washington (devol@u.washington.edu; bchang@ocean.washington.edu)
[2]Bigelow Laboratory (jchristensen@bigelow.org)

Despite the harsh environment in the Arctic, the region supports enough production to fuel substantial benthic respiration rates on the shelves and slopes. Since the Arctic contains approximately 25% of the world's continental shelf, biogeochemical processes that occur in it are thought to be significant though are not well studied due to limitations on accessibility to those areas.

This study examines oxygen consumption rates in the shelf and slopes of the western Arctic. In two cruises in the summer and spring of 2002 and 2004, respectively, profiles of oxygen concentrations in the shelf and slope sediments of the Chukchi and Beaufort Seas were measured by microelectrode. Measurements were made along 4 transects going from shelf to off slope (50-3000 m), each transect having different overlying water characteristics. Oxygen penetration depths ranged from as little as 3 mm in shallow sediments to over 20 cm in deep waters. Oxygen consumption rates calculated from the measured profiles were found to decrease with increasing water depth. Rates varied from about 15 mmol O_2/m^2 d for the shallow sediments to 1.6 mmol O_2/m^2 d in the deep. Oxygen consumption rates were found to vary between the two seasons which is not surprising considering the stark dichotomy of the overlying water conditions in the Arctic from spring to summer which result in unequal amounts of organic carbon reaching the sediments. This seasonal variation was more pronounced in the shallow water sediments, probably due to their increased sensitivity, relative to the deep, to the different amounts of organic carbon reaching the sediments in the spring versus the summer. Comparing the rates calculated in this study to rates obtained on the well characterized, very productive Washington state continental margin it was found that the consumption rates in the shallow waters of the western Arctic are generally lower. However, the rates of all four Arctic transects and the WA margin are comparable in the deeper waters.

Oxygen isotope fractionation in marine sediments during respiration

HILAIRY HARTNETT[1], ALLAN DEVOL[2], JAY BRANDES[3], AND BONNIE CHANG[2]

[1]Depts. of Geological Sciences and Chemistry & Biochemistry, Arizona State Univ. (h.hartnett@asu.edu)
[2]Sch. of Oceaongraphy, Univ. of Washington (devol@u.washington.edu; bchang@u.washington.edu)
[3]Marince Science Inst., Univ. of Texas at Austin (brandes@utmsi.utexas.edu)

Net community respiration of aerobic bacteria in sediments is predicted to have an isotopic fractionation factor of $\varepsilon = 9‰$ ($\alpha = 0.991$). This value is smaller than the fractionation determined for free-living aerobic bacteria ($\varepsilon = \sim 18‰$), due to the diffusive limitation inherent to an essentially two-dimensional sedimentary system. Previous measurements of the metabolic oxygen isotope fractionation in suboxic to anoxic sediments showed no oxygen isotope fractionation when the oxygen concentration is reduced to zero at the respiriing site.

We present direct mesurements of net community oxygen consumption and the isoptopic fractionation of oxygen in sediment core incubations. Cores were collected from the Washington State continental margin and the continental margin off the coast of Texas in the Gulf of Mexico. These sites represent a range of depths, bottom-water oxygen conditions, organic carbon rain rates, organic carbon oxidation rates, and sedimentary organic carbon contents. Oxygen consumption ranged from ~20 to 40 percent of the initial oxygen concentrations. Oxygen isotopic composition changes over the course of the experiments ranged from 1.7‰ to 5.9‰, corresponding to a fractionation factor of $\varepsilon = 6$ to 10‰ (assuming this is a closed system which can be modeled using Rayleigh fractionation kinetics). We hypothesize that the expression of the oxygen isotope fractionation is a funtion of the degree to which oxygen limits the aerobic respiration rate.

References

Bender, M. (1990) *J. Geophys. Res.* **95**(C12), 22,243-22,252.
Brandes, J. and Devol, A. (1997) *Geochim. Cosmochim. Acta.* **61**(9), 1793-1801.