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SILICA RETENTION IN THE SCHELDT CONTINUUM AND ITS IMPACT ON COASTAL EUTROPHICATION

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CONTEXT

Anthropogenic activities have significantly increased the riverine fluxes of N (nitrogen) and P (phosphorous) to the coastal zones. In contrast, the major land source of dissolved Si (silicon) is through chemical weathering of silicate minerals and dissolved Si inputs to aquatic systems have barely been altered. The excess delivery of N and P, compared to Si, has led to profound modifications of the phytoplankton succession and has thus perturbed significantly many coastal ecosystems.

The Si retention in the river-estuary-coastal zone continuum, a selective and efficient filter for nutrients, is poorly known at present time owing to our insufficient understanding of the processes affecting the biogeochemical cycling of Si. The processes controlling the Si riverine flux deserve thus a better quantification in order to evaluate its impact on primary production and on the further alteration of the marine food web.

PROJECT DESCRIPTION

Objectives
The overall objective of the project is to elucidate the biogeochemical cycling of Si and its anthropogenic perturbations in the river-estuary-coastal zone continuum of the Scheldt. We aim, in particular, at identifying the sources and sinks of Si in the aquatic continuum, and at quantifying the major processes controlling the biogeochemical behaviour of Si in the water column and in the sediments. The results will be used to assess the budget of Si and its fluxes carried by the Scheldt to the Southern Bight of the North Sea.

Methodology
In order to achieve the aims, the present research will be carried out by combining 1) analyses of historical data, 2) field surveys and laboratory investigations, and 3) model developments.

A Si database will first be constructed and its analysis will allow the evaluation of the historical evolution of the concentration of this nutrient along the Scheldt continuum. A series of fundamental physico-chemical and biological parameters will be measured in the dissolved and particulate phases along the continuum during the first two years. Pore water profiles of dissolved Si (DSi) and biogenic Si (BSi) contents in sediments will be determined to quantify the transformation of Si occurring during early diagenesis.

In addition to field surveys, biogeochemical processes controlling the production, regeneration and retention of BSi will be studied both in the field and in the laboratory using natural samples and cultured diatoms. Incorporation experiments of ^{14}C and ^{32}Si will be conducted to estimate the primary production versus diatom production. Dissolution assays of BSi will be carried out to evaluate the regeneration rate of this biogenic element. The diagenetic processes will also be studied to assess the DSi fluxes across the sediment-water interface.

Finally, a Si module will be developed and implemented within an existing coupled hydrodynamic and biogeochemical model (CONTRASTE), originally developed to estimate long-term fluxes of reactive species in strong tidal estuaries. The improved model will allow us to assess the reduction in Si fluxes along the Scheldt continuum and to evaluate its impact on coastal eutrophication by modifying the marine food web in the Southern Bight of the North Sea.

Interaction between the different partners
The co-ordinator, the Laboratory of Chemical Oceanography and Water Geochemistry at the University of Brussels (ULB-LOCGE), will focus its efforts on studying processes controlling the production, regeneration and retention of BSi in the water column and in the sediments.

The Laboratory of Protistology and Aquatic Ecology at the University of Gent (RUG-LPAE) is responsible for investigating diatom dynamics and the role of microbial activity on the regeneration of BSi. It will also be in charge of the diatom culture collection and its maintenance.

The department of Geochemistry at the Utrecht University (UU-GEO) is the European collaborator in the project. It is the leading partner for the modelling of Si biogeochemical cycle in the Scheldt continuum.

Link with international programmes
The link with international programmes will be made through our collaboration with the foreign members of the Users Committee:

- Prof. Hamborg is co-ordinating a EU project "SIBER" on the Si biogeochemical cycle in the Baltic

Sea Ecosystem. He is also actively involved in SCOR and IGBP-LOICZ who recently stressed the important role of Si in regulating coastal food webs.

- Dr. Conley, also a partner in SIBER, has the expertise in Si biogeochemistry and coastal eutrophication. He is participating in a EU funded research training network "Si-WEBS" to which the present network will be associated.
- Dr. Garnier has been actively involved in the French PIREN programme of the Seine basin on nutrient biogeochemistry and will provide knowledge in the diatom and Si dynamics.
- Dr. Middelburg will collaborate in the framework of a Dutch-Flemish project, aiming at studying the carbon and nitrogen dynamics in the Scheldt estuary.

Expected results and/or products

The following research results are expected from the project:

- A database of existing historical data on dissolved Si, other nutrients and related parameters incorporating the results acquired in the present project.
- A comprehensive understanding of the Si biogeochemistry in the Scheldt continuum.
- Parameterisation of rate constants for processes controlling the production, regeneration and retention of Si in the Scheldt continuum.
- A Si diagenetic model for the quantitative assessment of the recycling efficiency, the burial flux and thus the retention of Si in contrasting estuarine sediments.
- An improved transport-reaction model with the implementation of a new Si module, allowing the prediction of Si fluxes delivered by the Scheldt to the Southern Bight of the North Sea.

PARTNERS

Activities

ULB

The Laboratory of Chemical Oceanography and Water Geochemistry (LOCGE) has focused its research activities on studying the biogeochemical processes affecting the carbon cycle and associated elements in aquatic systems. Its expertise includes kinetics of mineral weathering and developments of methodologies in the field of aquatic and sedimentary geochemistry.

RUG

The Laboratory of Protistology and Aquatic Ecology specialises in protist biodiversity and their role in aquatic ecosystem functioning. Relevant expertise includes diatom culturing and a range of techniques to study natural protist and bacterial communities.

UU

The department of Geochemistry emphasises the study of biogeochemical complexity in earth surface environments combining field-, laboratory and modelling work. The partner of the present project, Prof. P. Regnier, is the co-ordinator of the modelling group and is the originator of the coupled transport-reaction model CONTRASTE.

CONTACT INFORMATION

Website of the network:
www.ulb.ac.be/sciences/dste/ocean/SISCO/frame.html

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Users Committee

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