Standardisation of ^{210}Pb by liquid scintillation techniques

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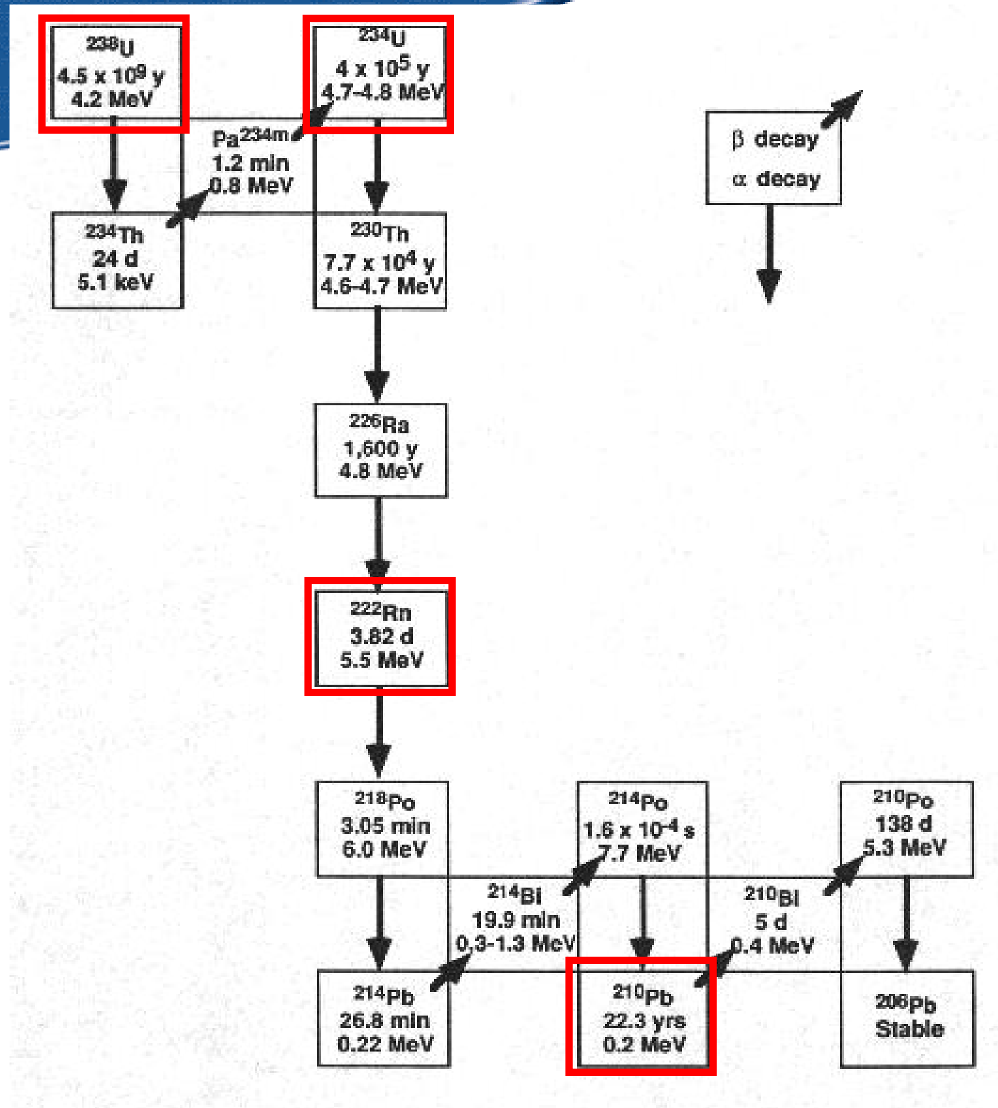
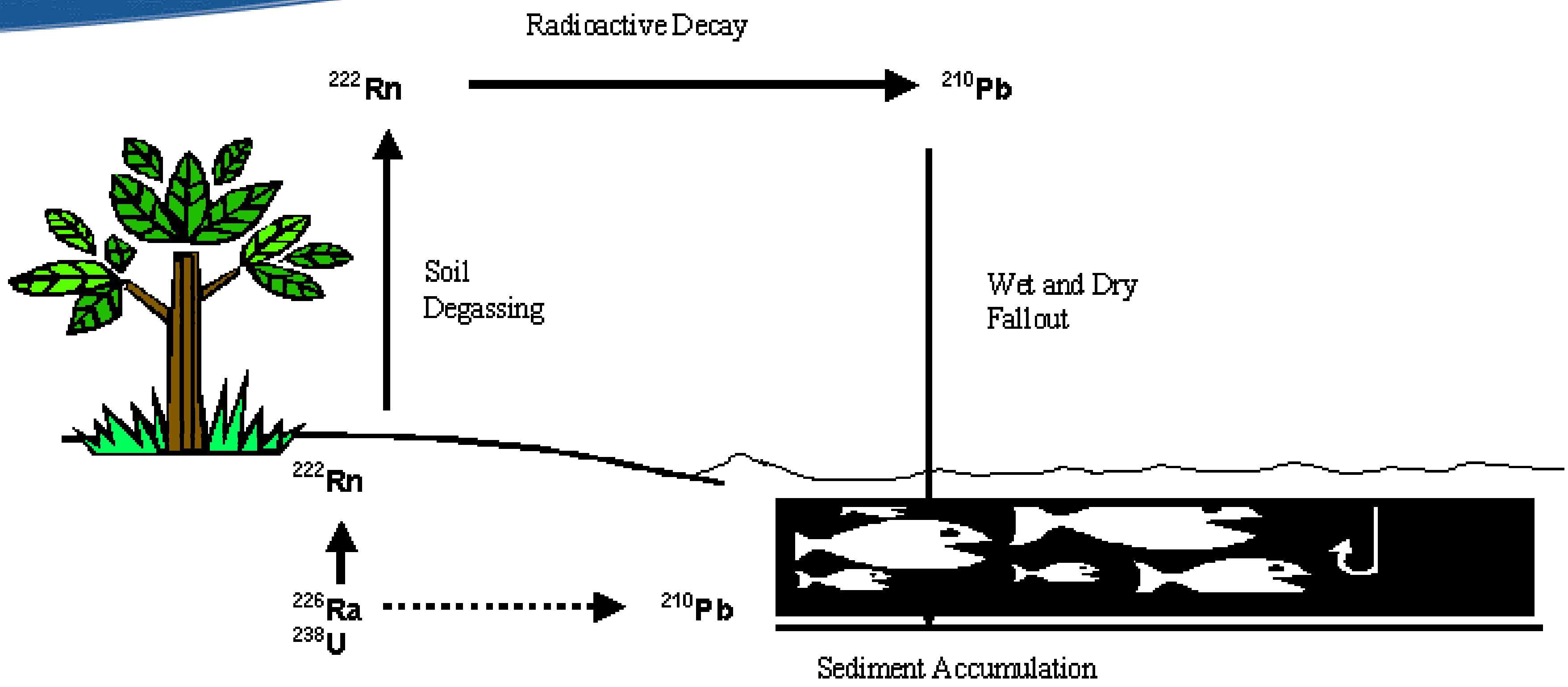
^{238}U decay chain



^{226}Ra – ^{210}Pb separation



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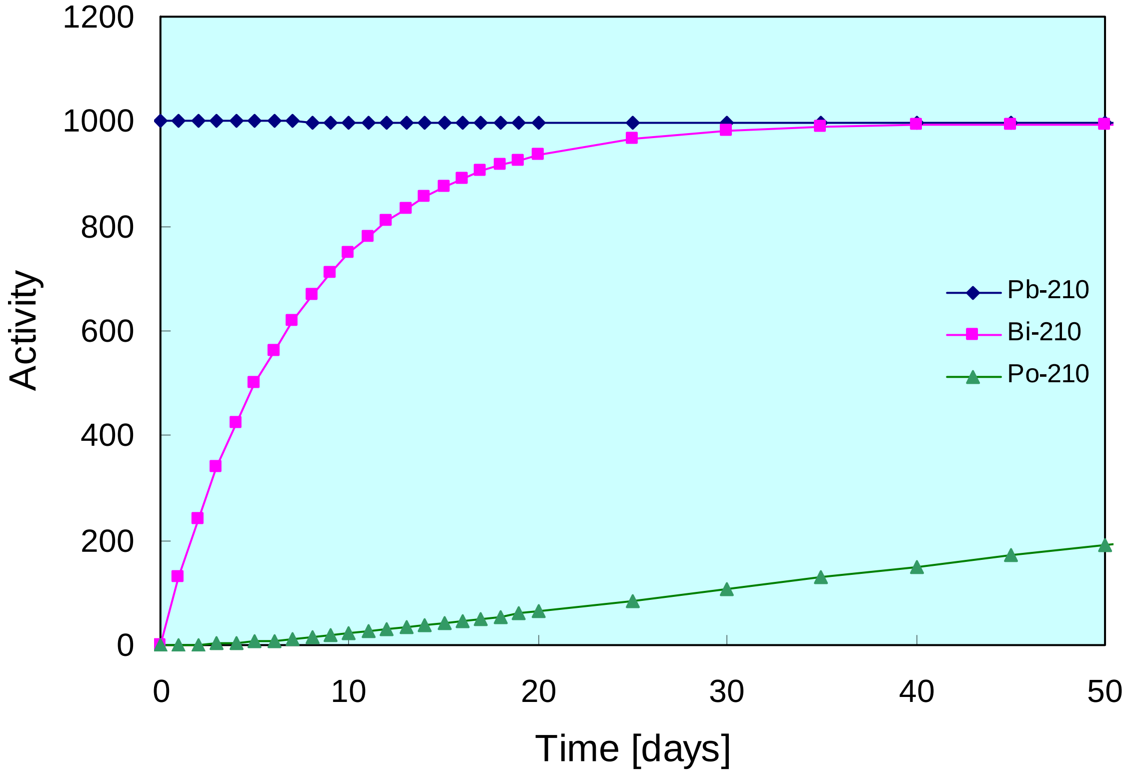
Geo dating

^{226}Ra of the ^{238}U decay chain produces **^{222}Rn**, which escapes to the atmosphere where it decays with a 3.8 day half-life ultimately to a longer-lived **^{210}Pb** radioisotope which precipitates back to earth within several days. The $t_{1/2}$ = 22.3 years of ^{210}Pb give this **geochronologic technique** a useful range of approximately **150- 200 years** and useful applications in **dating snowfall, recent fresh and marine sedimentation, and historic environmental pollutant rates (metals).**

Ingrowth curves



t=0 is the separation time

LS Method

The idea is to standardise ^{210}Pb by following the growth of ^{210}Bi with Cerenkov counting after radiochemical separation of the daughters of ^{210}Pb.

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Other method

β-γ coincidence counting of ^{210}Pb

Problems!

Weak gamma,

conversion electrons,

bremsstrahlung from ^{210}Bi,

in-growth corrections with assumed efficiencies

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Cerenkov counting (brief reminder)

- For measuring high energy beta emitters (> 300 keV)
- Discriminates against low-energy beta, alpha and gamma emitters
- Low backgrounds
- No chemical quench although colour quench possible
- Avoids use of scintillant, expensive to dispose of
- Allows measurements with strong alkali or acid

Chemical separation

Resin: EiChrom Sr Spec

^{210}Po separation — 8M HCl (^{210}Pb and ^{210} Bi passes)
eluted with 6M HNO_3

^{210}Bi separation — 2M HNO_3 (^{210} Bi passes)
more 2M HNO_3
^{210}Pb eluted with 8M HCl

LS Method (step 1)

1) Chemical separation

2) Standardise ^{210}Bi by CIEMAT/NIST technique

3) Prepare Cerenkov counting calibration vials of ^{210}Bi and measure them

$A(Bi) = \varepsilon N$

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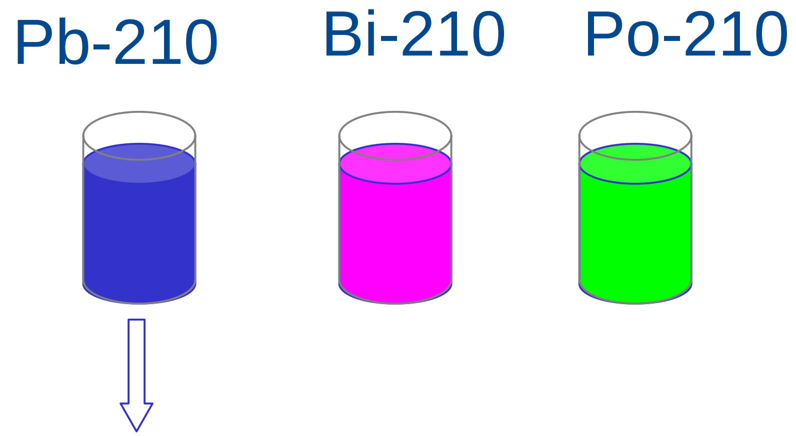
LS Method (step 2)



4) Prepare ^{210}Pb Cerenkov counting vials and follow the ingrowth of the ^{210}Bi with time

5) When in equilibrium: A (Pb) = A (Bi)

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Cerenkov vials

Prepared using the ^{210}Bi standard:

- Standard plastic vials
- 10g in each vial of 50μg/g of Bi and 50μg/g of Pb in 2M HNO_3
- 1 drop (20 mg) of ^{210}Bi solution

$\varepsilon_{Bi\text{-}210} = 0.1415 \pm 0.0008$

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Standardisation of ^{210}Bi

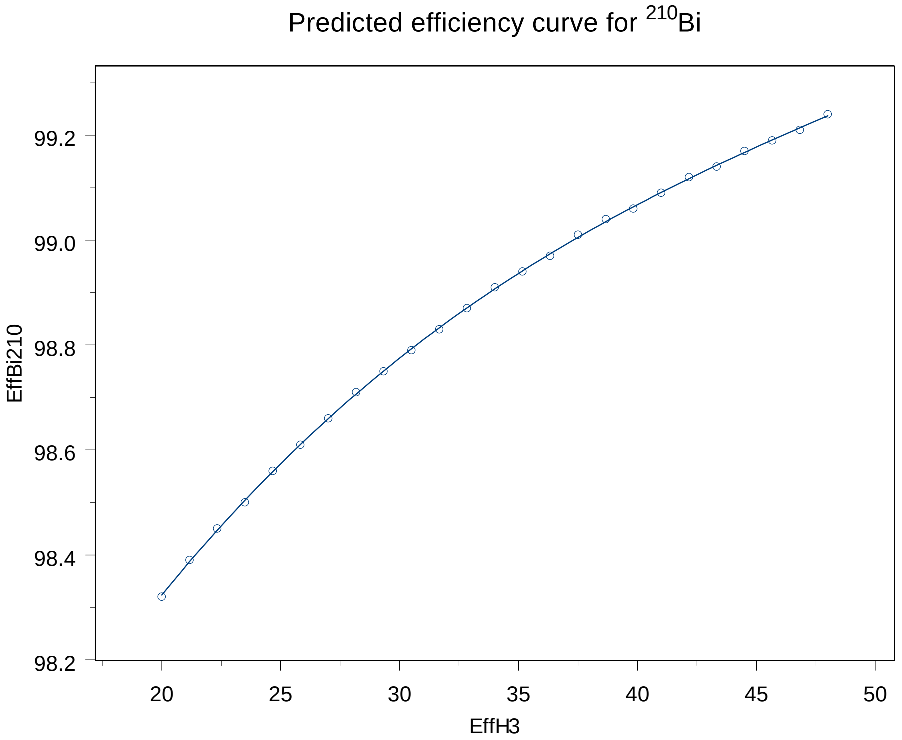
Calculated activity concentration of ^{210}Bi:

334 kBq.g^{-1}± 1.7 kBq.g^{-1}

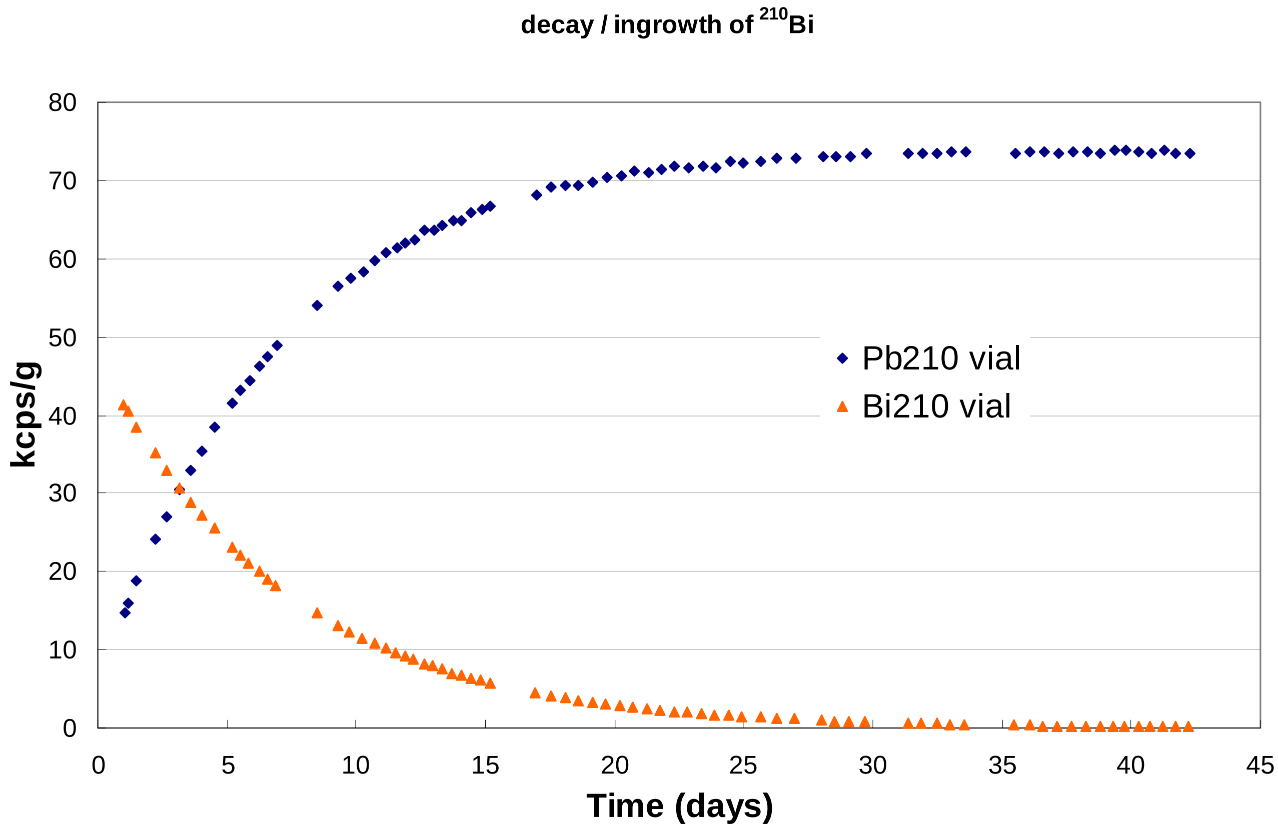
@ 17/10/2005 12:00

^{210}Po impurity content:

0.06% @ separation time



^{210}Pb Cerenkov vials



^{210}Pb standard

Standardised solution:

(529 ± 6)kBq/g @ 17/10 2005

Checked against coincidence counting:

(534 ± 12)kBq/g @ 17/10 2005

^{210}Pb standard - conclusion

The LS technique, using “Ciemat/NIST” in combination with Cerenkov counting, resulted in a lower uncertainty than achieved with classical methods

NPL has a stock of standardised ^{210}Pb solution that can be diluted to requested activity level (with insignificantly increased uncertainty)

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