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Heavy metals and ^{210}Pb in Finland air for the years 2000 - 2005

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Collection and Aerosol samples

FINNISH METEOROLOGICAL INSTITUTE

- Finnish Meteorological Institute, Helsinki, Finland (daily aerosol samples).
- Special air sampling devices (TFIA-2 Staplex).
- The duration of each sampling was one week (7-8 days) of each month, for the years 2000 – 2005.
- For the weekly sampling we used Whatman grade 42 paper – fibre filters.
- A total of 72 measurements for those 6 years.

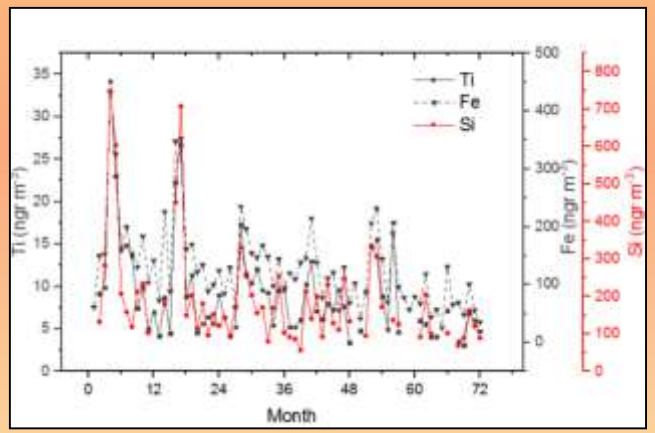
Evaluation of ^{210}Pb and heavy metal concentrations

- The filters underwent energy dispersive X-ray Fluorescense (ED-XRF) analysis for the determination of their content in **Pb**, Br, **Zn**, **Cu**, Ni, **Fe**, Mn, Cr, V, **Ti**, Ca, K, Cl, S, **Si**, Al and Na.
  - Non destructive technique for rapid, simultaneous multi-element analysis. When excited by an appropriate source, a sample will emit x-rays of energies that are characteristic for the elements composing the sample.
  - By measuring the energies of x-rays that are emitted from an excited sample and counting the number of x-rays of each energy, XRF allows us to identify which elements are present in a sample, and also determine the relative concentration of these elements within the sample.

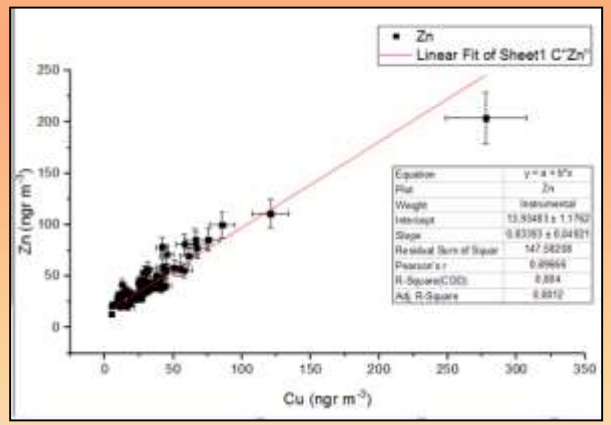
- Additional, the Finnish Meteorological Institute has collected daily aerosol samples for radioactivity monitoring purposes (**airborne ^{210}Pb**).
  - Installation in high resolution and accuracy low background Ge detectors (HPGe).
  - Receiving characteristic gamma radiation spectrum from each filter.

Experimental results

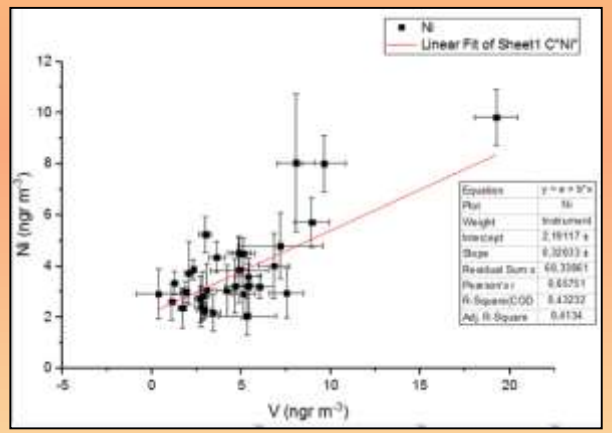
- There is a decline trend with the time for **Fe** and a slight decrease for **Ti**, **Si** (common source: **soil**).
- The high correlation coefficient observed between the **Cu – Zn** (R = 0.89) is an index of **traffic** source.
- The relative high correlation coefficient between the **Ni – V** values (R = 0.66) is an index of heavy **oil** source.



Strong correlation between Fe-Si-Ti is an index of soil source.



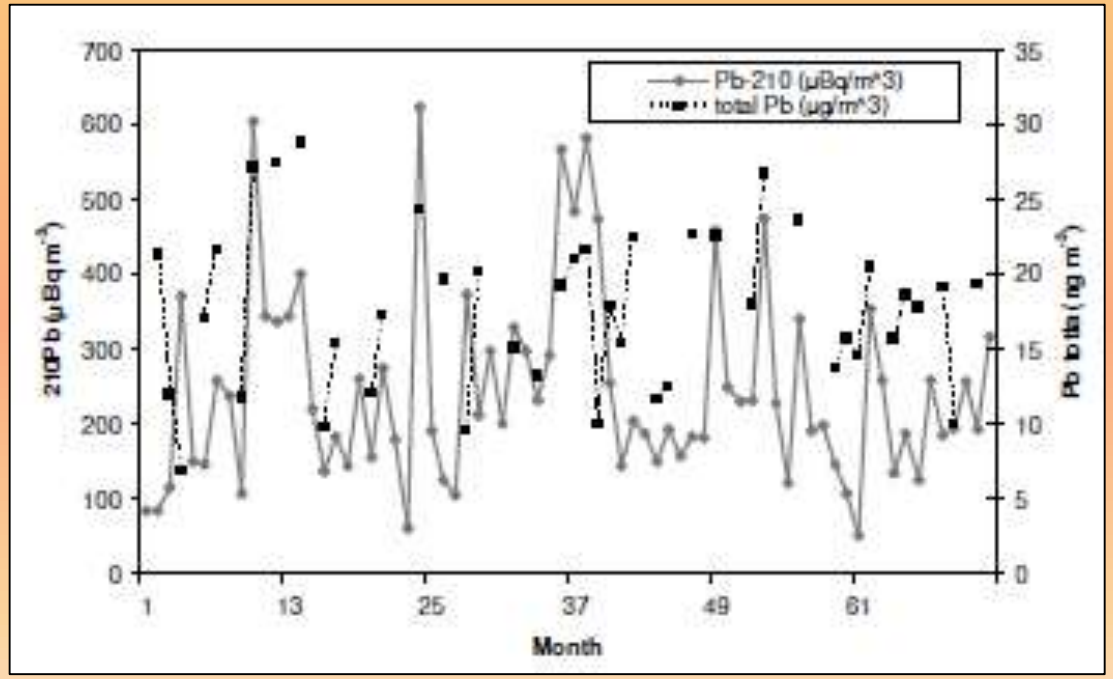
Strong correlation between Cu-Zn.



High correlation between V-Ni.

Experimental results

- The observed concentrations of Pb remain relative stable throughout the time period 2000 – 2005.
- ***Estimation of $^{210}Pb/Pb_{total}$.***



Concentrations of ^{210}Pb and Pb_{total} for the years 2000-2005 in Helsinki, Finland.

Experimental results

- High average concentration of Pb, 500 ngr m^{-3}, was typical of the air in central Helsinki throughout the '60s but after '70s decreased to around 150 ngr m^{-3} (*Mattsson and Jaakkola, 1979*).
- ***The observed average concentration of lead in the present study, equal with 17.7 ngr m^{-3}, reveals a decrease of its concentration of the order of one magnitude since '70s.***

- Other observed mean concentrations in ngr m^{-3}:
  - Cu: 34.5
  - Zn:44.9
  - Br: 15.8

  are also lower almost half of those observed during '70s:
  - Cu: 70
  - Zn: 172
  - Br: 49

Experimental results

- ✓ Anthropogenic lead emissions have low content of ^{210}Pb, so the anthropogenic lead emissions tend to decrease the specific activity of ^{210}Pb in the atmosphere.
- ✓ The ^{210}Pb specific activity is the ratio of the ^{210}Pb activity concentration to the total concentration of stable lead.
- ✓ The observed values of $^{210}Pb/Pb$ vary between 3.5 – 58 kBq g^{-1}.
- ✓ Previous reported values of ^{210}Pb in Southern Finland ranged between 0.67- 39 kBq g^{-1} and between 3.9 – 91 kBq g^{-1} in Northern Finland (Kauranen and Miettinen, 2015).
- ✓ with minimum values during the cold winter, due to the increased lead emissions from energy production (Paatero et al., 2015).
- ✓ The ^{210}Pb activity concentration in precipitation shows a decreasing trend from southeastern Finland north-westwards.
- ✓ The deposition of ^{210}Pb shows a seasonal variation with minimum in spring and maximum in autumn and winter.

Conclusions

- **Ti, Fe, Si**: strong correlation between them ⟶ common source: **soil**
- **Cu, Zn**: high linear correlation ⟶ common source **traffic**
- **V, Ni**: common source **oil**
- Pb: since 1970, the concentrations of lead in the atmosphere have been reduced up to one order of magnitude (anthropogenic sources).
- ^{210}Pb/Pb : specific activity of ^{210}Pb.
- Next stage: *Determination of **source apportionment** [has been used to estimate the contribution of sources to the mass of individual pollutants, total fine particle mass (e.g., PM2.5), and to health effects ranging from in vitro toxicologic effects and human health effects].*