Elinkeino-, liikenne- ja ympäristökeskus
Närings-, trafik- och miljöcentralen
Centre for Economic Development, Transport and the Environment

Sequential leaching procedure – tool for risk assessment of contaminated sites

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Area of operation of Northern Ostrobothnia ELY Centre

The main area of operation of the ELY Centre is Northern Ostrobothnia. It produces competence and cultural services to the Kainuu region, and the services of the transport and infrastructure area of responsibility.

The Northern Ostrobothnia ELY Centre was formed of the following abolished agencies

- Employment and Economic Development Centre for Northern Ostrobothnia
- Northern Ostrobothnia Regional Environment Centre
  (except for environmental permit matters, which were transferred to the regional state administrative agency AVI)
- Road Administration Oulu Road District
- Department of Transport and parts of the Department of Education of Oulu State Provincial Office
- Regional employment and economic development offices (TE; 6) were integrated into the service network

Elinkeino-, liikenne- ja ympäristökeskus
Närings-, trafik- och miljöcentralen
Centre for Economic Development, Transport and the Environment

Personnel
- *ELY 372*
- *TE offices 222*

Director General
Matti Räinä

Strategy Unit
Head of Unit
Riitta Ilola

Administrative Unit
Administrative Director
Timo Ronkainen

Strategy Operations
Development Manager**Juha Levy**

Customerships
Customership Manager
Heino Heikkinen
Private Custom. M.
Helena Pajunen

Precautionary Serv.
Secretary for P.S.
Tapani Rossi

Communications
Head of Comms.
Tuula Pörhö

Structural Funds
Group Manager
Eine Kela-Löytynoja

Industries, labour force, competence and culture

Head of the area of responsibility
Leila Helaakoski

Units:
- **Rural Areas and Energy**
  Timo Lehtiniemi
- **Competence, Employment and Enterpreneurship**
  Maire Mäki
- **Innovations and Internationalising Business**
  Pauli Berg

Transport and Infrastructure

Head of the area of responsibility
Matti Räinä

Units:
- **Control**
  Tuomo Kanniainen
- **Support and Development**
  Hannu Tolonen
- **Permit Services**
  Tapani Rossi
- **Transport System**
  Timo Mäkikyrö
- **Planning**
  Risto Leppänen
- **Maintenance and Construction**
  Markku Tervo

Environment and Natural Resources

Head of the area of responsibility
Heikki Aronpää

Units:
- **Unit for Regional Land Use**
  Liisa Koski-Ahonen
- **Nature Protection Unit**
  Eero Melantie
- **Environmental Protection Unit**
  Juhani Kaakinen
- **Water Resources Unit**
  Timo Yrjänä

Employment and Economic Development Offices

Environmental Protection Unit

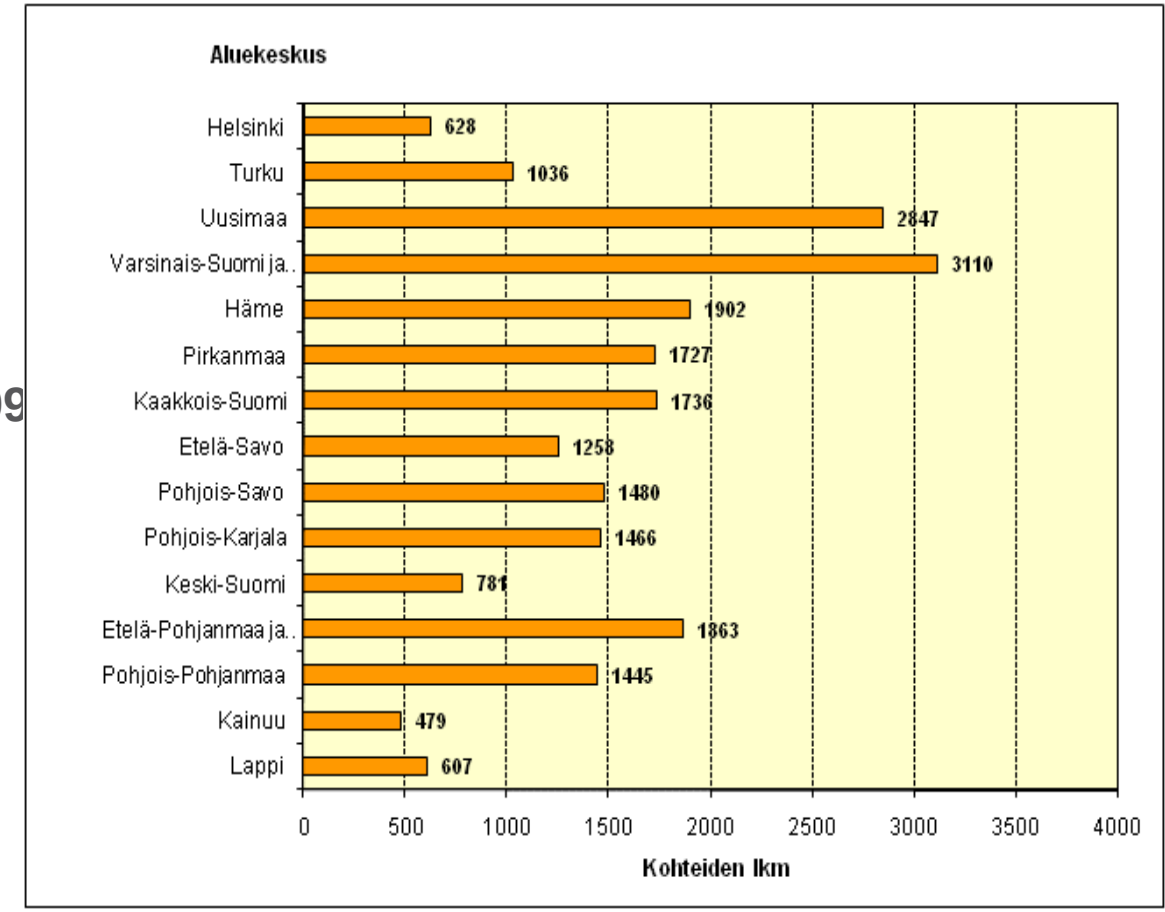
- planning and promoting environmental protection
- environmental protection with respect to
  - industrial sites
  - energy generation
  - residential areas and scattered settlement
- environmental impact assessment (industrial sites)
- control of environmental permits
- improvement of waste management
- remediation of contaminated sites
- …

Remediation of contaminated sites

- In 2004 Finland's environmental administration was aware of more than 20,000 sites where the soil could be contaminated
- Many activities are known to cause soil contamination; thus, in urban areas, the need for a site investigation usually arises because of a change in land use.

National **database for soil statuts ”MATTI”**

- **Toimiva kohde**: **8326**
- **Selvitystarve: 8533**
- **Arvioitava/puhdistettava: 2199**
- **Ei puhdistustarvetta: 3307**
- **Yhteensä: 22 365 kpl**



Activities

- Waste treatment 15 %
- Repair shops 12 %
- Shooting ranges 5 %
- Metal industry 6 %
- Saw mills and impregnation sites 5 %
- Other brances of industry 11 %
- Others 11 %
- Service stations, fuel storages 35 %

Government Decree on the Assessment of Soil Contamination and Remediation Needs

- This Decree lays down the provisions for the assessment of soil contamination and remediation needs.
- The Decree shall not be applied to the assessment of sediment contamination and remediation.

The threshold and guideline values

Metal	Threshold value (mg/kg)	Lower guideline value (mg/kg)	Higher guideline value (mg/kg)
Sb	2	10	50
As	5	50	100
Hg	0,5	2	5
Cd	1	10	20
Co	20	100	250
Cr	100	200	300
Cu	100	150	200
Pb	60	200	750
Ni	50	100	150
Zn	200	250	400
V	100	150	250

The guideline values

- The guideline values have been defined on the basis of either ecological risks (e) or health risks (t). If the risk of groundwater contamination is higher than normal in concentrations below the lower guideline value, the substances are marked with the letter p.

Application of threshold values

- Soil contamination and remediation needs must be assessed if the concentration of one or several harmful substances in the soil exceeds the threshold value prescribed in the appendix to this Decree. The background concentration is regarded as the assessment threshold in areas with a background concentration higher than the threshold value.

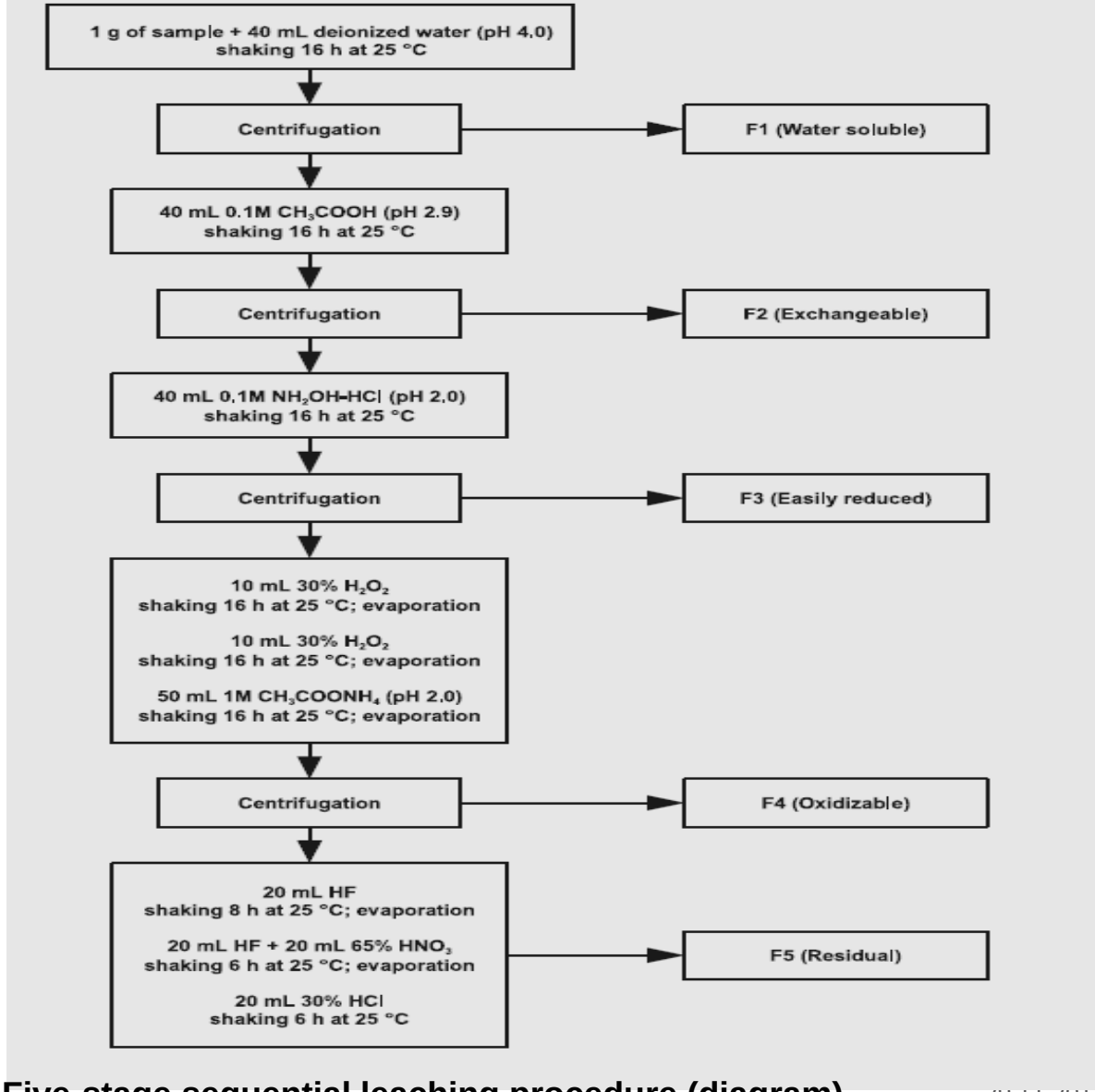


Figure 1. Five-stage sequential leaching procedure (diagram)

Five-stage sequential leaching procedure

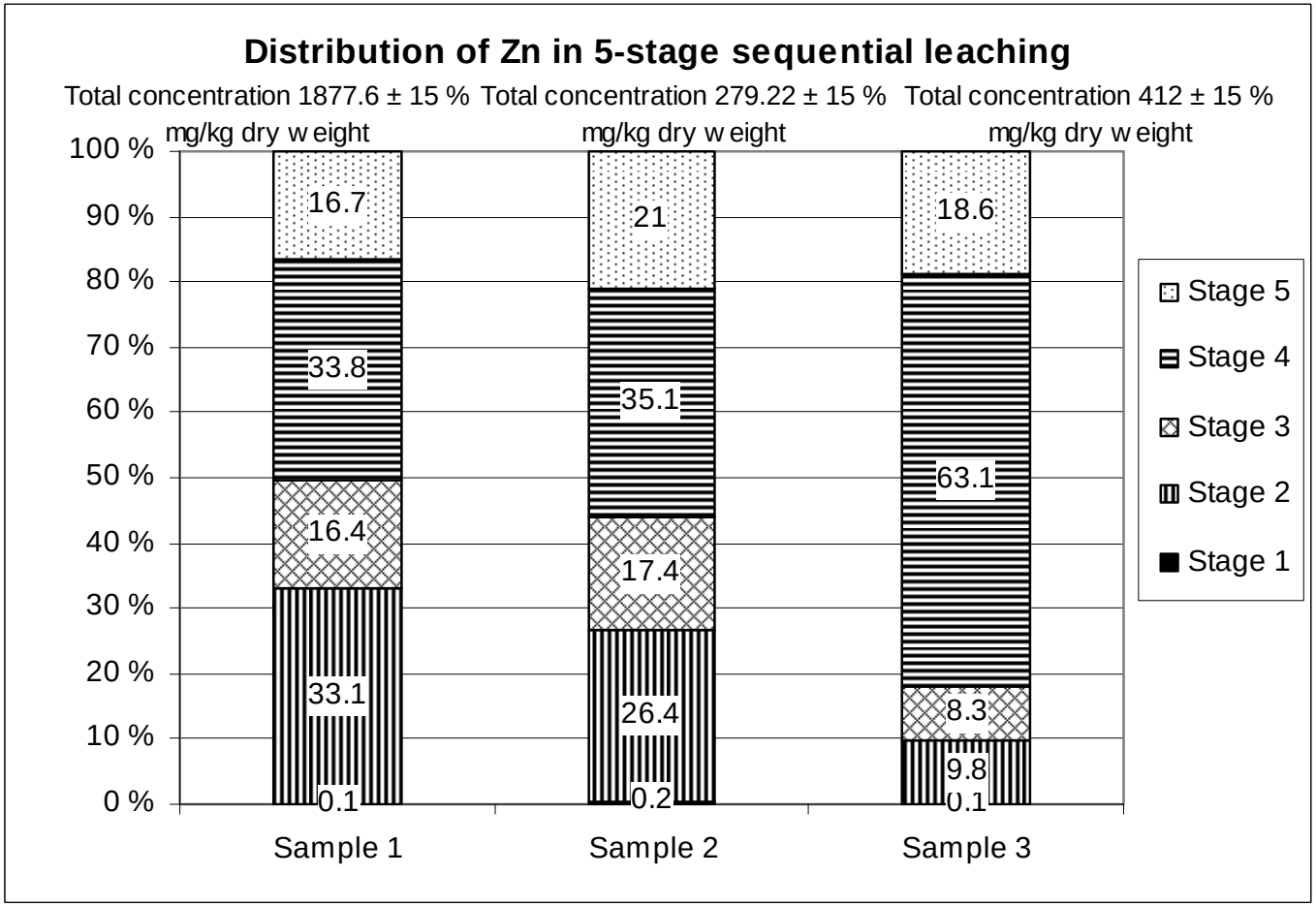
Phase	Fraktio eli jae	Reagenssia/1g näytettä	Ravisteluaika ja lämpötila
1	Water soluble eli vesiliukoinen	40ml H_2O (pH = 4,0)	16 h / 25 ˚C
2	Exchangeable eli vaihtuva fraktio	40 ml CH_3COOH (pH = 2,9)	16 h / 25 ˚C
3	Easily reduced eli helposti pelkistyvä	40 ml $NH_2OH \cdot HCl$ (pH = 2,0)	16 h / 25 ˚C
4	Oxidizable eli hapettuva	10 ml 30 % H_2O_2 (haihdutus) + 10 ml 30 % H_2O_2 (haihdutus) + 50 ml CH_3COONH_4 (pH = 2,0)	1 h / 85 ˚C 1 h / 85 ˚C 16 h / 25 ˚C
5	Residual eli $HF/HNO_3/HCl$ -happo-seokseen uuttuva	20 ml HF + 20 ml HF + 20 ml 65 % HNO_3 + 20 ml 30 % HCl	8 h / 90 ˚C 6 h / 25 ˚C 6 h / 25 ˚C

Table 1

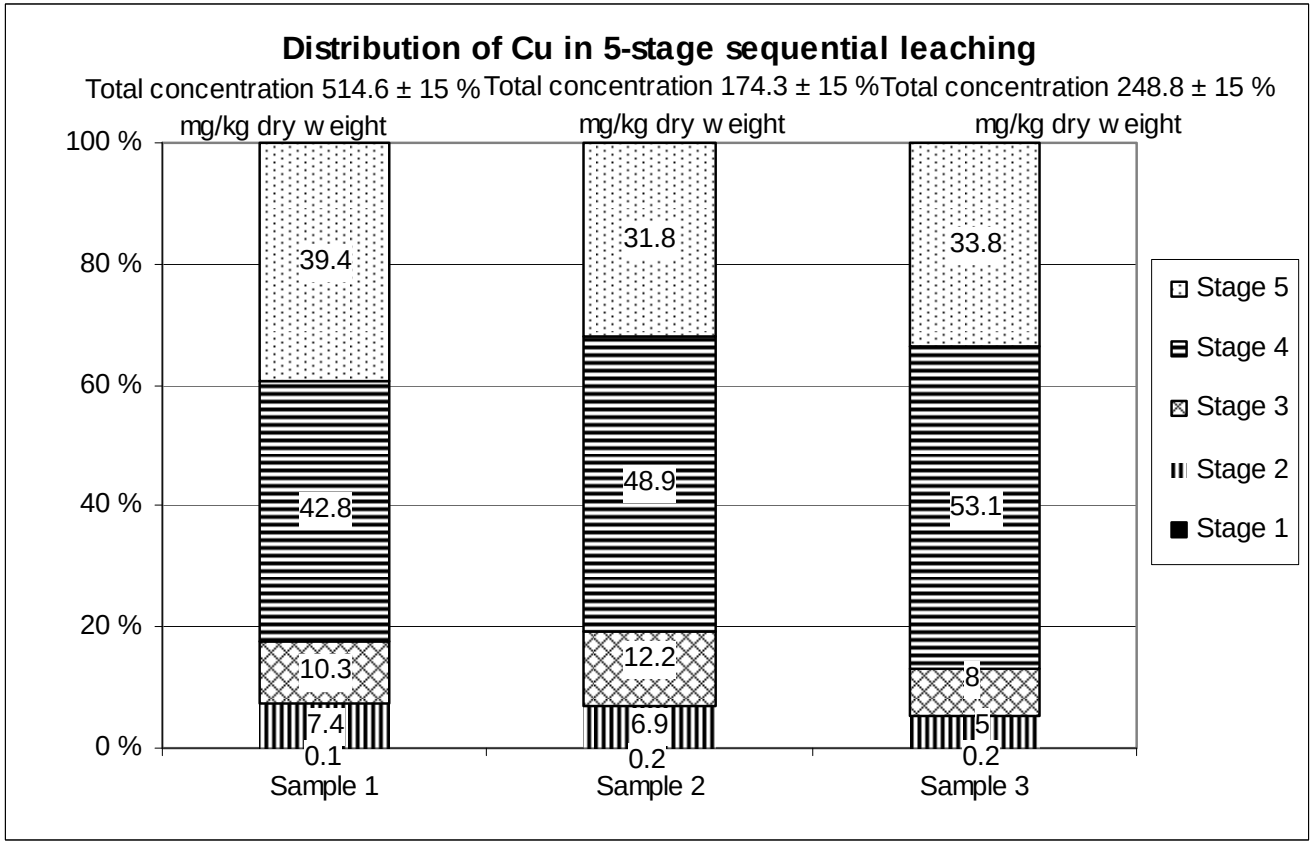
Different guideline values of VNa 214/2007 and heavy metal concentrations of metals in three combination samples taken from waste rock material, originating from the Lampinsaari mines and used as railway ballast.

				Sample 1	Sample 2	Sample 3
Metal	**Threshold value**	**Lower guideline value**	**Higher guideline value**	**Total concentration**	**Total concentration**	**Total concentration**
Sb	2	10	50	< 4	< 4	< 4
Cd	1	10	20	7.0	1.0	1.8
Co	20	100	250	72	24.0	20.5
Cr	100	200	300	***555***	198	176
Cu	100	150	200	***500***	161	***269***
Pb	60	200	750	309	65.9	47.9
Ni	50	100	150	140	60.2	119
Zn	200	250	400	***1960***	273	382
V	100	100	250	40	90	114
As	5	50	100	14	6.7	9.6

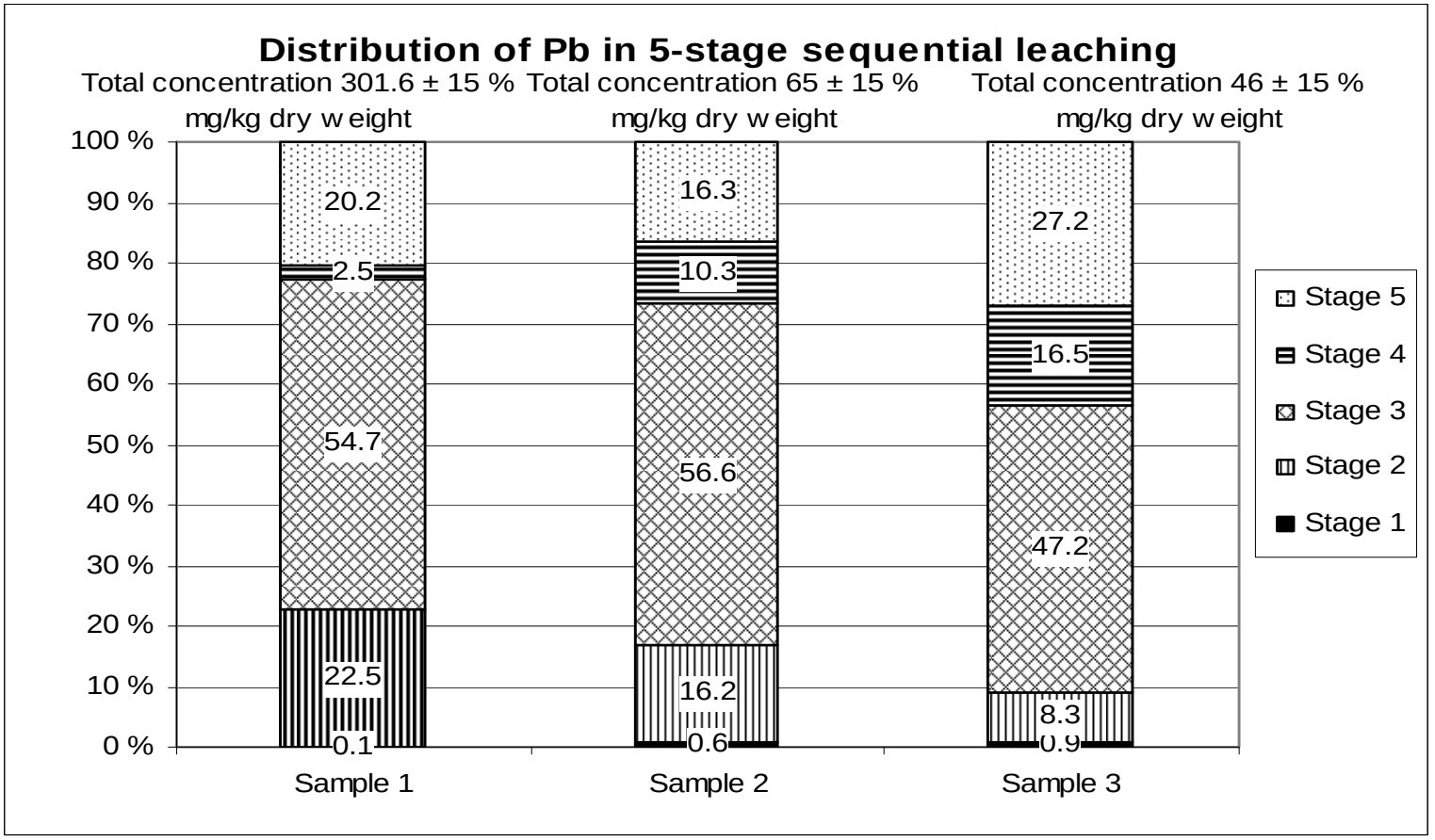
Distribution of Zn in the 5-stage sequential leaching procedure.



Distribution of Cu in the 5-stage sequential leaching procedure



Distribution of Pb in the 5-stage sequential leaching procedure



Conclusions

- The results show, in agreement with all earlier studies, that conditions have a large effect on the solubility of all heavy metals, and therefore on their mobility, bioavailability and environmental risk.
- In addition, the total concentration of every element is much larger than its solubility in each first four fractions (1) - (4) – the potential bioavailability fractions – because the highest concentrations of all metals occurred in the residual fraction (5).

Conclusions

- The conditions of this phase – three strong acids and strong, long-lasting shaking – are never possible in the nature, and therefore the residual fraction is called the inert phase.
- Sequential leaching studies such as the 5-step procedure used here give valuable information about the effect of conditions on the leachability/solubility, mobility and bioavailability for risk assessment of harmful heavy metals
- This information is necessary if we will know the real environmental risk of metals in different conditions, possible in natural conditions now and in the future, i.e. not only in terms of the conditions pertaining to permission applications.