Supported lead in Pb-210 chronology

Daniela Pittauerová; Bernd Hettwig; Helmut W. Fischer

Institute of Environmental Physics, University of Bremen, Bremen, GERMANY

pittauerova@iup.physik.uni-bremen.de

Introduction

How does a possible supported ^{210}Pb underestimation affect the ^{210}Pb chronology?

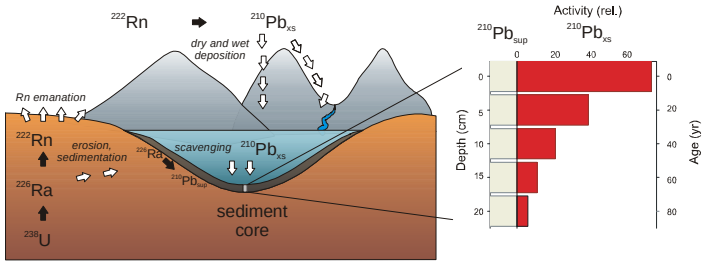
The total signal of ^{210}Pb in recent sediment profile consists of:
- supported ^{210}Pb, which is present due to autigenic material of the sediment and
- unsupported (excess) ^{210}Pb, which originates from the atmospheric deposition.

$^{210}Pb_{tot}$=$^{210}Pb_{sup}$+$^{210}Pb_{xs}$

$^{210}Pb_{sup}$ is usually assumed to be in radioactive equilibrium with its parent nuclide ^{226}Ra (half-life 1600 yr).

$^{210}Pb_{sup}$ analytical options using gamma spectroscopy:
- direct estimation using the ^{226}Ra gamma line at 186.2 keV (interference with the ^{235}U 185.7 keV gamma line and higher detection limits)
- using ^{226}Ra daughter products (risk of $^{210}Pb_{sup}$ **underestimation due to lack of radioactive equilibrium caused by Rn loss from the sample**)

A principle of the ^{210}Pb dating method



Methods

Two model sediment activity profiles

1)A simple profile

INPUTS:

Depth	30 cm
Slices	1 cm
Sedimentation rate	0.25 cm/yr
Initial total ^{210}Pb activity	100 (rel.)
Supported ^{210}Pb	const., 25% of initial total ^{210}Pb
Its underestimation	12%

2) A scattered (more realistic) profile

INPUTS:
The same as 1)
A scatter added (using normally distributed random number generator) to $^{210}Pb_{tot}$ and $^{210}Pb_{sup}$.
Error bars added.

Constant initial concentration (CIC) model:

(Robbins, 1978)

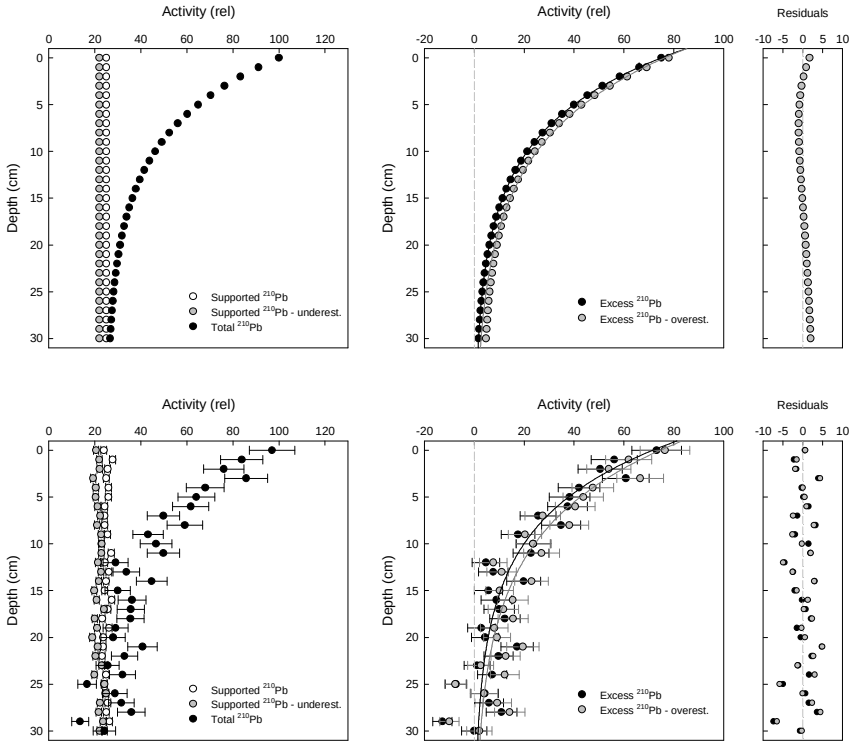
$^{210}Pb_{xs}$ profiles were fitted by a simple 2 parameter exponential function using least square algorithm. Based on resulting parameters, sedimentation rates were calculated.

Constant rate of supply (CRS) model:

(Appleby and Oldfield, 1978)

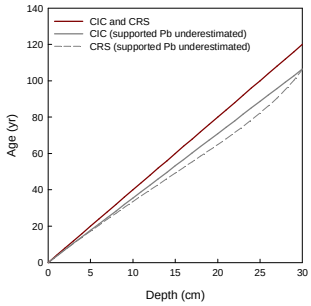
For comparison, $^{210}Pb_{xs}$ profiles were used for calculation of ages according to CRS chronology model.

Results

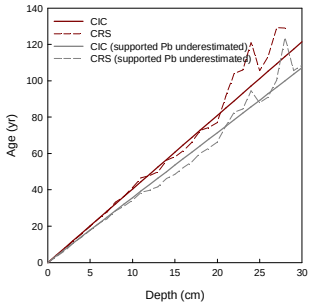


Comparison of chronologies derived by the CIC and CRS models

A simple profile



A scattered profile



Conclusions and outlook

Sedimentation rates (cm/yr) derived by the CIC model:

	Correct supported lead	Underestimated supported lead
Simple profile	0.250	0.284 ± 0.004
Scattered profile	0.247 ± 0.024	0.280 ± 0.026

- Systematic underestimation of $^{210}Pb_{sup}$ by 12% leads to overestimation of sedimentation rates by over 13%. That results in underestimation of ages in $^{210}Pb_{xs}$ derived chronologies.
- On a realistic dataset (with scatter caused by counting statistics and other natural causes) the $^{210}Pb_{xs}$ overestimation can remain unobserved, and could also be attributed to not reaching the “dating horizon”.
- The described effect will be strongest in environments with higher proportion of $^{210}Pb_{sup}$.
- A method for testing and correcting possible underestimation of $^{210}Pb_{sup}$ in sediment profiles measured by gamma-spectroscopy is currently being developed.

References

- Appleby PG and Oldfield F, 1978. Catena 5, 1-8.
- Robbins JA, 1978. In Nriago JP (Ed.) The biogeochemistry of lead. Elsevier, Amsterdam.

Universität Bremen

iup

pip physics international postgraduate

Presented at:
IAEA International Symposium on Isotopes in Hydrology, Marine Ecosystems, and Climate Change Studies
27 March - 1 April 2011
Monaco

IAEA