Joint collaboration of SFB754 subprojects B1, B2, B4, B5, B6.
Anticipated working-collaboration with IMARPE (Peru) and AMOP (France).

Research Questions

1. Are marine pelagic and benthic bacteria in the oxygen minimum zone (OMZ) off Peru a source or sink of bioavailable phosphate?
2. How does bacterial regeneration of dissolved inorganic phosphorus (DIP) and dissolved organic phosphorus (DOP) from particulate organic phosphorus (POP) regulate biological productivity in OMZ's?
3. Are sulfide plumes with high bacterial activity (Schunck, et al. 2013) associated with observed excess phosphate concentration in the water column?

Introduction

Recent publications have highlighted the potential of P storage and release by microorganisms under changing redox conditions in the sediments and at the sediment water interface (Goldhammer, et al. 2010, Brock and Schulz-Vogt 2011, A. Noffke, et al. 2012). Several bacterial strains, e.g., the sulfideoxidizing bacteria Thiomargarita amibiensis and Thioploca spp. as well as some species of the genus Beggiatoa are known to accumulate intracellular polyphosphates under oxic conditions which are then hydrolyzed to phosphate under anoxic conditions to gain energy and survive anaerobiosis (Schulz 2005). Therefore, the role of sulfur bacteria in the P cycle of marine oxygen deficient areas arrants further investigation. Preliminary results of the M92 cruise suggest that different strains of sulfideoxidizing bacteria also occur in the water column. Hence, microbial storage and release of phosphorus should be quantified in the framework of the relevant biological and biogeochemical processes.

Project overview

We will construct a 1D water column biogeochemical model based on data from the M92 cruise at the 12°S transect of the Peruvian OMZ and previous SFB754 cruises. With collaboration of Michelle Graco and Dimitri Gutiérrez (IMARPE) and Aurélien Paulmier (AMOP) the model will simulate a more comprehensive seasonal cycle. The main objective of the model is to determine the influence and efficiency of pelagic and benthic bacterial processes and to quantify their impact on the marine phosphorus (P) cycle in that region. We will couple our 1D water column model, written in FORTRAN, with the benthic biogeochemical model of Dale et al. (2013). Coupling with the benthic model is needed to describe the interactions of bacteria and phosphate fluxes across the sediment-water interface. Frequent changes in redox conditions suggest bursts of bacterial phosphate release, which diffuses into the surrounding waters and may contribute to the surface P pool by upwelling (Ingall and Jahnke 1997, Mort, et al. 2010, Dale, et al. 2013). The model will be used to analyze the role of the phosphate bursts in the local P cycle. The data for the development of the above model comprise water column measurements and benthic work from the 12°S transect between 80 and 400 m water depth sampled by CTD and MUC deployments during the M92 cruise. The data set is a joint effort of subprojects B5, B6 and A8 and provides information on filtered particulate matter of the water column, nutrient, oxygen and chlorophyll concentrations of the water column and phosphorus pore water concentrations, benthic bacteria samples and benthic P fluxes from the sediments into the bottom water. First on board experiments with benthic bacteria showed a great potential to store P and has to be further investigated. The determination of particulate organic carbon (POC), particulate organic nitrogen (PON), total particulate phosphorus (TPP), particulate inorganic phosphorus (PIP) and particulate organic phosphorus (POP) in the water column will provide a dense data basis to develop the 1D water column biogeochemical model. POC

and PON will be measured using an elemental analyzer after a standard procedure from Sharp (1974). The TPP and PIP measurements will be performed after the modified method according to Aspila et al. (1976) which allows to calculate POP. The gene analysis to identify the bacteria occurring in the water column and sediments will be performed in cooperation with Harald Schunck (B4) and Tina Treude (B6). The combination of benthic and pelagic measurement approaches and coupling of the data to a model provides an auspicious way to define the microbial control in the P cycle of the Peruvian OMZ.

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