B9. Behandling av gruvavfall med hjälp av basiska restprodukter

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Part 1 - Solidification/Stabilisation methods

Part 2 - Ashes for treatment of soil contaminated by mining related activities

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Part 1,

Solidification/Stabilisation methods

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Principle

- Mix additives with sediment, soil, material to improve:
  - The geotechnical properties (increase the strength)
  - The environmental properties (reduce metal leaching)

of the material to be treated in order to e.g. utilise it in constructions, dispose it of in a safer way.

Factors influencing leaching

- pH: Most metals are less mobile at high pH

  $Me^{2+} + 2CaCO_3 + 2H_2O \rightarrow Me(OH)_2 + 2HCO_3^{-} + 2Ca^{2+}$

- Organic matter: metal ions bind to organic matter
- Redox: sulphide formation and in general reduced mobility for metals with different oxidation states (e.g Cr, V…)

Materials / Additives

- Dredged sediment, metal contaminated soil, mine tailings
- Cement, lime, coal fly ash, blast furnace slag, paper mill sludge

Paper mill by-products

- Calcium carbonate by-product (mesakalk)
- Green liquor dregs (Grönlutsslam)
- Ash

Stabilisation of mine waste with calcium carbonate residues and sewage sludge (Linda Höckert, 2007)

- Mine waste

+ 6,6% mesakalk and 3% sludge

- Results:
  - pH increased from 3 to near neutral in the leachate from treated waste
  - Metals concentrations were 40 to 4000 times lower in the leachate from treated waste

Hornträsk mine, Lyckselse (GeoEnvix, 2006)

- Injection of calcium carbonate sludge and sewage sludge in an open pit mine filled with waste rock.
- Alkaline and anaerobic environment
- Reduction of metal leaching (copper) and a clear increase in pH

Green liquor dregs (Grönlutsslam)

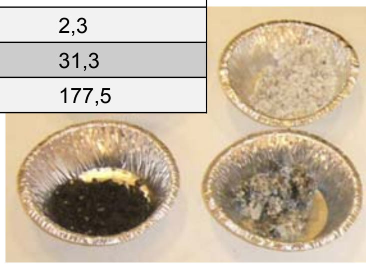
- Solidification/stabilisation of mine tailings with GLS and other by-products from a paper mill (fly ash and bark sludge)
- 2 interesting properties of GLS:
  - High pH
  - Low permeability
- 2 types of test:
  - Permeability tests
  - Leaching tests

GLS

Green liquor dregs

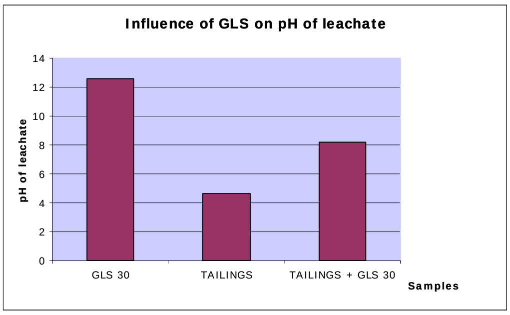
1st results : GLS with different properties

Sample	Permeability (m/s)	pH of leachate	EC (mS/cm)
GLS 30	1,2 E-06	12,55	2,3
GLS 30 EM	2,2 E-08	12,21	31,3
GLS 31	2,5 E-07	13,04	177,5



Green liquor dregs

1st results : influence of GLS on tailings



Sample	Permeability (m/s)
Tailings	3,4 E-07
Tailings + 10% GLS30	2,8 E-07

Green liquor dregs

Future tasks:

- Permeability tests on tailings mixed with 30% GLS + Fly Ash
- Batch leaching tests in oxidised conditions on tailings, tailings & GLS and tailings & GLS + Fly Ash

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Ashes for treatment of soil contaminated by mining related activities

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Europeiska regionala utvecklingsfonden

In Sweden

- 1 million tons of ashes per year
- Utilization:
  - Use for forest fertilization
  - In roads and other surface constructions
  - As stabilizing amendment for contaminated soils – to reduce contaminant spread in the environment

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Coal and biofuel fly ashes

pH ≈ 12
Particle size < 7 µm

- FA – Fe, Al, Si, Ca, CO_3 → clays, lime
- Increase of soil pH → decreased leaching of metals:
  - Precipitation
  - Metal sorption
  - Cation exchange

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Pilot scale experiment

Contaminants (mg/kg)
Cu = **327**
Pb = **3743**

Soil pH=4

Experimental design:

Contaminated Soil + 5% Fly Ash (FA) + 5% OM (w/w)

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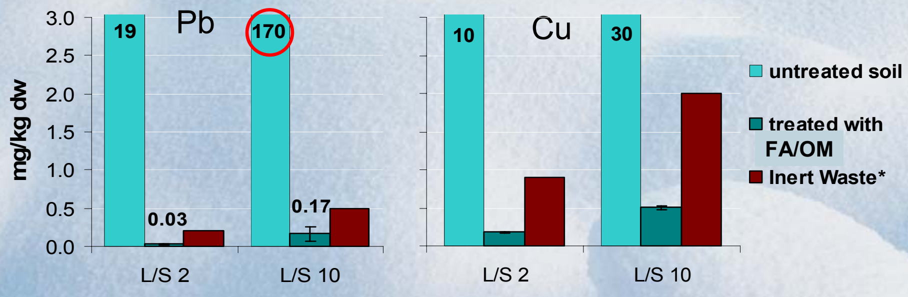
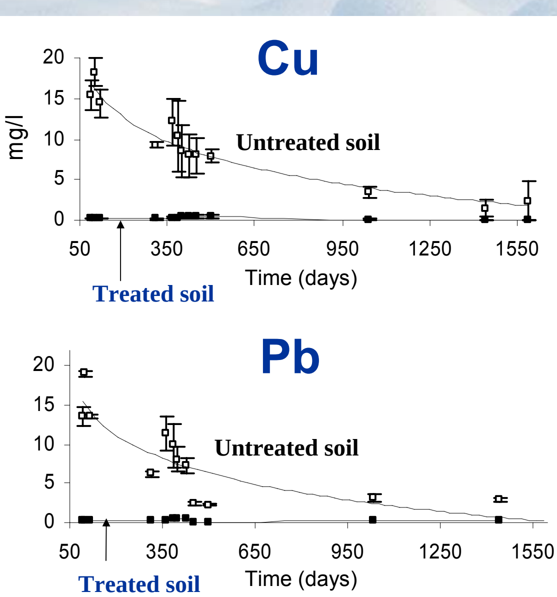
Batch leaching test –
waste characterisation



	L/S 2 l/kg		L/S 10 l/kg	
	Pb	Cu	Pb	Cu
	Criteria values, mg kg^{-1} dry substance			
HW	25	50	50	100
NHW	5	25	10	50
IW*	0.2	0.9	0.5	2

Leaching in field
(lysimeter experiment)



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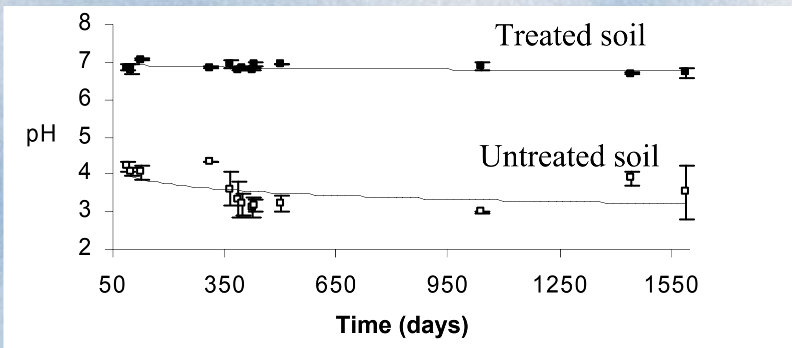
Observed buffer capacity



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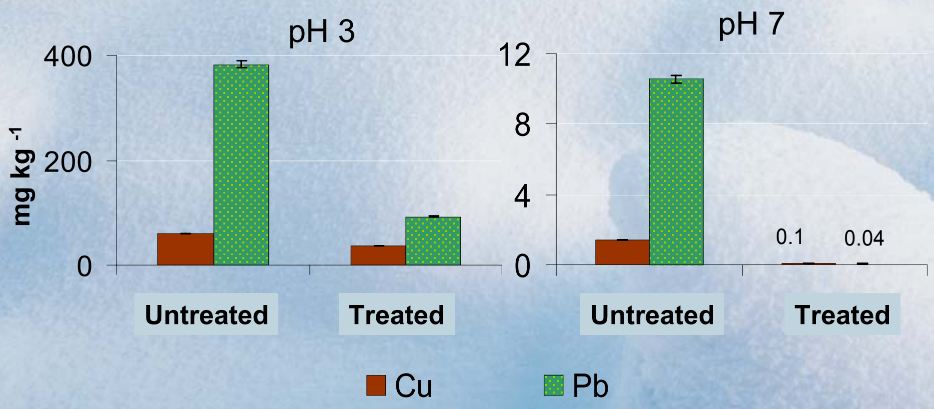
Resistance to acidification

pH stat leaching



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Build up of new mineral phases (from equilibrium calculations)

- Al and Fe (hydro)oxides – sorption of metals
- Secondary minerals: CuO tenorite, $Cu_2(OH)_2CO_3$ malachite, $PbCO_3$ cerrusite

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Recovery of key soil functions

Increased:

- soil microbial biomass and respiration
- enzyme activities → turn-over of nutrients
- plant colonization → surface protection

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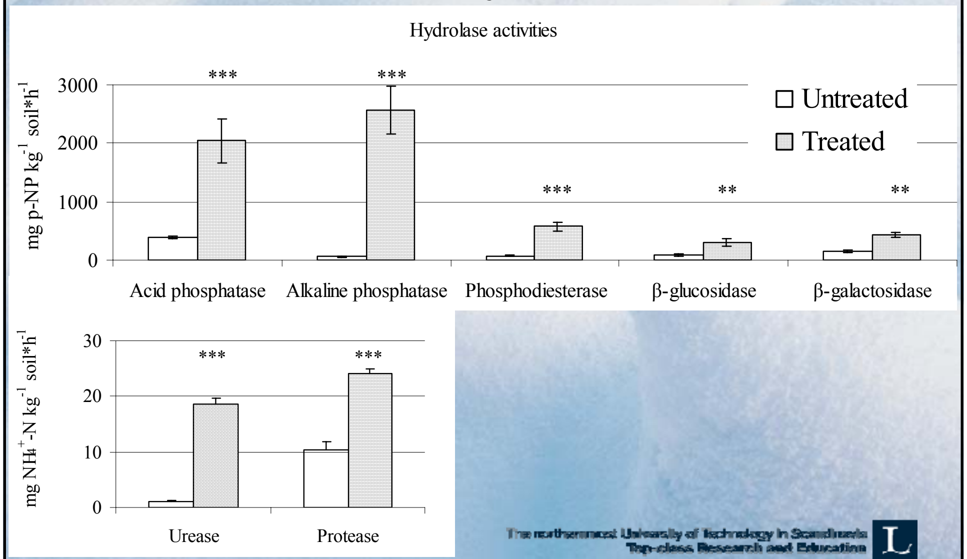
Recovery of key soil functions

Increased enzyme activities



Recovery of key soil functions

Plant establishment

Cu/Pb contaminated soil **FA/OM amended soil**

4 years after the treatment

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Conclusive remarks

- Soil treatment with FA/OM reduced soil acidity, Cu and Pb leaching and restored key soil functions
- pH neutralization was not the only mechanism responsible for the metal retention

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