Comparison of leaching methods for the estimation of bioavailability in two CCA-contaminated soils

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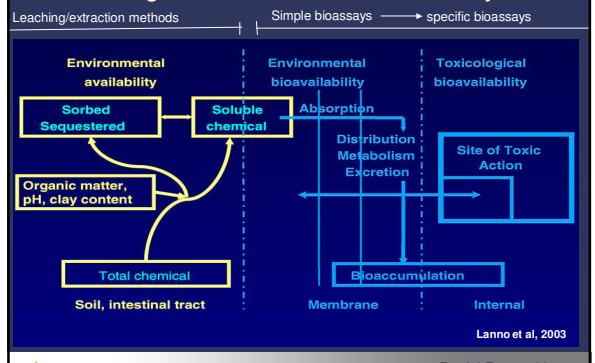
Background - Risk Assessment of polluted sites

- Total concentrations of contaminants compared to permissible levels (e.g. PNECS, guideline limit values from national EPA´s) → estimation of risk
- Lack of site-specific information, soil conditions , combination effects, and bioavailability may lead to over- and underestimation of risk
- Other tools to better estimate risk is necessary

Background - Risk Assessment of polluted sites

- Combination of toxicological methods and chemical analysis is beneficial
- Standardised bioassays (USEPA, ASTM, OECD,etc.) have been proposed
  Plants, soil living organisms e.g. earthworms, springtails, plants etc.
- Ecologically relevant, but often laborious → high costs!!
- Spatial distribution is necessary at large contaminated sites
- Fast och cheap surrogate methods for screening purposes are needed

Background - What is bioavailability?



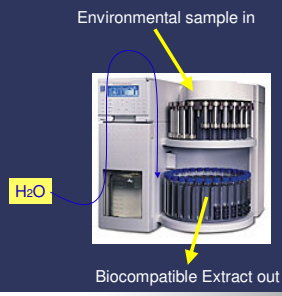
Aims of the study

- **Compare the relative bioavailability of arsenic and arsenic species between methods**
  - Leaching/extraction efficiency – yield of metals/metalloid in the leachates
  - Cytotoxicity and genotoxicity in the leachates

Leaching/extraction methods for estimation of bioavailability

- **ASE - Accelerated Solvent Extraction (or Pressurized liquid extraction (PLE)) 10MPa and 150 ℃, 100 ℃, 50 ℃**
- **Batch leaching EN- 124 57-2, L/S=10, 24h.**
- Batch leaching 0.01 M $CaCl_2$, L/S 10, 2h (Houba et al. 1996).
- **IVG anaerobic, 37℃, 2 x 1h (Rodriguez et al., 1999)**

ASE - Accelerated Solvent Extraction

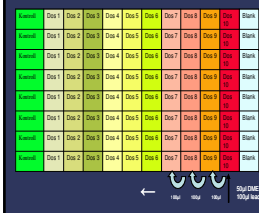


- High through put, ca 20 min/sample
- High temp. & pressure
- Solvent is water
- Medium effective extraction
- Worst case scenario of mobile and water soluble fraction of contaminants

Bioassays

✓ ***L-929***-cytotoxicity: General toxicity, disturbed basal cellular functions affecting growth.

✓**Genotoxicity using CHO-cells: mutagenic properties e.g. metal/metalloid (Helleday et al.2001)**



- **AA8:Wild-type**
- **UV4: Deficient in DNA-repair**
- **UV5: Deficient in DNA-repair**
- **EM9: Deficient in DNA-repair**

Test soils

Wood impregnation sites using CCA-based preservatives

	Forsmo mg/kg	Robertsfors mg/kg
Arsenic	276	311
Cadmium	3	4
Chromium	45	54
Cobalt	6	4
Copper	18	10
Lead	20	13
Nickel	11	6
Zinc	135	105
TOC	2.6%	8.7%

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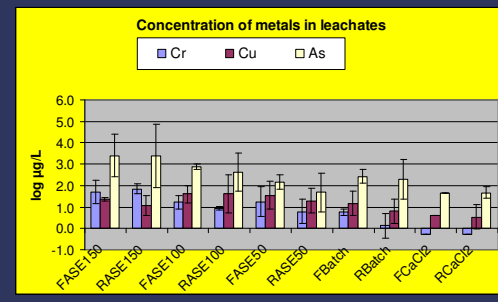
Results



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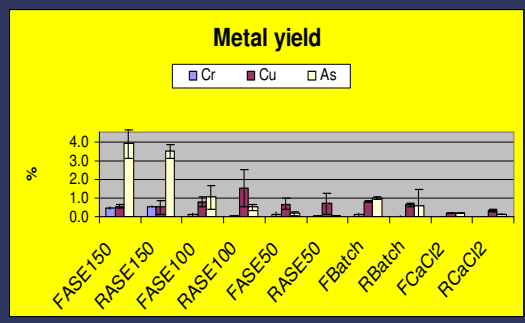

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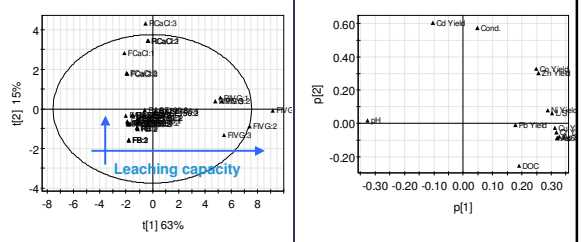
Principal component analysis (PCA)

Chemical characteristics



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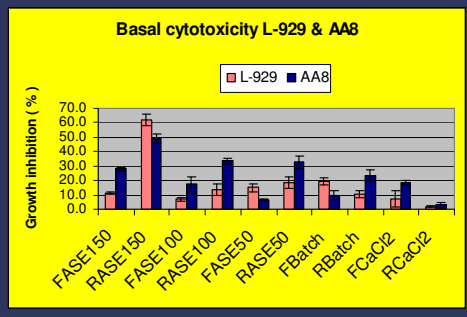
Leachate toxicity



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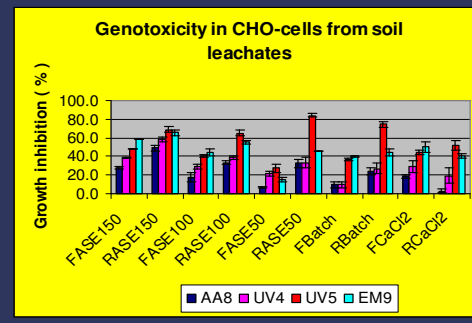
Leachate Genotoxicity



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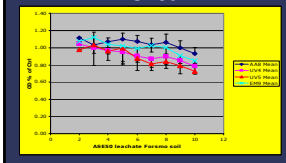
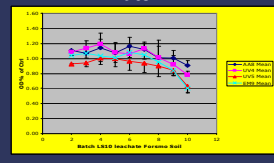
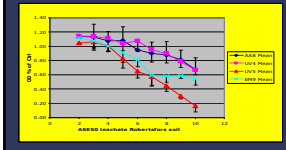
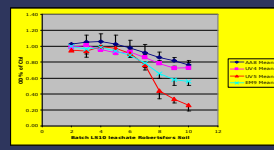
ASE50 / Batch





Forsmo leachates





Robertsfors leachates

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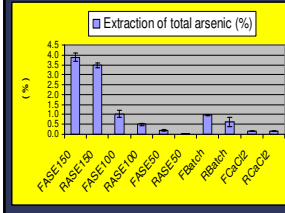

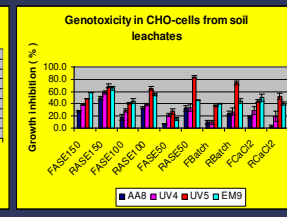

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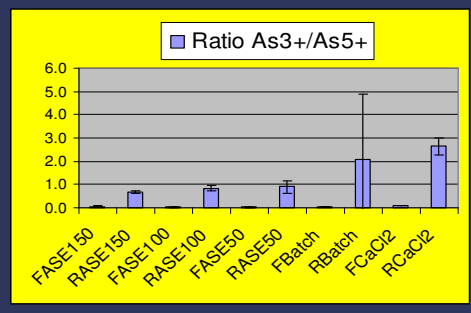

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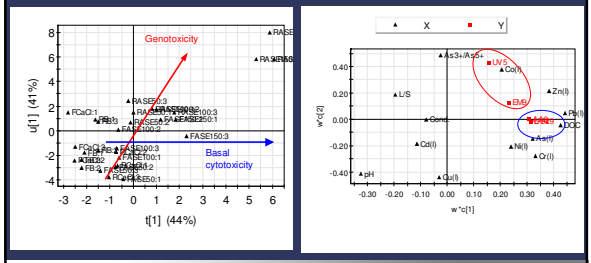
Partial least squares to latent structures (PLS)

Exposure vs Toxicity



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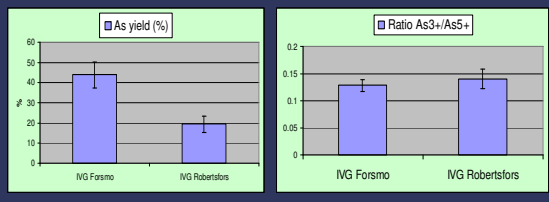
Risk associated to oral intake according to IVG



Higher Yield in Forsmo
= Higher bioavailability

Similar ratio of As^{3+}/ As^{5+}

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Conclusion 1

- Higher yield and toxicity in PLE/ASE at 150 C – suitable for screening purposes to assess the toxic potential in soil samples
- Comparable results from ASE at lower temperatures (100℃ & 50℃) and the batch leaching methods, EN12457-2 and 0.01M CaCl2

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Conclusion 2

- **Speciation of Arsenic is essential for risk assessment of CCA - contaminated sites**
- **Both analysis of chemical speciation and bioassays for genotoxicity reveal these differences compared to total concentrations!**

Conclusion 3

- Drink Forsmo soil leachates - Eat Robertsfors soil!

Thank you for your attention!!