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Leaching tests in risk assessments of contaminated areas

A project within the Environmental Protection Agency's programme on Sustainable Remediation ("Hållbar Sanering")

Nordrocs, Malmö 20 september 2006
Parallel session 2 – Contaminant leaching
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Outline

- Description of the project on soil contaminant leaching
- Results from evaluation of leaching tests (~150 tests)
- Conclusions and preliminary methodology for leaching tests in risk assessments
- Calculating ”Kd-values” from leaching tests – pit-falls!
- Limitations and uncertainties when using standardised leaching tests for waste

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Project organisation

- Kemakta Konsult AB
  - Gabriella Fanger, Lars Olof Höglund, Mark Elert, Celia Jones
- SGI, Swedish Geotechnical Institute
  - Ebba Wadstein, Pascal Suér
- DHI Water and Environment
  - Jette Bjerre-Hansen, Christian Groen

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Critical issues

- Leaching tests more and more common
- Guidance for performing and interpreting results is lacking
- May lead to a variety in risk assessments between different contaminated sites

➔ QUESTIONS

- Analysis based on total content - how much is available for leaching?
- Controlling mechanisms of leaching? How to choose tests?
- Batch tests vs percolation tests – similar use and results?
- Can leaching tests be used in risk assessments?

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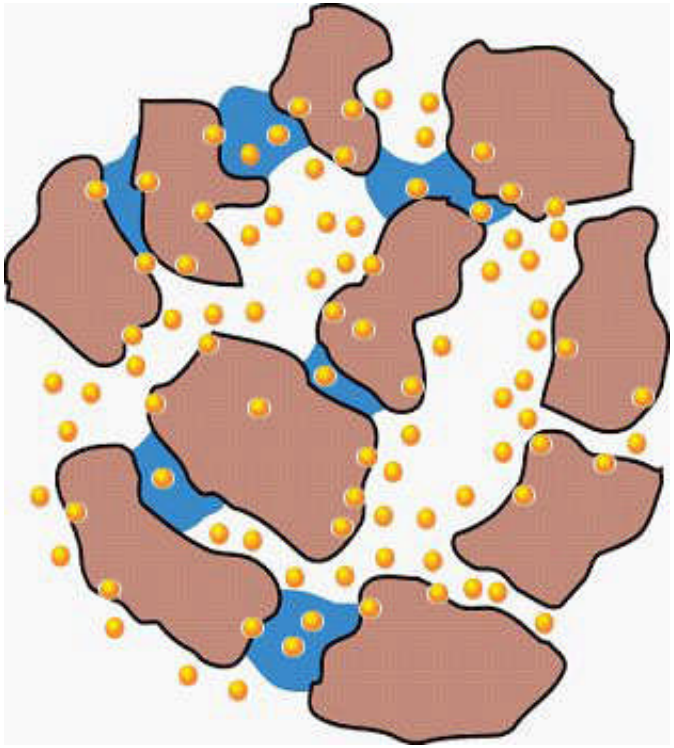
Definition of "Kd-values"

- Kd is used in transport models and in the Swedish model for generic guidelines to determine leaching
- Project definition

Kd (l/kg)=

total content (acid leachable) [mg/kgTS] divided with the concentration in eluate from leaching test [mg/l]

- Kd is used to describe leaching, **not** sorption to uncontaminated soil!



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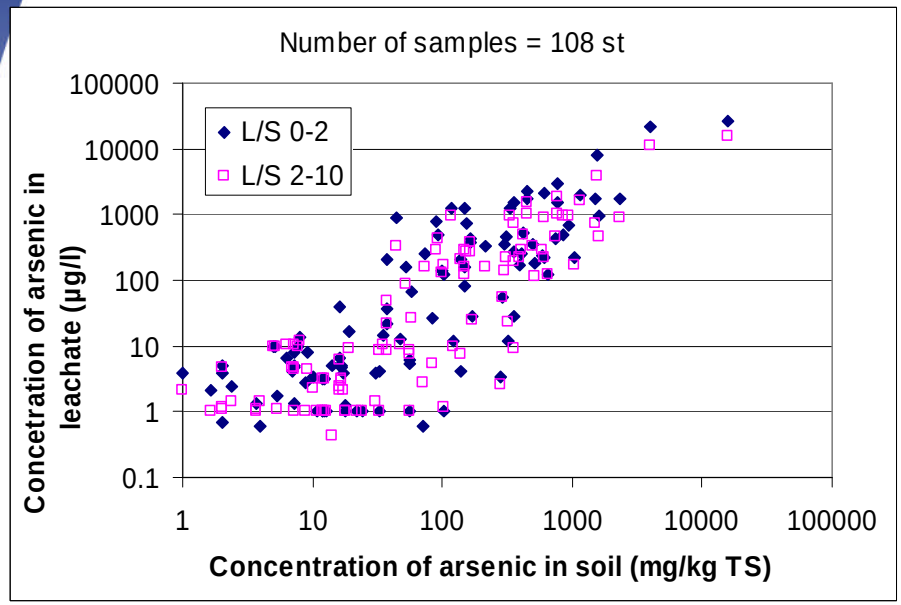
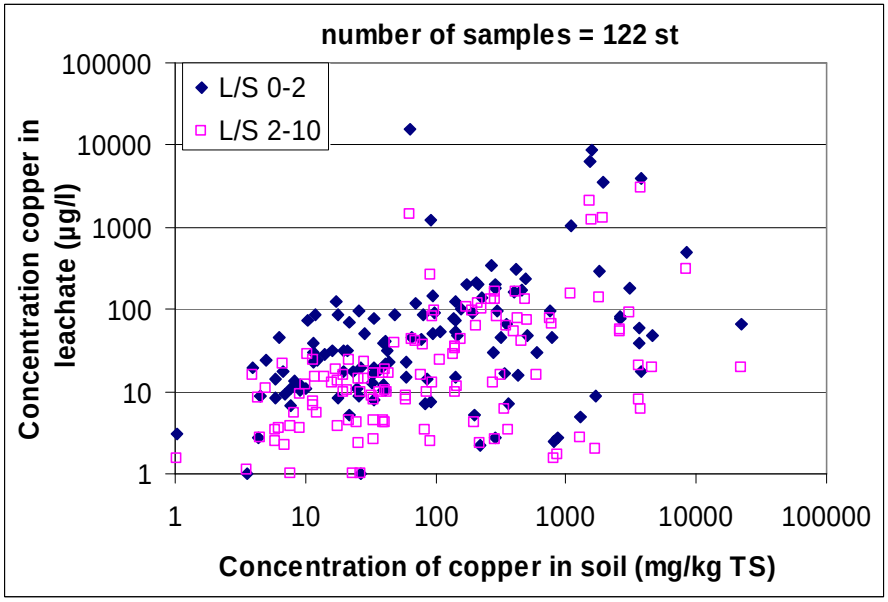
Total content and leaching (>100 batch tests from different sites)





- Linear correlation for arsenic and cadmium, possibly copper and lead - Kd can be calculated!
- No correlation for nickel, zink, chromium (large data set, different factors controlling leaching)
- ”Kd-values” in different soils – great variation (factor 100-1000)
- Very high Kd-values - use with care!

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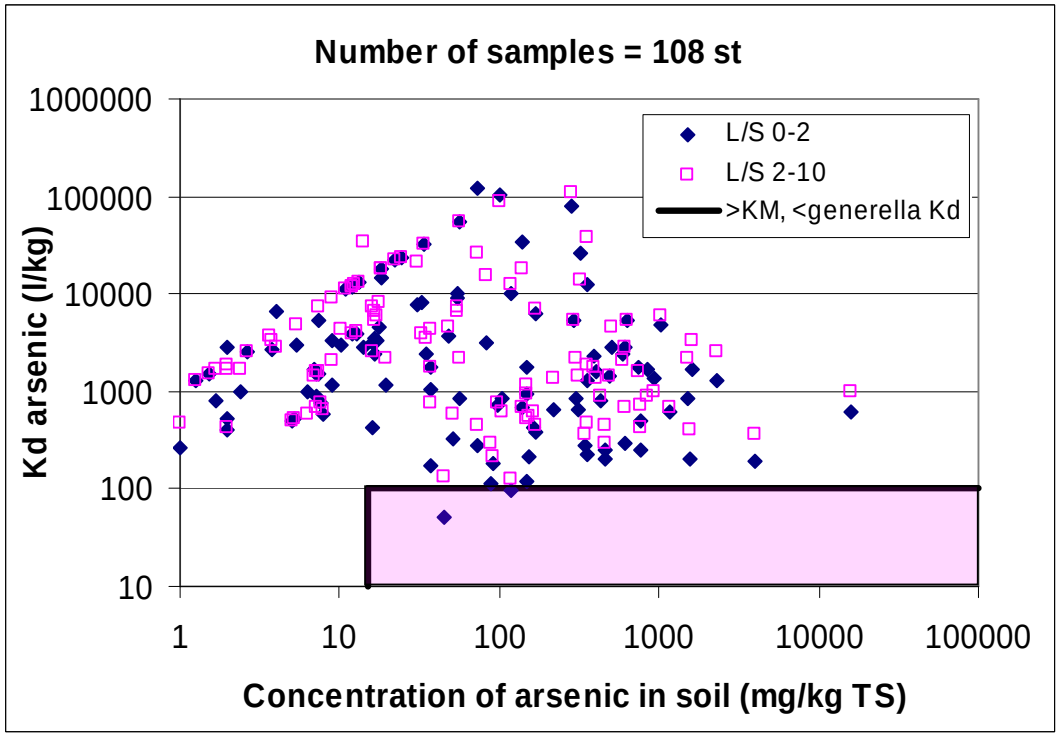
"Kd" and data in Swedish model (>100 batch tests from different sites)



- 80-95% of the calculated Kd-values > Kd for generic guidelines (SEPA)
- Conservative Kd-data in general model!
- Lower Kd for soils at wood treatment plants – higher leaching
- No background information to separate different geological materials

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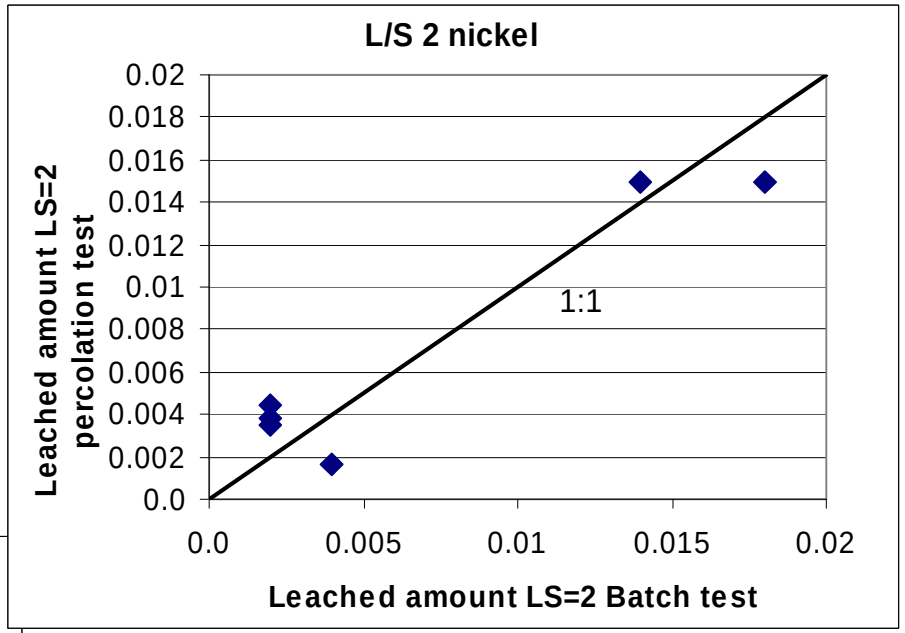
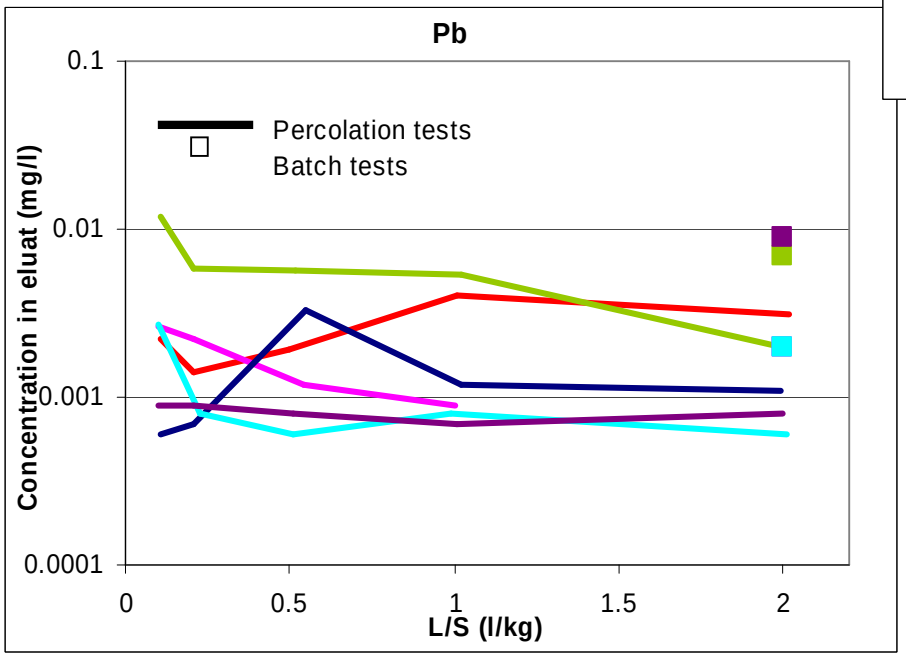
Percolation test vs Batch test

- Reasonably similar results for L/S 2 and 10 for nickel and zink
- Higher leaching in percolation test for arsenic and chromium
- Several tests on the same soil - Kd 3 times higher in batch test (As)
- Possibly higher leaching in batch test for lead





➔Results indicate that batch tests may underestimate leaching

➔ The variation in leaching between soil samples from a site is generally greater than the variation between the methods

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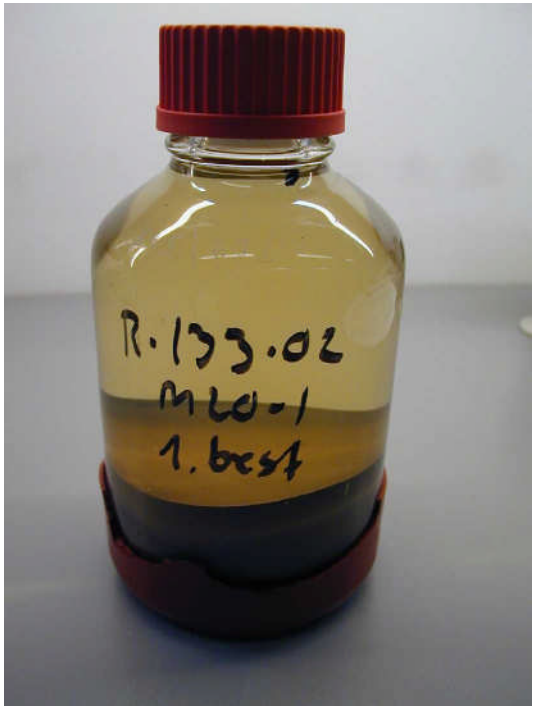
Conclusions – use of standardised leaching tests in risk assessments

+ Advantages with standardised tests
  - Allows comparison of results from different sites and materials
  - Quality control (laboratories, etc)
- ”Simplification of reality”
  - Performed under a short time
  - Great amounts of water – dilution
  - Naturally organic compounds not added



➔ When evaluating important to consider
  - Time scales – extrapolation to long term releases or to other materials and levels of contamination should be done with care !
  - Changes in pH or redox potential will have a great impact on leaching
  - Controlling processes (solubility limited leaching, kinetic effects etc; Kd-calculation not relevant)

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Proposed set of leaching tests

Leaching test	Aim	Results
BATCH TEST L/S 2 and L/S 10. EN 12457-3	Basic information on leaching behaviour	Concentration in eluate and leached amounts at 2 L/S
PERCOLATION TEST pr EN 14405	Information on leaching with time and controlling processes	Concentration in eluate and leached amounts at 7 L/S
ACID NEUTRALISING CAPACITY (ANC)	Indicates the sensitivity to long term changes in pH	Amount of acid to adjust pH to 4
pH STATIC TEST prEN 14997 at selected pH (4.5, 6 och 7.5)	Change in leaching to long term changes in pH	Concentration of contaminants in eluate at different pH

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Calculation of "Kd-values"

"The aim of the leaching test is to describe the maximum leaching that may occur from a soil in a long-term perspective, while being reasonably conservative"

- Use maximum concentration in eluates from
  - batch- and percolation tests (L/S, samples)
- Consider the potential long term effect in leaching
  - pH-static tests, ANC
- Compare with in-situ Kd from field measurements
  - groundwater, soil
- Other tests
  - lysimeters

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Uncertainties and continued work

- Short contact time in leaching test
- Geochemical modelling indicates that equilibrium is not reached!

⇩

- Follow-up project – case studies
- Recirculation tests to investigate equlibrium conditions
- Prepare more detailed guidelines!
  - Use of leaching tests and other field or laboratory data
  - Interpretation of results for transport models and risk assessments

- Project organisation, phase 2
  - Kemakta, project leading
  - SGI (Swedish Geotechnical Institute)
  - IVL (Swedish Environmental Research Institute)
  - SLU (the Swedish University of Agricultural Sciences)
  - KTH (Royal Institute of Technology)