Dating of a German riverine lake sediment using Pb-210 and Be-7

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Introduction

Chronology using 210Pbex

Sediment Chronology using classical models: CF-CS (Robbins et al. 1978) and CRS (Appleby and Oldfield 1978) are technical methods well tested during the last 50 years (Sanchez-Cabeza and Ruiz-Fernández 2012). Models are based on determining the unsupported 210Pbex which reaches the lake surface. The unsupported 210Pbex has two principal input components: first, the surrounding catchment area and second, the atmospheric deposition (Fig. 1). Unsupported 210Pbex can be determined by subtracting from the total activity signal the supported activity signal which is continuously produced within the sediment and assuming secular equilibrium between 226Ra and the daughter products.

Goals

In this work we attempted to use both classical models in a riverine lake environment where models assumptions (CF-CS: constant flux and constant sedimentation) and (CRS: constant rate of 210Pbex supply) might not be fulfilled (Abril 2004, Sanchez-Cabeza and Ruiz-Fernández 2012).

Methods

Sampling

The sampling point is located in a riverine lake, part of Lower Havel, situated west of Berlin with a maximal depth of 11m and an average depth of 5.1m. The hydraulic residence time of the water is 180 on average (Fig. 2). The core was extracted on October 2014. After the extraction it was sliced into 1cm layers, freeze-dried, homogenized by grinding, mixed with wax, pressed into pellets and sealed using radon-tight aluminum barrier foil. After sealing, samples were stored during at least 3 weeks awaiting the secular equilibrium between 226Ra and 222Rn.

Detection

A HPGe detector with carbon window housed in a 10 cm Pb shielding with Cu, Cd and plastic inner linings and operated by Genie 2000 software was used. Efficiencies had been determined previously using pellets with the same geometry and sediment/wax composition.

Results

Measurements

Results from the gamma-spectrometric determinations are presented in Fig. 3. An exponential decrease of 210Pbex can be seen. A 7Be activity of 31.0±13.5 Bq·kg⁻¹ in the uppermost section indicates recent sediment (age <1 year) and therefore the sampling date (10/2014) can be used as a reference date for the core top. Markers from 137Cs could not be used - the Chernobyl peak could be expected at 29a (equivalent depth ~39.5cm). The 137Cs signal increase below 2 g·cm⁻² might be a "tail" of such a peak. Results indicate a good agreement between the sedimentation rates derived by both models (Fig. 4). Mean calculated sedimentation rates can be found in Tab. 1.

Tab 1. Average mass sedimentation rates Rs (g·cm⁻¹·yr⁻¹) for both models.

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<tr>
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<th>CF-CS</th>
<th>CRS</th>
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<td>0.141±0.016</td>
<td>0.144±0.003</td>
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Conclusions and outlook

It could be shown that both models can be used for calculation of the sedimentation rate and to produce a sedimentation chronology. The results also show a rare case of a "smooth" profile in a riverine lake. The chronology developed in this work in cooperation with has been implemented (Rothe 2015) and supported by Leibniz Institute for Freshwater Ecology and Inland Fisheries (IGB).

References