Final Report for

"Sources and Turnover Times of Dissolved, Colloidal and Particulate Organic Carbon in the Middle Atlantic Bight and Chesapeake Bay" (PIs J. Bauer, VIMS, Grant no. DE-FG05-94ER61833 A002 and E. Druffel, UCI, Grant no. DE-FG03-95ER62063) 2

Current and On-Going Work

Radiocarbon (^{14}C) and stable carbon (^{13}C) isotopic natural abundances have been measured in over 307 samples of dissolved organic carbon (DOC), suspended particulate organic carbon (POC), colloidal organic carbon (COC), and dissolved inorganic carbon (DIC) in seawater collected from Mid-Atlantic Bight (MAB) shelf and slope waters between Long Island and Cape Hatteras in April-May 1994 (R/V Columbus Iselin cruise) and March 1996 (R/V Endeavor cruise), and August 1996 (R/V Seward Johnson cruise). This dataset represents the largest spatial and temporal assemblage of natural radiocarbon measurements of marine organic matter ever conducted in a single research program (i.e., DOE's Ocean Margins Program). Results to date are as follows:

- a. Carbon isotopic evidence suggests that ocean margins are sources of both ^{14}C -enriched and ^{14}C -depleted DOC and of ^{14}C -depleted POC to this region of the interior ocean.
- b. Young, ^{14}C -enriched DOC of shelf and shallow slope waters contains a terrestrial component (i.e., low $\delta^{13}\text{C}$) that persists throughout the entire MAB.
- c. Deep (300-1000 m) slope waters contain old, ^{14}C -depleted marine DOC and POC (i.e., higher $\delta^{13}\text{C}$), possibly the result of lateral advection of eroded, ^{14}C -depleted slope sediments and pore waters.
- d. Carbon isotopic values indicate that the northwest Atlantic margin can introduce relic (^{14}C -depleted) DOC and POC to the interior ocean basin. The origin of this relic material is likely derived from resuspended sediment from shelf and slope regions.
- e. Relatively ^{14}C -depleted DIC confirms that an older source of DIC exists in some MAB slope waters, and possibly arises from a component of older upwelled waters originating in Antarctic Intermediate Water (AAIW) or Antarctic Bottom Water (ABW) or Labrador Sea Water (LSW) as has been previously observed by other workers.

The final geochemistry cruise of this program was conducted aboard the R/V Seward Johnson in August 1996, during which the same transects and stations were occupied as during the March 1996 geochemistry cruise. Taken in total, these three cruises will evaluate the temporal variability (seasonal and intra-annual) in DOC and POC pool sizes and isotopic signatures, their radiocarbon ages and residence times, and, using general mass-balance models, the relative fluxes of these forms of organic matter along and across the MAB to open ocean waters. In addition, vertical profiles of colloidal organic carbon (COC) were also collected at all of the deepest MAB shelf stations to evaluate the role of colloids in carbon partitioning.

Work has also been conducted in the York River estuary, a major subestuary of the Chesapeake Bay. Samples have been collected along the York River estuary salinity gradient on a seasonal basis for $\Delta^{14}\text{C}$ and $\delta^{13}\text{C}$ analyses in order to identify the major sources (terrestrial vs. marine, young vs. old) and radiocarbon ages of DOC and POC being transported to the Chesapeake and subsequently to the MAB. Microbial incubations have also revealed the proportion and radiocarbon ages of this estuarine DOC that is labile and the isotopic signatures of the highly labile and relatively refractory forms of DOC in this system that are both utilized within the York and available for export to the MAB.

Products of the Research

This work has resulted in the publication of one *Nature* paper, with three other manuscripts being submitted and prepared for publication. Fifteen abstracts and talks at international meetings have presented the results of this component of the Ocean Margins Program. Both publications and meeting abstracts are listed below.

~~We have no objection from a patent standpoint to the publication or dissemination of this material.~~

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MP Druffel 6/16/2000
Office of Intellectual Property Counsel Date
DOE Field Office, Chicago

Publications

- Bauer, J.E. and E.R.M. Druffel. 1998. Ocean margins as a significant source of organic matter to the deep open ocean. *Nature* 392: 482-485.
- Raymond, P.R. and J. E. Bauer. Estimation of net productivity in the York River Estuary using inorganic carbon measurements. Submitted to *Limnology and Oceanography*.
- Bauer, J.E., E.R.M. Druffel, D.M. Wolgast and S. Griffin. Sources and apparent radiocarbon ages of dissolved and particulate organic carbon in the Middle Atlantic Bight. In preparation for *Geochimica et cosmochimica Acta*.
- Raymond, P.R. and J.E. Bauer. Ages of dissolved and particulate organic matter transported by temperate rivers to the western North Atlantic Ocean. In preparation for *Science*.

Meeting Abstracts

- Bauer, J.E., E.R.M. Druffel, D.M. Wolgast, S. Griffin and P.M. Williams. 1994. Isotopic (^{13}C and ^{14}C) signatures of dissolved organic carbon on the northeast US continental shelf. AGU Fall Meeting, San Francisco, CA.
- Druffel, E.R.M., J.E. Bauer, S. Griffin, C. Masiello, D.M. Wolgast and M. Kashgarian. 1996. Sources of carbon to the Middle Atlantic Bight, Western North Atlantic Ocean: A perspective from ^{14}C studies. Ocean Sciences Meeting (AGU/ASLO), San Diego, CA.
- Bauer, J.E., E.R.M. Druffel, D. M. Wolgast and S. Griffin. 1997. Role of ocean margins in global ocean carbon fluxes: Evidence from radiocarbon studies. ASLO Aquatic Sciences Meeting, Santa Fe.
- Raymond, P. and J.E. Bauer. 1997. Microheterotrophic respiration of dissolved organic matter in the York River estuary. ASLO Aquatic Sciences Meeting, Santa Fe.
- Bauer, J.E., J. Cherrier, E.R.M. Druffel and R.B. Coffin. 1997. Radiocarbon signatures of bacterial nucleic acids and their relationship to carbon substrates in marine waters. XVI Radiocarbon Conference, Groningen, The Netherlands.
- Moore, T., P. Raymond and J.E. Bauer. 1997. Diel Changes in pCO_2 in the York River Estuary. Estuarine Research Federation Annual Meeting, Providence, RI.
- Jestel, E.A., A.N. Loh and J.E. Bauer. 1997. Distribution and fractionation of dissolved organic nitrogen and phosphorus in the York River Estuary. Estuarine Research Federation Annual Meeting, Providence, RI.
- Bauer, J.E. 1997. Carbon isotopes (^{14}C and ^{13}C) in DOM of ocean margins: Implications for open ocean carbon cycling. Gordon Conference on Chemical Oceanography, Meredith, NH. (Invited).
- Bauer, J.E., E.R.M. Druffel, S. Griffin and D.M. Wolgast. 1998. Temporal variability in the radiocarbon signatures of dissolved and particulate organic carbon in the Middle Atlantic Bight. Ocean Sciences Meeting, San Diego.
- Raymond, P. and J.E. Bauer. 1998. Stable and radiocarbon isotopic composition of DOC in the York River Estuary, Virginia. Ocean Sciences Meeting, San Diego.
- Cherrier, J.C., J.E. Bauer, E.R.M. Druffel, R.B. Coffin and J.P. Chanton. 1998. Radiocarbon in estuarine and oceanic bacteria: evidence for the age of assimilated organic matter. Ocean Sciences Meeting, San Diego.
- Schrope, M.K. and J.E. Bauer. 1998. Dissolved organic C, N, and P in estuarine porewaters. Ocean Sciences Meeting, San Diego.
- Raymond, P.R. and J.E. Bauer. 1999. Estimation of net metabolism in the York River Estuary using inorganic carbon measurements. ASLO Aquatic Sciences Meeting, Santa Fe.
- McCallister, S. L., J. E. Bauer and H. W. Ducklow. 1999. Bioavailability of dissolved organic matter in the York River Estuary: an enzymatic and stoichiometric study. ASLO Aquatic Sciences Meeting, Santa Fe.
- Bauer, J. E., P. R. Raymond, and D. M. Wolgast. 1999. ^{14}C and ^{13}C evidence for the utilization of terrigenous DOC in estuaries. ASLO Aquatic Sciences Meeting, Santa Fe.

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