PERGAMON

Continental Shelf Research 19 (1999) 2019–2040

CONTINENTAL SHELF RESEARCH

Dissolved and particulate trace metal fluxes through the central English Channel, and the influence of coastal gyres

P.J. Statham[a,*], S. Leclercq[b], V. Hart[a], M. Batté[a], Y. Auger[b], M. Wartel[b], J. Cheftel[a]

[a]*School of Ocean and Earth Science, University of Southampton, Southampton Oceanography Centre, European Way, Southampton SO14 3ZH, UK*

[b]*Laboratoire de Chimie Analytique et Marine, Université des Sciences et Technologies de Lille I, 59655 Villeneuve d' Ascq, France*

Received 20 March 1998; received in revised form 2 February 1999; accepted 23 March 1999

Abstract

Measurements of dissolved Cd, Co, Cu, Mn, Ni, Pb, and Zn have been made on a seasonal basis at five stations on a north–south transect across the central English Channel between Cherbourg and the Isle of Wight. Vertical and horizontal distributions of dissolved Cd, Pb, Cu and Zn are relatively uniform except for sampling sites near the English coast. Dissolved Mn and Co show increased concentrations in the English coastal waters, and for Mn the seasonal trend in concentration follows the pattern seen in the Strait of Dover with higher values in the late summer. Ni and Cu are higher in concentration on the English side, which reflects mainly riverine sources. Measurements were also made of particulate forms of the metals above plus particulate Al, Ca, Fe, Mg, Sr and Ti. Water column concentrations of particulate metals broadly follow the distribution of suspended particulate matter, with highest concentrations near the UK coast. Trace metal concentrations have been integrated with modelled data on fluxes of water to provide estimates of fluxes for these elements into the eastern Channel, and an initial comparison is made with data for fluxes of metals through the Strait of Dover obtained during an earlier study. A major influence on the fluxes of particulate metals through the Isle of Wight-Cherbourg transect is the gyre system to the South east to the Isle of Wight, which has important east to west as well as west to east transport components. For those elements where the dissolved form of the metal dominates, the large flow of water in the central Channel waters leads to major fluxes of the metals towards the east and the Strait of Dover. However, the high suspended particulate matter loadings in the coastal waters and impact of the gyre system lead to net east to west fluxes of particulate Al, Fe, Mn and Ti. Comparison of these fluxes with data

* Corresponding author. Tel.: + 44-23-8059-2679; fax: + 44-23-8059-3059.
E-mail addresses: peter.j.statham@soc.soton.ac.uk (P.J. Statham)

0278-4343/99/$ - see front matter
PII: S0278-4343(99)00051-5

on the net west to east transport of these materials through the Strait of Dover infers that there must be a significant supply of these particulate metals to the eastern Channel.

Keywords: Trace metals; Fluxes; Gyres; FLUXMANCHE II; Northwest European Shelf; English Channel

1. Introduction

The coastal zone is a key area in the transfer of metals from rivers to the open ocean (Martin and Windom, 1991). A range of processes can occur here (Balls, 1988; Kersten, 1988; Burton et al., 1993) including removal of dissolved forms by uptake on both biotic and abiotic particles, and exchange of dissolved and particulate across the water–sediment interface. The importance of these processes will depend on the biogeochemical pathways and reactivity of the individual metal concerned, but the general view is that the coastal shelf system acts as a significant removal filter in the transfer of metals to the open ocean (Martin and Windom, 1991). These coastal cycling and removal processes thus have important implications for the transport and long-term fate of natural and anthropogenic metals introduced from the land. The study described here formed part of the larger interdisciplinary, European Union funded, programme FLUXMANCHE II, and its main objectives were to study concentrations and distributions of dissolved and particulate metals across the central English Channel in relation to sources, to look for seasonal changes in metal distributions, and to estimate metal fluxes through the section by combining metal data with modelled water flows. As the net water flux through the Channel is from west to east, these new metal flux data have allowed a comparison with earlier estimates of metal fluxes through the Strait of Dover to the east (Statham et al., 1993), and can thus potentially give information on input and removal processes in the eastern Channel.

2. Sample collection

The positions of the five sampling sites across the Channel (Stations FX7–FX11) are given in Table 1, and these locations are shown in Fig. 1. Sampling for dissolved and particulate trace metals was divided between the University of Lille and Southampton University Department of Oceanography (SUDO) groups. The Lille group sampled on five cruises in September 1994, November 1994, May 1995, July 1995 and September 1995. Samples were collected by the SUDO group on cruises in September 1994 (duplicates taken for inter-calibration), January 1995, March 1995, October 1995, and May 1996. Similar sampling methods, storage, and precautions to prevent contamination were used by both groups.

Precautions against contamination which were developed for open ocean trace metal work were applied throughout the work. Samples were collected at 5 m below