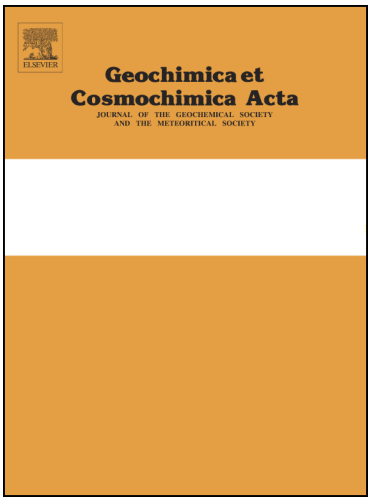

Labile organic carbon dynamics in continental shelf sediments after the recent collapse of the Larsen ice shelves off the eastern Antarctic Peninsula: A radiochemical approach

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Labile organic carbon dynamics in continental shelf sediments after the recent collapse of the Larsen ice shelves off the eastern Antarctic Peninsula: a radiochemical approach.

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Abstract

Labile organic carbon (LOC) dynamics (i.e., of recently produced, planktonic material) and sediment dynamics were studied in the seabed using naturally occurring $^{14}C_{org}$ and ^{210}Pb measurements in the region where the Larsen Ice Shelves A and B were floating almost two decades ago. A non-steady-state diagenetic model was used to estimate sediment mixing coefficients as well as LOC fluxes to the seabed and LOC turnover times (i.e., mean residence times) in a suite of 14 sediment cores from the continental shelf, including a glacial trough. At four of the stations, cores were collected during 2007 and 2011 cruises, enabling a time-series approach for understanding the evolution of sedimentary processes and LOC dynamics in the deposits below a collapsed ice shelf. Sediment mixing coefficients, based on non-steady-state ^{210}Pb profiles, varied between 0.01 cm^{-2} y^{-1} and 1.6 cm^{-2} y^{-1} in these post-ice shelf sediments. These values were similar to those found in polar deep-sea environments, where sedimentary conditions are less dynamic than in shallower provinces. LOC, whose abundance decreased uniformly with depth, was detected to depths ranging from 2 to 16 cm, with LOC seabed inventories varying from 1.5 to 22 mg LOC cm^{-2}. Excess ^{210}Pb and LOC fluxes were relatively uniform across the study area suggesting that similar particle fluxes have taken place within the Larsen system since the disintegration of the various ice shelves. The LOC mean residence time at the different stations varied from 3 y to >60 y. The $^{14}C_{org}$ approach, calculating LOC content based on a two-end member model with planktonic $^{14}C_{org}$ as the labile carbon end member, most closely correlated with the lipid content of the sediment, which has been considered one of the best descriptors of reactive organic matter readily available to benthic consumers. We suggest that the irregular combination of sea ice coverage, organic matter production and supply to the sea floor introduce scatter in the determination of sediment and LOC dynamics such that short-term temporal (<5 years) and spatial trends could not be readily resolved.

Introduction

In 1995 and 2002, sections A and B of the Larsen ice shelf (eastern Antarctic Peninsula) collapsed, uncovering thousands of square kilometers of the continental shelf (Skvarca et al., 1993; 1999; Domack et al., 2005). In addition to natural ice shelf advances and retreats, these late events have been associated with anthropogenic global warming (Vaughan et al., 2001; Marshall et al., 2006), which accelerates the reduction of the ice shelf thickness and enhances the retreat of the glacier front (Shepherd et al. 2003; Cook et al. 2005; Wingham et al., 2009). Under ice shelves, primary production is negligible as is the consequent flux of fresh organic matter to the sea floor (Littlepage and Pearse, 1962; Lipps et al., 1972). Primary production in the Larsen A and B bays started developing after the ice shelf collapse, which allowed light penetration into the sea surface, enabling