# Sediment deposition and accumulation rates determined by sediment trap and $^{210}$Pb isotope methods in the Outer Puck Bay (Baltic Sea)

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## Abstract

Two methods – in situ sediment trap experiments and an isotopic method based on measurements of $^{210}$Pb activities in the sediment cores taken near the traps – were applied for determining sediment deposition and sediment accumulation rates in the eastern part of Puck Bay. The sediment deposition rate (1.67 mm year$^{-1}$) based on the in situ measurement was comparable with the sediment accumulation rate calculated using the Constant Flux:Constant Sedimentation Rate model for the isotopic method. The age of the sediment layers was determined with the Constant Rate of Supply model; the deepest layers had accumulated around 1900.

The complete text of the paper is available at http://www.iopan.gda.pl/oceanologia/

## 1. Introduction

Sedimentation is defined as the overall process of particle transport to, emplacement on, removal from and preservation in the seabed (McKee et al. 1983). This definition discerns certain phases/stages of the sedimentation process. The first stage is deposition defined as temporary emplacement from and preservation on the seabed and pertains to this relatively short time of sediment formation. Sediment accumulation is the stage pertaining to a decidedly longer period: it is the result of particle deposition and removal, leading to the preservation of the strata. Particle removal may be due to several mechanisms, e.g. physical erosion, biological resuspension and chemical dissolution (McKee et al. 1983). The usual method of determining the deposition rate is the in situ technique relevant to this short sedimentation time, where sediment traps are deployed in the natural conditions of seas, bays or lakes (Faas & Carson 1988, Lund-Hansen et al. 1999, Roos & Valeur 2006). The accumulation rate of the sediment comprising a $>100$ year period can be determined only by an isotope method based on the analyses of changes in $^{210}$Pb activity in the sediment profile (Musielak 1985, Appleby & Oldfield 1992, Appleby 1997). The rate of accumulation of marine sediments has been a research topic for many years (Nicholas 1989, Pempkowiak 1991, Mojski 1995, Hille et al. 2006, Roos & Valeur 2006). Nevertheless, it remains an important scientific problem because of the still unresolved issues emerging from the variety of methodologies and diverse interpretations of the results. The rate of sediment accumulation has a significant impact on many geochemical processes; it is also vital for the functioning of benthic organisms in this environment, particularly the seabed fauna (Musielak 1983, Kozerski 1994, Żytkowicz 1994, Szczuciński 2007).

Determining the rate of sediment accumulation is usually a complicated task, even when using theoretical models for a perfectly calm water basin. When applying a theoretical approach, it is obvious that not only should gravitational force be considered in order to calculate the sedimentation rate but also other aspects such as eddy viscosity, turbulent diffusion and the grain distribution of suspended sediment (Massel 2010). Theoretically, if in calm waters only gravitation were used as the dominant force, it would be possible to determine what percentage of particles of a specified diameter would settle and which particles would have a velocity too low to ensure settlement. An example of such an approach was given by Imam et al. (1983), who established the vertical velocity field using a finite difference model of the vorticity transport stream function equations with a constant eddy viscosity. The eddy viscosity is obtained by applying a theoretical model. That is, in order to determine the sedimentation rate