Geotraces cruise in the Baltic Sea (Nov 03 – Nov 13 2011, R/V OCEANIA), process study

Objectives and summary of the cruise

Science objective

Shelf and marginal seas are important sources and sinks in the marine biogeochemical cycles of trace elements and their isotopes (TEI). The Baltic Sea is a stratified low-salinity sea with an estuarine circulation that has several anoxic basins in its deeper central part which are flushed episodically about once in a decade by salt water intrusions from the North Sea. Exchange with the North Sea and the Atlantic occurs only through narrow silled passages at the Baltic Sea's western end. The objective of this cruise was to sample the major fresh water input sources of TEIs to the central Baltic, to obtain high resolution profiles of TEIs across the redox cline at the central Baltic anoxic deep basins, and to sample the exchange with the western Baltic through surface export and the only deep channel permitting salt water inflow. The expected outcome of this study is the identification of sinks and sources of TEIs in marginal seas and an understanding of relevant processes governing the export and import fluxes, particularly their modification by redox cycling in the water column. It is planned to conclude the study of Baltic Sea exchange with the Atlantic with a follow up cruise to the western Baltic Sea and into the North Sea.

Cruise narrative

The scientific crew comprised researchers from Bristol, Cologne, Kiel, Oxford, Sopot, Lulea, Stockholm and Southampton. Samples were taken as outlined below according to the three main objectives inputs, exports, and redox cycling from 7 depth profiles using a PTFE lined pump-CTD and normal CTD bottle casts, from several surface stations and surface transects using a PTFE lined near-surface pump at the ship's bow (approx. 3 m below surface), and additional near bottom sampling at some stations by CTD casts. The pump-CTD and surface pump were connected directly with trace metal suitable tubing and valves to three laminar flow cabinets in the ship's lab. This allowed for in-line filtration of anoxic waters with minimal exposure to atmosphere, the conduction of redox reaction experiments and direct sampling with minimal risk of contamination. Sampling was conducted for later on-shore analysis of transition metals by FIA, stable isotopes of Fe, Cu and Zn by MC-ICP-MS, U-series elements by MC-ICP-MS (long-lived) and on-board counting (short-lived Ra isotopes), As & Hg by AAS, REE by ICP-MS, Nd and Hf isotopes by MC-ICP-MS and O-isotopes (Gas-IRMS). In addition, samples were taken for DOC & POC. Analysis of nutrients, pH and alkalinity were carried out on board.

Surface sampling for input of TEI from continental sources were focused on the exit of the Bay of Finland (input from river Neva), the Archipelago Sea around the Åland island (input from the Bottnian Sea), the southwestern Swedish coast (various Swedish rivers) and the Bay of Gdansk (Vistula river). Sampling for studying exchange with the western Baltic and North Seas was focused along a cross-over transect from the Bay of Gdansk to the Swedish coast south of Öland island. The transect included two depth profiles (at 10 and 20 m spacing with CTD bottle casts) at the exit and entry of the Slupsk channel (75 m deep, the only path of salt water intrusion from the North Sea.

The focus of the redox cycling aspect was on the redox-cline of the three deepest basins, which were sampled by pump-CTD (operational down to 200 m depth) and CTD bottle casts (below 200 m).

These basins are the Landsort Deep (459 m deep, permanently anoxic below 90 m, 2 m sampling resolution across the redox cline, 20 – 50 m resolution at other depths), the Gotland Deep (238 m deep, anoxic below 120 m except for episodic flushing on average once in a decade, 5 m sampling resolution across redox cline, 10 m resolution at other depths), and the Gdansk Deep (110 m depth, currently anoxic below 90 m, 20 m sampling resolution). At Landsort and Gotland Deep on-board mixing and reaction experiments were conducted to study transient Mn redox species and redox related Fe isotope fractionation. Additional depth profiling was conducted at a suspected dump site in the northern part of the Gotland basin and in the Åland basin (ca. 300 m deep, ventilated throughout the column, at 20 m resolution). Additional near bottom-samples were taken around the margin of the wider Gotland Basin.