Rapid method for determination of polonium isotopes in biological matter

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Topics

- Project description
- Polonium isotopes
- Analysis review
- Method and validation
- Results and discussions

Project

Radioactivity in wild living fish (2010-2011)

Funded by Austrian Ministry of Health

Scope

- **Determination of radionuclides concentration in wild fresh water living fish**
- **Ingestion dose calculation of manmade and natural radionuclides in human**
- **Which radionuclides contribute the most into ingestion dose?**
- **Are there geographical differences?**
- **Radionuclide concentration depending on the fish type**

Polonium isotopes

- 28 radioactive isotopes (Z=84, A = 192-218)
- ^{235}U, ^{238}U, ^{232}Th decay chain
- ^{210}Po ca. 100 µg per ton Uranium ore
- ^{210}Po comes in the atmosphere through ^{222}Rn (^{238}U)
- ^{210}Po specific activity 166 TBq g^{-1}
- Chemical valence -2, +2, +4 and +6
- Complex formation
- Volatility
- ^{210}Po (138 d, alpha 5,3 MeV)
- ^{209}Po (113y, alpha 4,9 MeV)

Review of polonium analysis

Two main methods

- Extractive organic material & Liquid Scintillation Counting
- Spontaneous deposition & Alpha spectrometry

Advantages

Liquid Scintillation Counting

- ✓ Easy
- ✓ Simultaneously ^{210}Po, ^{210}Pb, ^{210}Bi

Alpha-Spectrometry

- ✓ Easy
- ✓ No interferences
- ✓ No need to extract or separate Polonium
- ✓ No need to wait for equilibrium

Disadvantages

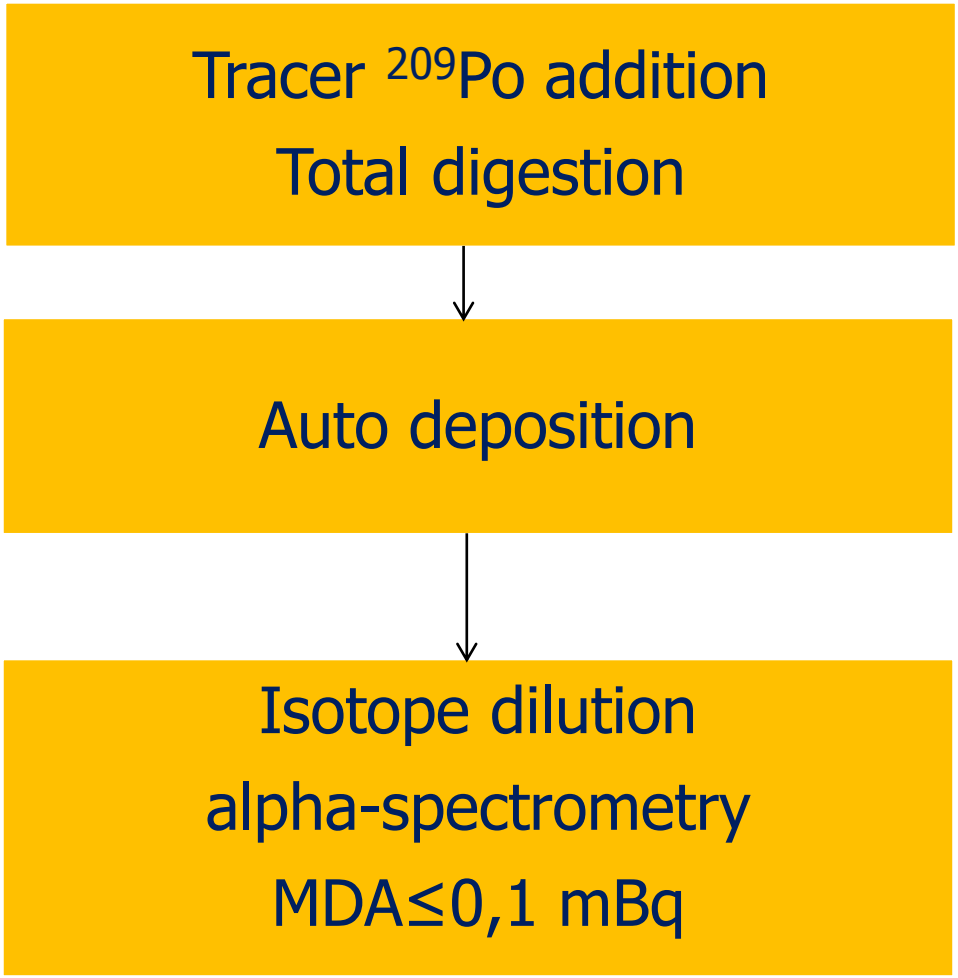
Liquid Scintillation Counting

- **Total chemical recovery is assumed**
  - **Same self absorption**
  - **Same extraction yield**
  - **Same Polonium volatility**
- **Alpha-Beta crosstalk correction**
- **Other interferences**

Alpha-Spectrometry

^{210}Pb can not be simultaneously measured with ^{210}Po

Methode


Tracer ^{209}Po addition
Total digestion
Auto deposition
Isotope dilution
alpha-spectrometry
MDA≤0,1 mBq

Methode validation

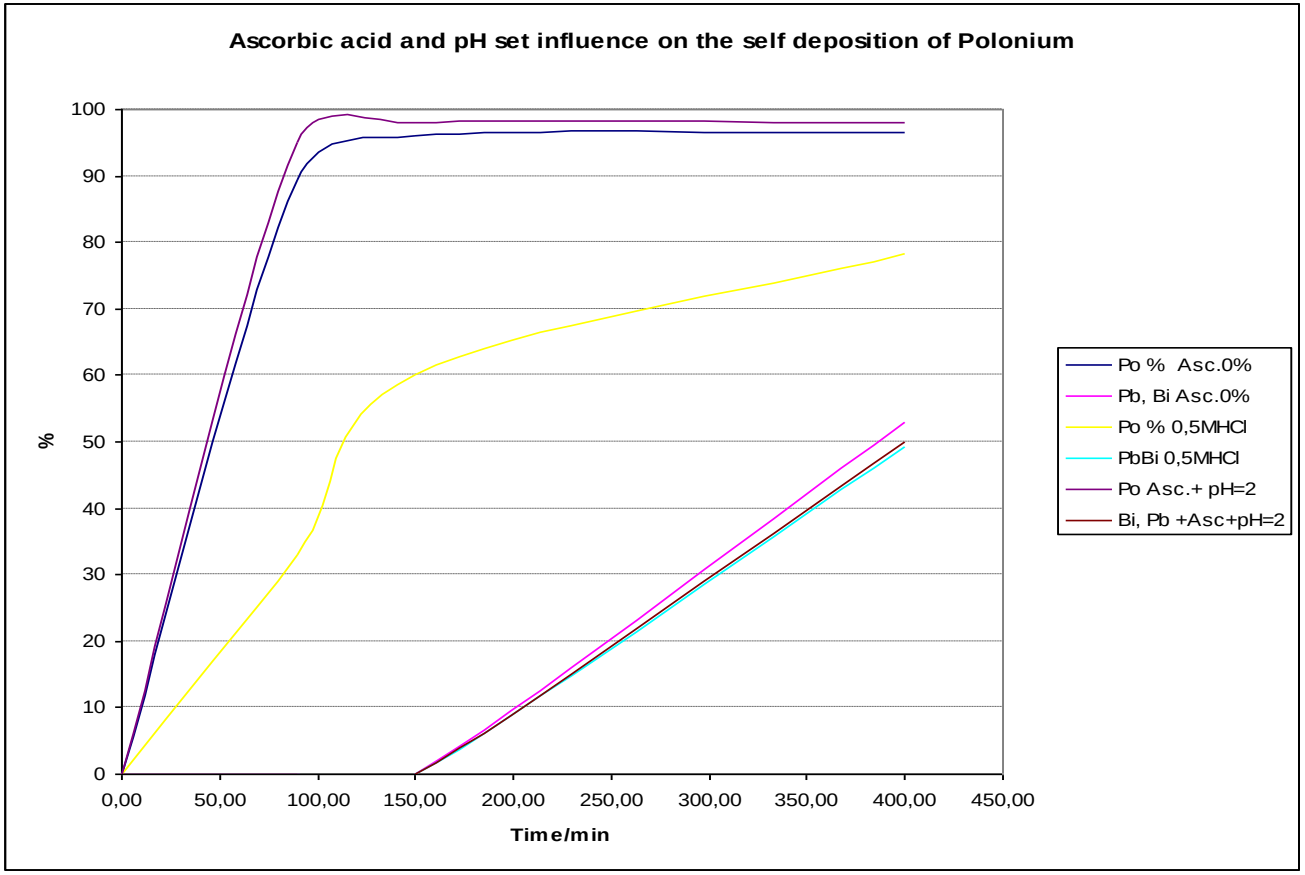


Fig.1. Influence of ascorbic acid and pH set during the self-deposition of Polonium, Lead and Bismuth

Method validation

Time interval correction

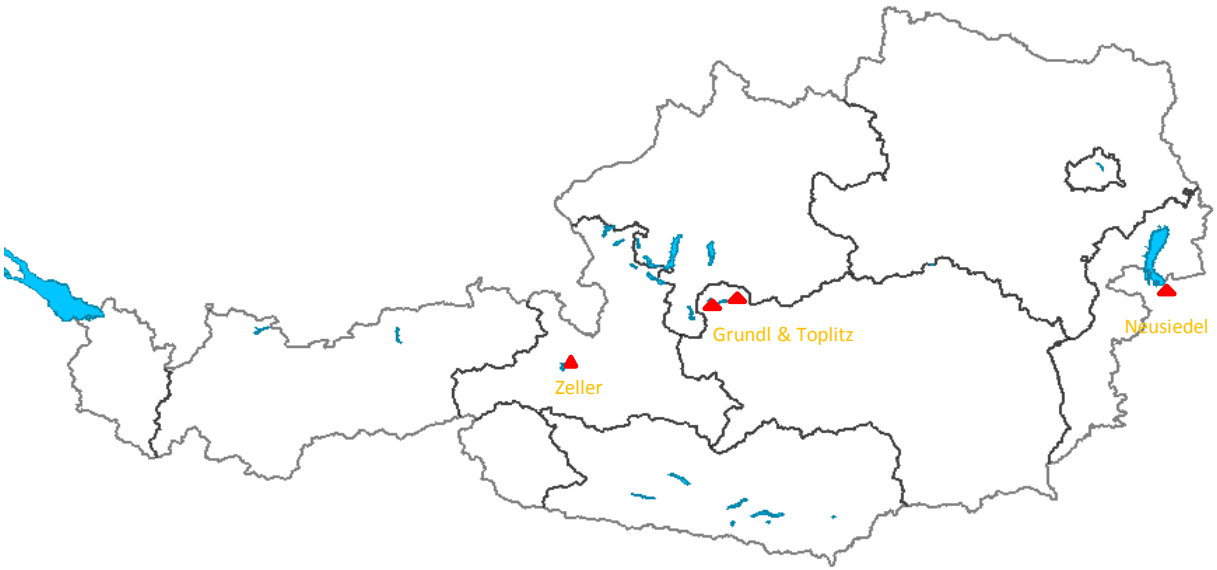
- **Reference time**
- **Equilibrium (^{210}Pb, ^{210}Bi)** ***prompt analysis**
- **Separation time**
- **Measurement time**

Interferences (^{210}Pb, ^{210}Bi)

Reference materials

Reference material	Matrix type	Information Activity Bq kg^{-1}	Laboratory Activity Bq kg^{-1}
IAEA-414	Fish	1,8-2,5 (11)	1,9 ± 0,2 (5)
IAEA-385	Sea sediment	31,2-35,3(16)	32,4 ± 1,9 (2)

Sampling location



Results and discussion

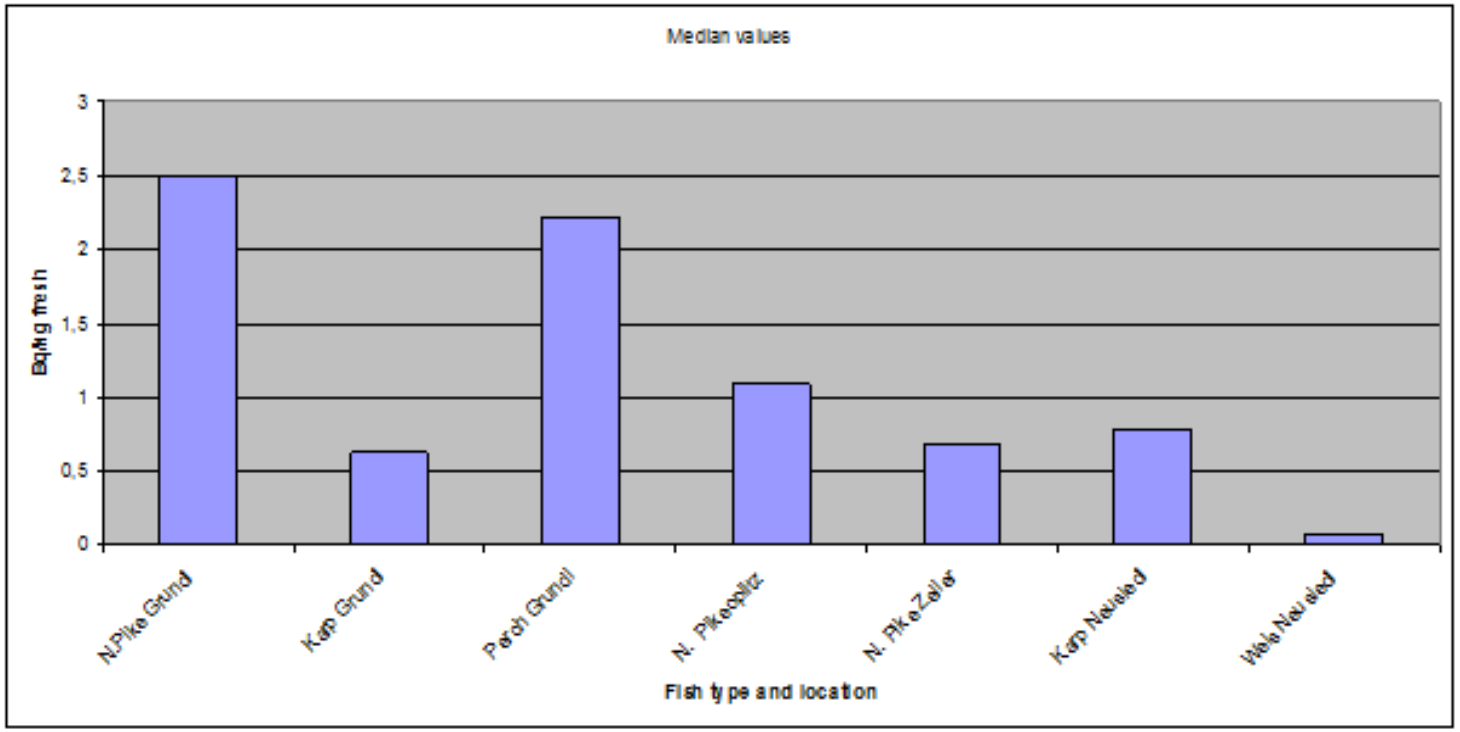


Fig. 2 Median values of the concentration of ^{210}Po in different type of fish in the Grundl, Zeller, Toplitz and Neusiedl lakes in Austria

Discussion

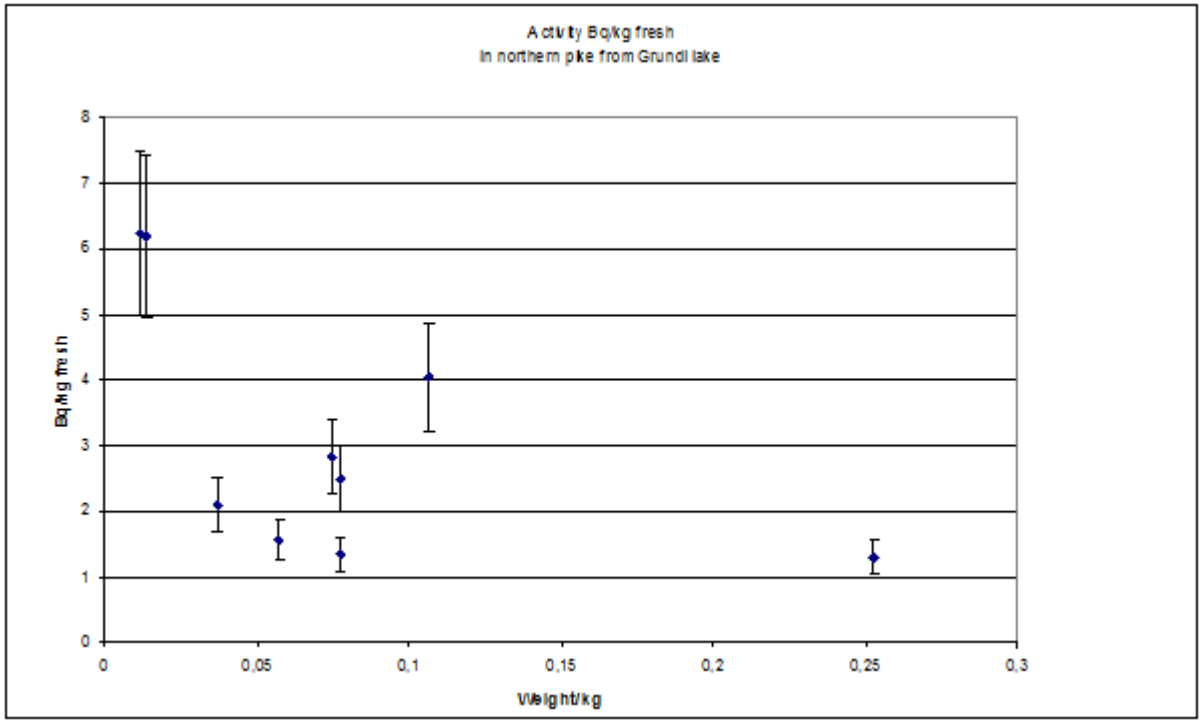


Fig. 3 ^{210}Po Activity concentration in northern pike in Grundl lake variation with fish weight

Results and discussion

COUNCIL DIRECTIVE 96/29/EURATOM of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation

Annex III, Table A. Ingestion dose coefficients for members of the public

Freshwater wild fish consumption in Austria is ca. 0,5 kg/year (*2010)

Group	Conversion factor	Ingestion dose
Children≤1a	26 µSv Bq^{-1}	58 µSv $year^{-1}$
Adults>17a	1,2 µSv Bq^{-1}	2,7 µSv $year^{-1}$
Worst case (0,5 kg/week)	26 µSv Bq^{-1}	4 mSv $year^{-1}$

Thank you for your attention