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

M. Perez-Mayo[1], D. Pittauer[2], H.W. Fischer[1]

[1]*Institute of Environmental Physics, University of Bremen, Bremen, 28359, Germany*
[2]*MARUM – Center for Marine Environmental Sciences, University of Bremen, Bremen, 28359, Germany*
manuel@iup.physik.uni-bremen.de

Introduction

Chronology using $^{210}Pb_{xs}$

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 $^{210}Pb_{xs}$ which reaches the lake surface. The unsupported $^{210}Pb_{xs}$ has two principal input components: first, the surrounding catchment area and second, the atmospheric deposition (Fig.1). Unsupported $^{210}Pb_{xs}$ 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 ^{226}Ra 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 $^{210}Pb_{xs}$ 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 18d 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 ^{226}Ra and ^{222}Rn.

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 $^{210}Pb_{xs}$ can be seen. A ^{7}Be activity of 31.0±13.5 $Bq \cdot kg^{-1}$ 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 ^{137}Cs could not be used - the Chernobyl peak could be expected at 29a (equivalent depth ~39.5cm). The ^{137}Cs signal increase below 2 $g \cdot cm^{-2}$ 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 R_s ($g \cdot cm^{-1} \cdot yr^{-1}$) for both models.

CF-CS	*CRS*
0.141±0.016	0.144±0.003

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 of Freshwater Ecology and Inland Fisheries (IGB).

References

Abril, J. M. (2004). *Environmental Pollution* 129, 31-37.
Appleby, P. G. & F. Oldfield (1978). *Catena* 5, 1-8.
Robbins, et al. (1978). *Quaternary Research* 10, 256-278.
Rothe, A. K. , et al. (2015). *PLOS One, in press*
Sanchez-Cabeza, J. A. & A. C. Ruiz-Fernández (2012). *Geochimica et Cosmochimica Acta* 82, 183-200.

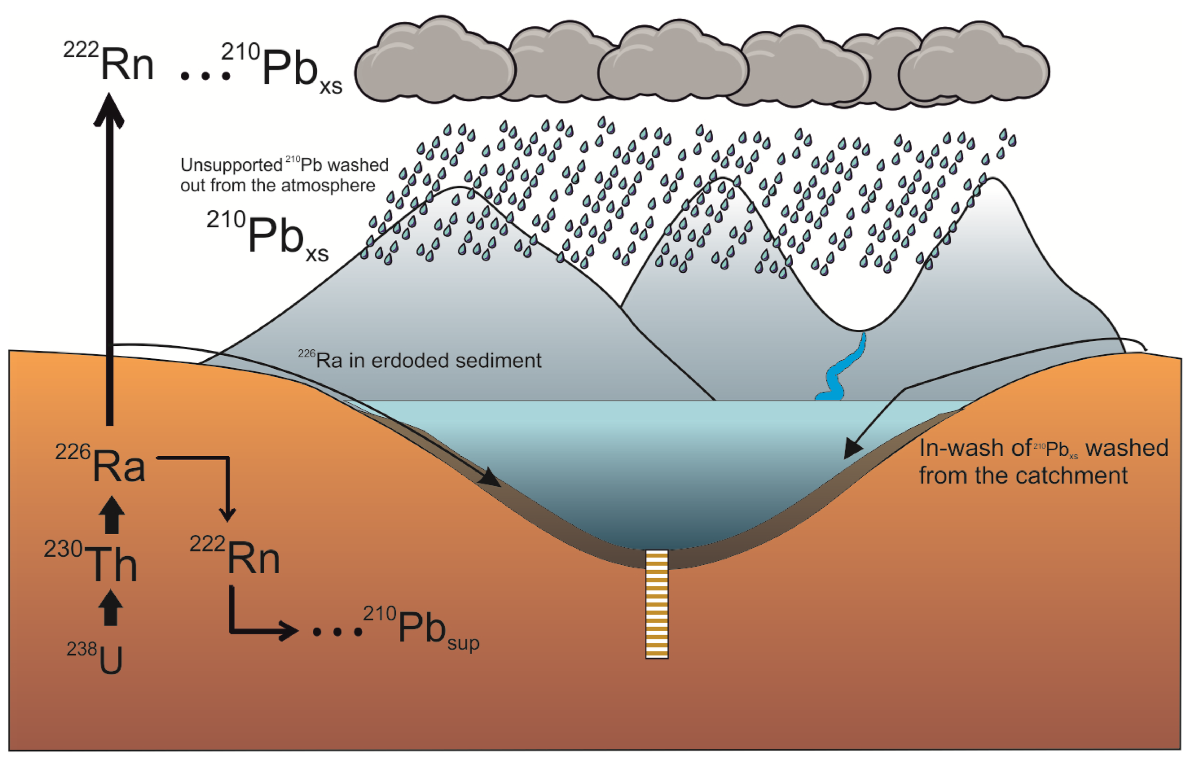

Fig. 1. Diagram of the Uranium decay chain and behaviour of the ^{210}Pb.

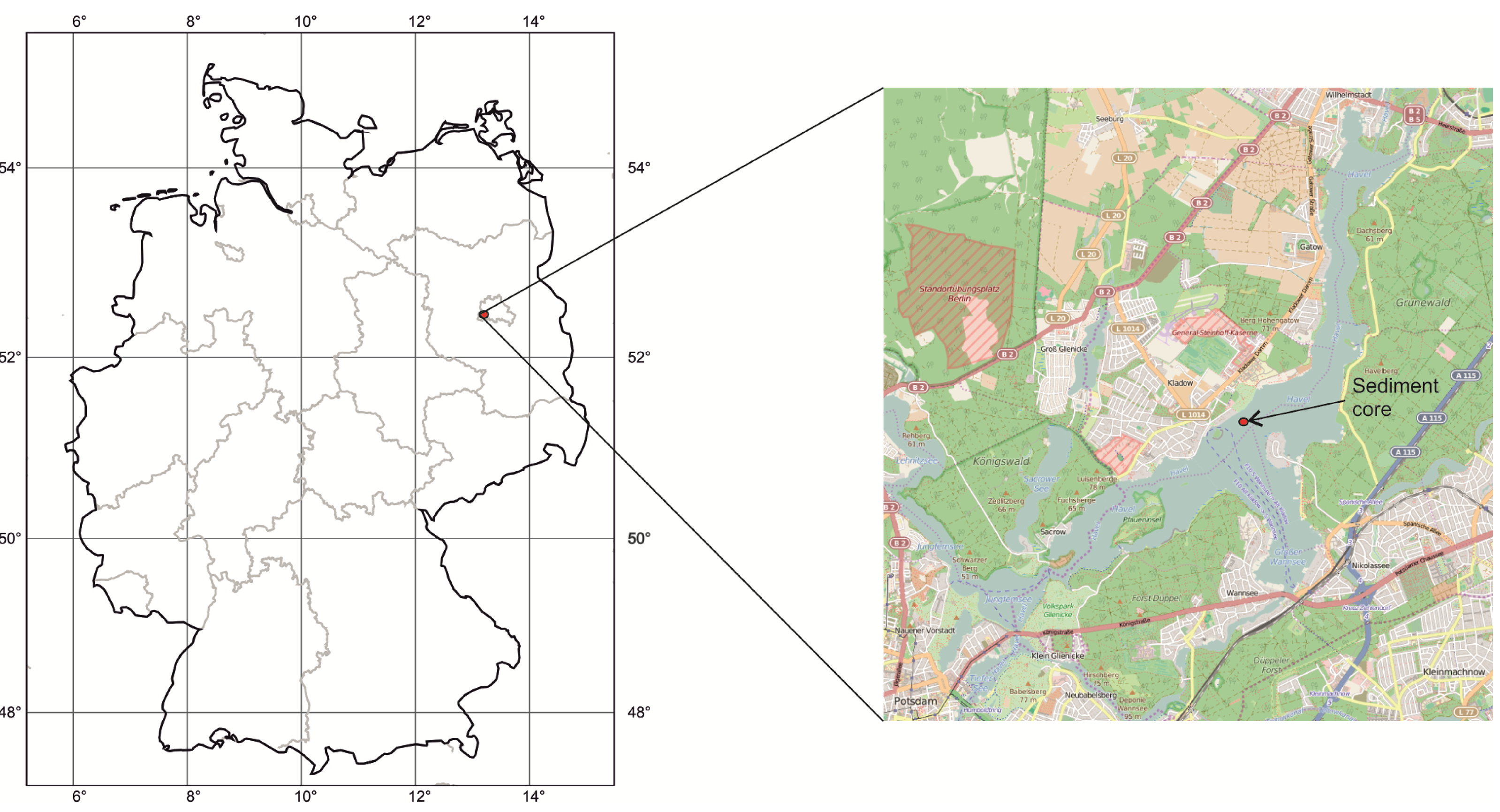

Fig. 2.Location of the sediment core. Source: openstreetmap.org

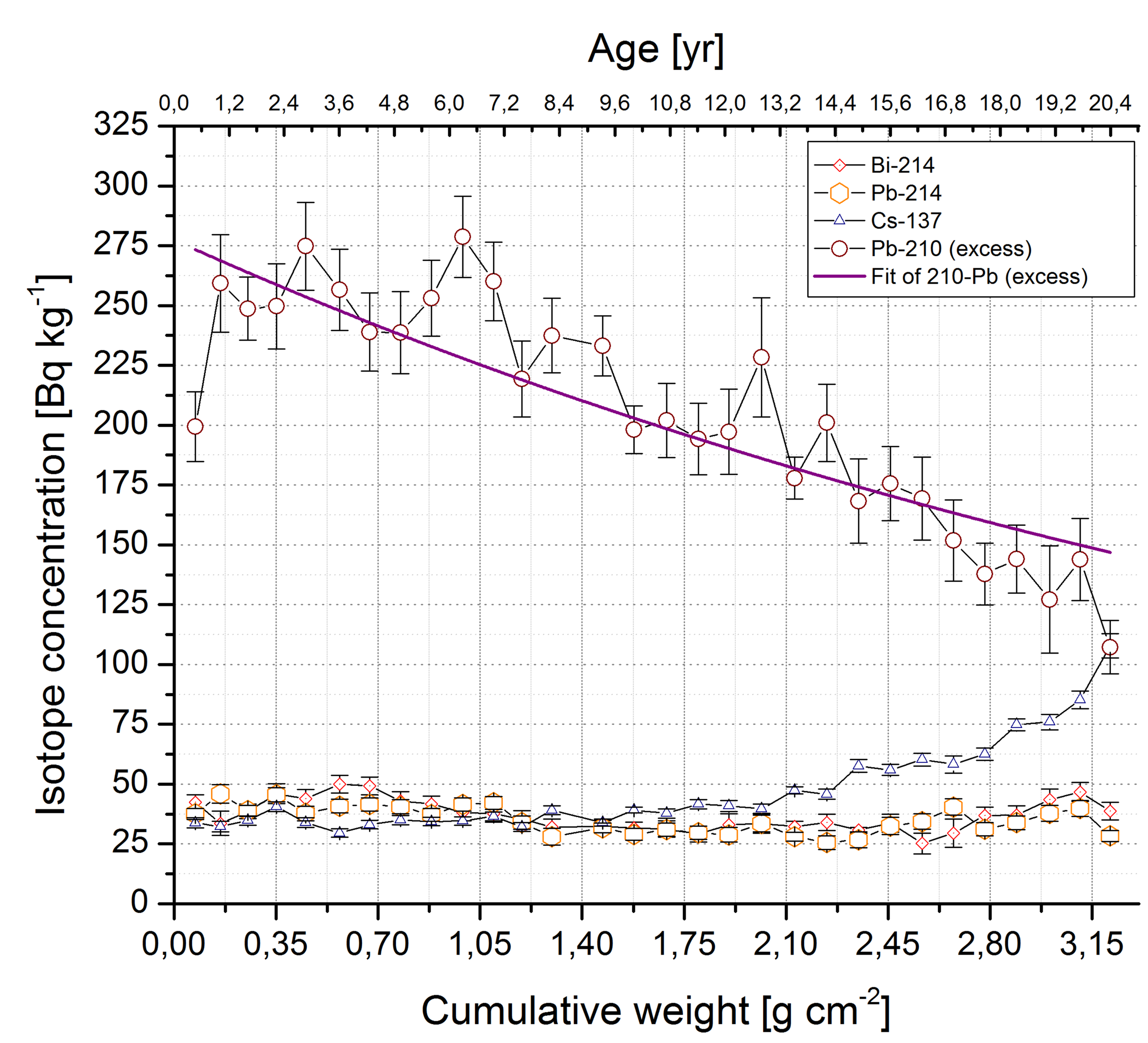

Fig. 3. Depth distribution of the excess ^{210}Pb for lake Lower Havel and the exponential function fit (CF-CS chronology and calculating the missing inventory in the CRS model), together with activity concentration of ^{214}Bi, ^{214}Pb and ^{137}Cs. Age on the second x-axis was determined using the CF-CS model.

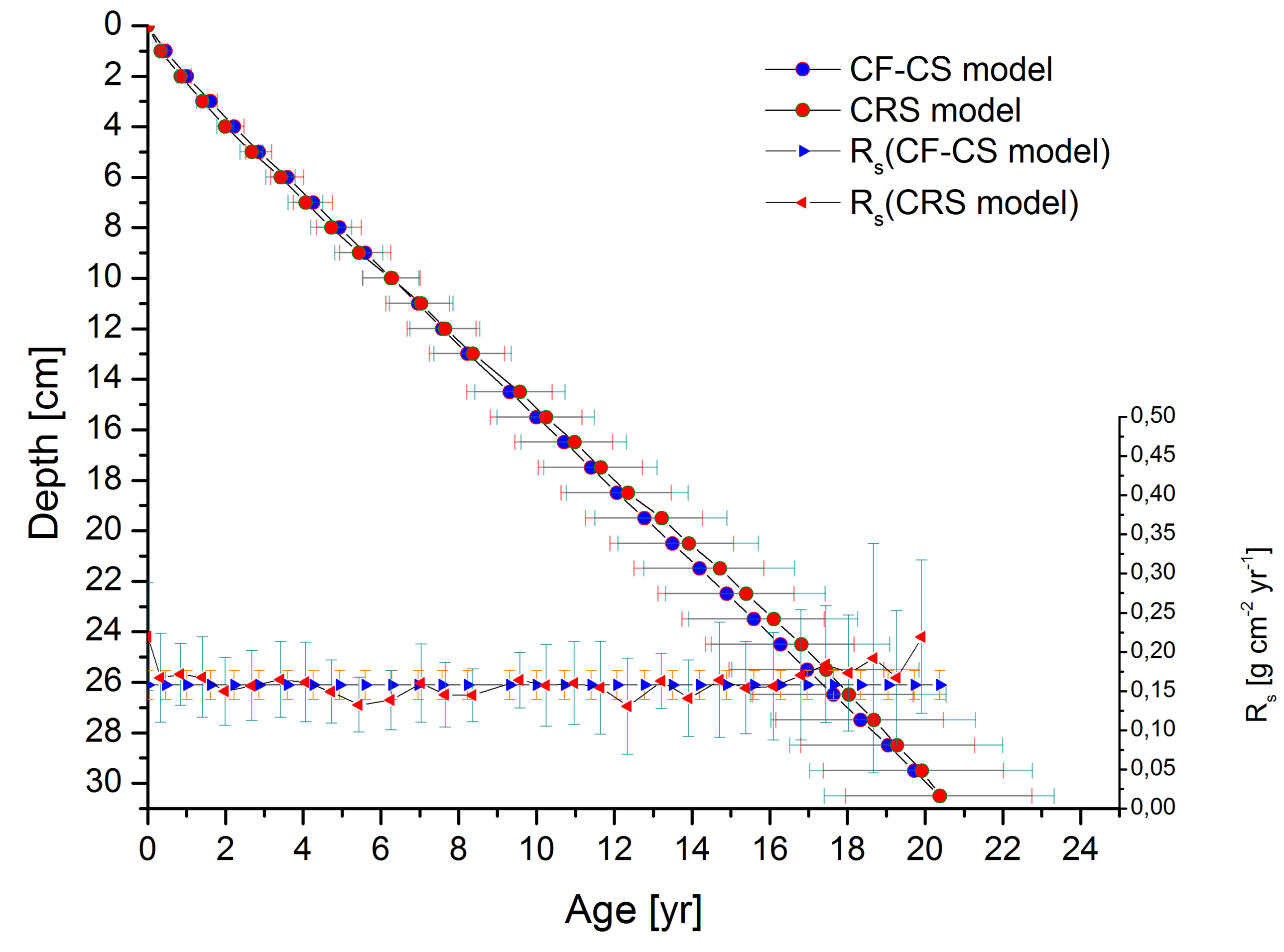

Fig. 4. Chronology of sediments from lake Lower Havel. Comparison of the depth vs. age using models CF-CS (blue points) and CRS (red points). Sedimentation rates R_s are plotted for both models.

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