Author : Allan H. Devol
Address: School of Oceanography, Box 355351
University of Washington
Seattle, WA. 98195
Phone: 206-543-1292
e-mail: devol@u.washington.edu

Data questions: Same as author.

Funding source and Grant Number

NSF grant# 0612436, Collaborative Research: BEST: Denitrification and global change in Bering Sea shelf sediments.

Data set Overview:

The high productivity in the Bering sea coupled with shallow water depths over the shelf result in a large fraction of the productivity reaching the sediments. This fuels the productive benthic ecosystem there. It also results in high benthic oxygen consumption and denitrification rates. The goal of our project is to look at the benthic geochemistry in the BEST study region, especially the benthic cycling of nitrogen. We hypothesize that the tight coupling of surface productivity and the benthic community results in considerable denitrification in the sediments and that this denitrification acts as a negative feedback control on productivity. We also hypothesize that the denitrification rate will be highest at intermediate levels of sedimentary marcofauna. Low macrofaunal densities will limit benthic irrigation and thus within sediment nitrification rates thus limiting the nitrate supply available for denitrification. However, if irrigation rates are too high then irrigation of oxygen into the sediments will begin to limit denitrification. This report contains the pore water nutrient data from several BEST cruises: HLY–0701, HLY-0802, HLY-0803, HLY-0902, KN195-10, TN-249, and TN-250.

Sample collection

Sediment cores were retrieved from the bottom using an Ocean Instruments MC800 multicore. This instrument collected up to 8, 10-cm i.d. cores varying in length from 20 to 60 cm in clear poly-carbonate tubes, depending on the sediment type. At each station the multicore was deployed multiple times in order to collect the number of cores required for all analysis. All cores were stored refrigerated until use. Only cores with clear sediment-water interfaces were used in experiments.

Analytical methods

Benthic oxygen (and Nitrogen gas) fluxes were determined by several methods; not all methods were used on all cruises. Simple molecular fluxes of oxygen across the sediment water interface were estimated from pore water dissolved oxygen profiles determined using a Unisense ® polarographic oxygen micro-electrode. For pore water oxygen profiles one core from the multi core was selected and subcored into a 5 cm id by about 25 cm subcore, being careful to retain about 2 cm of overlying water. Pore-water oxygen profiles were then measured by oxygen microelectrode immediately. The electrode was mounted in a manual micromanipulator and the oxygen electrode was inserted into the core in 0.5 mm steps. The oxygen electrode was calibrated using a saturated seawater solution (~32 psu) and the same solution deoxygenated

using sodium sulfite. Details of the method can be found in Revesbech (1989) Pore water oxygen profiles were the fit using the model of Berg et al (1998) to yield benthic oxygen fluxes (Benthic oxygen consumption). These calculations yield minimum estimates of fluxes because they do not include the effects of macro-organisms. The second method used to determine sediment oxygen uptake, as well as, denitrification rate was core incubation coupled to membrane inlet mass spectrometry (MIMS; Kana et al. 1998). For this method 2 or 3 cores from the multicore were subcored into 7.5 cm i.d by 25 cm subcore. Cores were allowed to equiblirate with the cold-room temperature (~2^{o}C) for 18-24h and then 80-90% of the overlying water was removed and replaced with bottom water that was also equilibrated with the cold-room temperature. Cores were then capped with PVC caps that had O-ring seals in such a way that no air bubbles were trapped. Each cap contained a magnetically coupled teflon stirring bar and two valve ports, one for removal of sample and one for replacement of sample water with bottom water that was contained in reservoir connected to the cap by a nylon tube. After 15-30 min of equilibration an initial measurement was made by connecting the sampling outlet tube the stainless steel inlet tube for the MIMS system. An oxygen optode was mounted inline between the incubation core and the MIMS. A peristaltic pump on the outlet side of the MIMS inlet drew sample water from the incubation core past the optode and into the MIMS. In total about 5 ml of sample water were drawn out of the incubation core, which was replaced from the bottom water reservoir. The 5 ml sample volume represented about 1% of the water overlying the incubation core (~500 ml). In this way both an optode oxygen measurement and a MIMS oxygen measurement were made simultaneously. Agreement between the two measurements was generally excellent. The MIMS system also gave measurements of N2 gas concentrations so N2 fluxes (denitrification) could also be calculated. Benthic oxygen fluxes were calculated by fitting a 2nd order polynomial to the oxygen concentration versus time data and differentiating and solving the resulting equation for Ti, the initial slope at the beginning of the incubation (Chang and Devol, 2009). Finally, for selected cores initial and final time points were drawn for isotope ratio mass spectrometry (IRMS) analysis of O2 and N2. Samples were drawn into pre-evacuated, pre-poisoned sample flasks that were returned to the University of Washington Stable Isotope Laboratory for analysis after the cruise (Method described in Chang and Devol (2009). These samples also supplied data from which oxygen consumption and denitrification could be calculated. For these samples only the initial and final time points were available for rate calculation.

Finally, we also report sulfate reduction rates. Rates were measured using 35SO4 as described in Fossing et al., 1989 and modified by Hartnett and Devol, 2002. Sulfate reduction rates are presented as the integrated rate (mmoles m-1d-1) over the depth of sampling (10-40 cm, depending on depth of cores). And the average sulfate reduction rate (mmoles/m3/d).

Data Set Overview.

File structure: comma delimited ASCII text
Naming convention: PI name_Program_Cruise_data type (Devol_BEST_HLY 0701_SedimentRates.txt)
Data layout: header row1, Cruise
header row2, variable1, variable 2, etc
header row3, units for variables
Data rows (variable number depending on number of stations, usually about 20)
Missing data designator -99

References.

Berg,P., Risgaard-Peterson,N., Rysgaard, S, 1998. Interpretation of measured concentration profiles in sediment pore water. Limnology and Oceanography, 43:1500-1510.

Chang,B. and Devol, A. 2009. Seasonal and spatial poatterns of sedimentary denitrification rates in the Chukchi sea. Deep-Sea Res. II. 1339-1350.

Fossing H. and Jorgensen B. B. (1989) Measurement of bacterial sulfate reduction in sediments: Evaluation of a single-step chromium reduction method. *Biogeochemistry* 8: 205-222.

Hartnett, H.E. and Devol, A.H. 2003. Role of a strong oxygen deficient zone in the preservation and degradation of organic matter: a carbon budget for the continental margins of NW Mexico and Washington State. *Geochimica et Cosmochimica Acta*. 67: 247-264.

KanaT.M., Sullivan,M.B., Cornwell,J.C., and Groszkowske K.M. (1998) Denitrification in sediments determined by membrane inlet mass spectrometry. *Limnology and Oceanography* 43: 334-339.

Revesbak, N.P. 1989. An oxygen microsensor with guard Cathode. Limnology and Oceanography, 34:374-378.