ALKOR 346: First IFM-GEOMAR - HYPOX expedition to the Gotland Basin underway.

From 18. Sept to 6 Oct. R/V ALKOR is working in the eastern Gotland Basin (central Baltic Sea.). The cruise led by R. Olaf Pfannkuche, is carried out within the framework of the new FP-7 project "***HYPOX***" (In situ monitoring of oxygen depletion in hypoxic ecosystems of coastal and open seas, and land-locked water bodies, www.hypox.net/). Besides IFM-GEOMAR scientists researchers from Sweden and Denmark participate in the expedition.
A major focus of this cruise is on in situ measurements of turnover and fluxes of nitrogen compounds, phosphate, iron, manganese and carbon in the benthic boundary layer at variable oxygen concentrations of the bottom water. In parallel to these measurements of the natural environment, the effects of variable oxygen availability (thresholds) in the bottom water on N-speciation and release of nutrients shall be determined by additional in situ experiments. Further activities of this cruise comprise biological investigations (meiobenthos, epibenthos) and sea floor imaging

R/V ALKOR: Tonnage 1322GT, Length 54,5m, Beam 12,5m, Scientific Crew 12 (Foto IFM-GEOMAR)

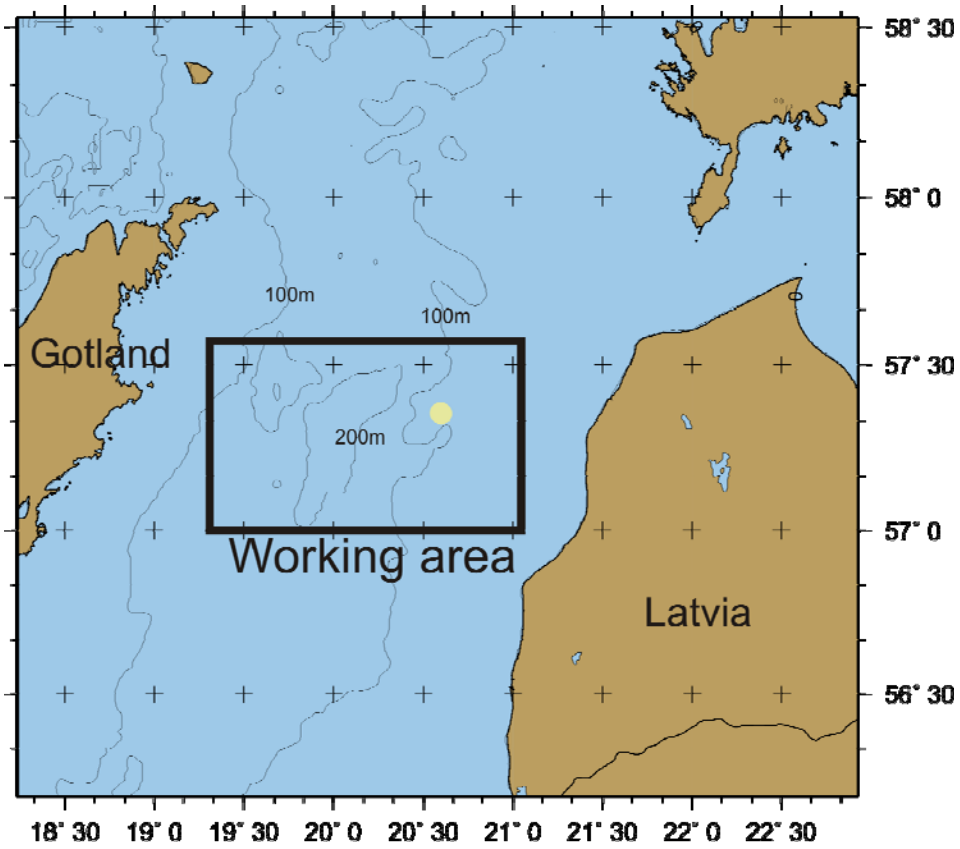

Fig. : Map of ALKOR cruise No. 346 working area (O. Pfannkuche, IFM-GEOMAR).

The Baltic Sea is the largest brackish water basin in the world after the Black Sea. Since the residence time of the water in the Baltic Sea is as long as 25-35 years, and the average depth is not more than about 60 m, sediments play an essential role in the biogeochemical cycles of nutrient elements and carbon in the Baltic Sea system. The Baltic Sea is a marine system with severe environmental problems. Oxygen is depleted at 90-110 m depth (Figure) and the area of anoxic bottoms is at present around 45 000 km^2.

The water body of central Baltic is distinctively stratified. A permanent halocline at appr.60-80m water depth prevents vertical mixing between the almost homo-haline surface water and the deeper water masses of higher salinity. A seasonal thermocline develops in the summer months in the surface water body producing an intense stratification.The Gotland Basin is a flat basin with gentle slopes with a maximum depth of 249m that displays almost permanently anoxic conditions in its deepest parts. Annual sedimentation rates in the central Gotland Basin are estimated to 1.0-1.3mm/yr. Values on the slopes are lower and re-suspension occasionally occurs which can cause lateral transport of suspended materials. The Holocene muds exhibit a high concentration of organic matter (10-15% dry weight). The surface sediments of the area of investigation are soft, black organic rich and of high porosity.

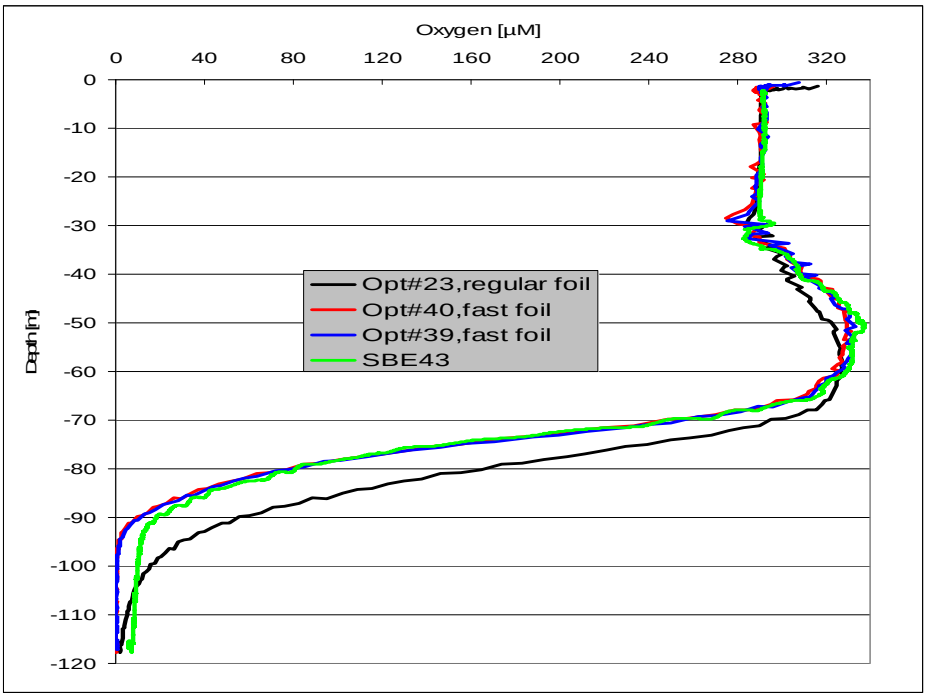

Fig. : Oxygen distribution in the water column of the eastern Gotland Basin, Sept. 2008. Comparative oxygen down casts of two 4330 fast foil optodes (blue and red), one 4330 regular foil (black) and one SBE43 (green). The optodes were sampled at 0.5 Hz and the SBE43 at 24 Hz. The descent rate was around 35 m/min (Data and Fig. Per Hall UGOT)

Massive summer blooms of cyanobacteria in surface waters of the Baltic Sea are well known (Figure).

Fig. : Massive occurrence of cyanobacteria in the Gotland Basin forming brownish strains at the water surface. POSEIDON cruise 369, 2008 (Fotos O. Pfannkuche IFM-GEOMAR).

They can be toxic and have been plaguing the Baltic proper since many years influencing e.g. the recreational value of the coast and hence tourism. The cyanobacteria summer bloom in 2005 was greater than the preceding spring bloom

in terms of P-uptake. Roughly 0.5 million tons N is imported to the Baltic Sea annually through pelagic cyanobacterial N_2-fixation. It is believed that internal sources (P-mobilization from sediments) and sinks (denitrification in sediment and suboxic/anoxic water) in the Baltic proper are causing N/P ratios in the water column that are lower than the Redfield ratio. This is a prerequisite for cyanobacteria summer blooms.

3.1 Goals ALKOR Cruise 346

Overall objective

To understand the role of open sea sediments of the Baltic Proper under low oxic to anoxic conditions as sources and sinks for nitrogen, phosphorus, trace metals and carbon.

Specific aims

1) Gain novel knowledge and improved understanding of nitrogen (N), phosphorus (P) and carbon (C) cycling in the Gotland Basin through the use of state of the art and in-situ methodology combined with coupled physical-biogeochemical circulation modeling;
2) Initial characterization of source and sink functions for N and P in open sea sediments of the Baltic Proper through determination of the stoichiometric ratio of C:N:P in benthic fluxes;
3) Provide new insight into the most important factors controlling the magnitude and response times of benthic nutrient (N, P) and DIC fluxes in the Gotland Basin;
4) Determine the relative importance of burial, denitrification and anammox as removal pathways for fixed nitrogen in sediment and anoxic water of the Baltic Proper (fixed N comprises all forms of N except di-nitrogen gas, N_2);
5) Contribute to a decreased uncertainty for the Baltic Sea system of the balance between (on one hand) N_2-fixation (data from literature) and (on the other) removal of fixed N through denitrification and anammox in sediment and anoxic water;
6) Contribute to a better understanding of the role of benthic fluxes (internal loading) of nutrient P and N versus the estimated anthropogenic load (including river run-off and atmospheric deposition; from literature) of P and fixed N to the Baltic Sea system.
7) Regional (Gotland Basin) estimate of the sink/recycling function of the benthic boundary layer for fixed N based on sea floor image analysis in concert with benthic biogeochemistry.

3.2 Working programme / Arbeitsprogramm

3.2.1 Working area with station map / Arbeitsgebiet mit Stationskarte

Major working sites will be in the eastern Gotland Basin of the Baltic Proper along three depth transect lines, (Figure). The transect lines include 8 stations, which have been visited during a pre-study with R/V Poseidon (POS 369. July-August 2008; Sat. B – G) and a Swedish cruise with RV Skagerak (September 2008; Stat. S1 and S2). These stations, ranging from shallow water (~ 67 m, stat. B) to deep water (~219 m, stat. F), are representative for the Gotland Basin and include sites with both oxygenated and anoxic bottom water. Stations are selected so that the major bottom types, are included. Coarse-grained erosional bottoms are not relevant for the present project.

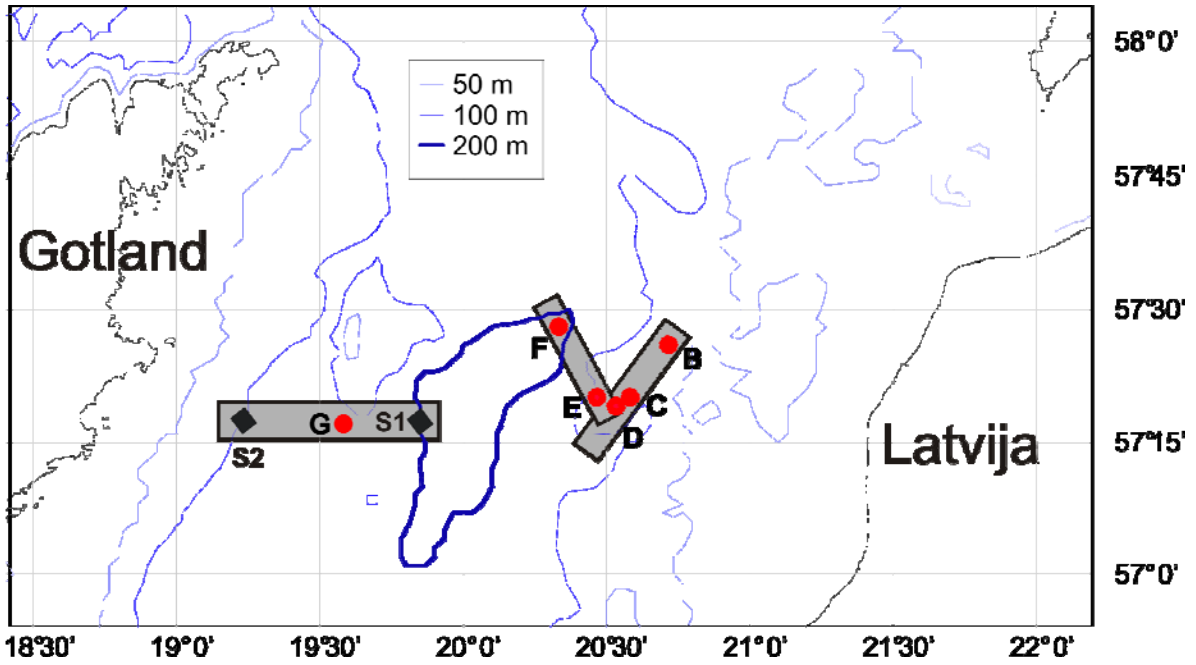

Figure 5: Station map: Studies will be carried out in Latvian waters along depth transects including station B-F which were visited during POS 369 cruise (July/August 2008) and along a transect in the Swedish EEZ including Station G, S1 and S2 the later two were visited on a recent Swedish cruise with RV SKAGERAK (September 2008).

In situ measurements and experiments in benthic mesocosms deployed with lander systems are a prominent feature of the cruise. 3 Lander of the GEOMAR—Type (Fig.) and two lander of the UGOT-type (Fig) will be in operation . Other major gear operated are: a TV-guided multicorer, a towed benthic camera observation system and a CTD/Rosette-watersampler.

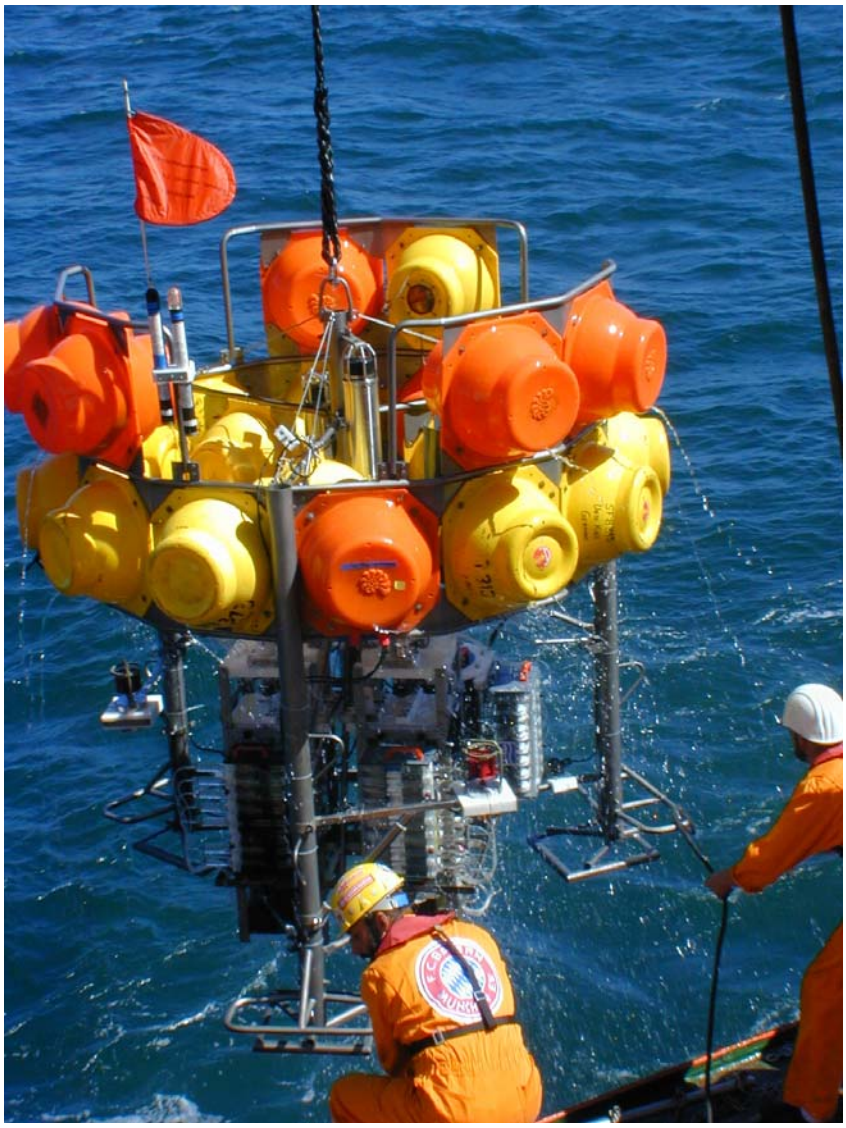

Fig.: Retrieval of the biogeochemical observatory (BIGO) in a GEOMAR-lander frame. (Foto O.Pfannkuche, IFM-GEOMAR)

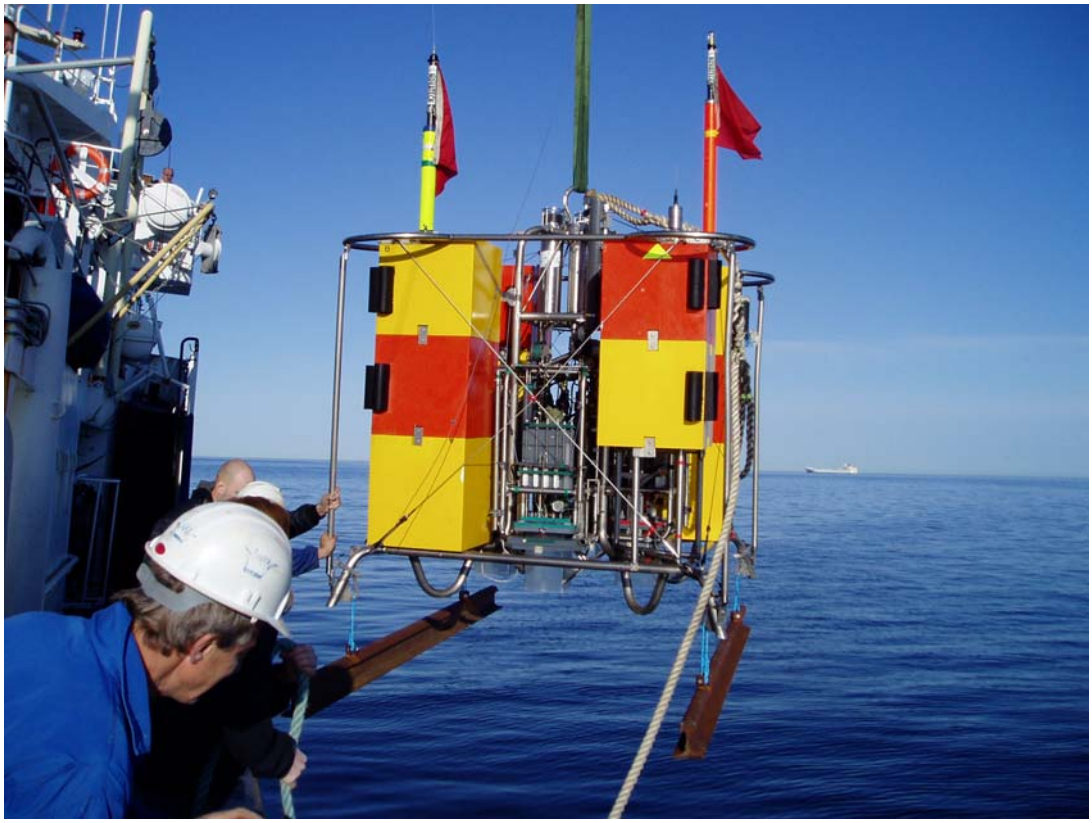

Fig. Deployment of the University Göteborg benthic chamber Lander (Foto UGOT)