LUT CENTRE FOR
SEPARATION TECHNOLOGY
PO Box 20, FIN-53851, Lappeenranta
Phone: +358 5 621 11, Fax: +358 5 621 2199, www.lut.fi/cst

HELSINGIN YLIOPISTO

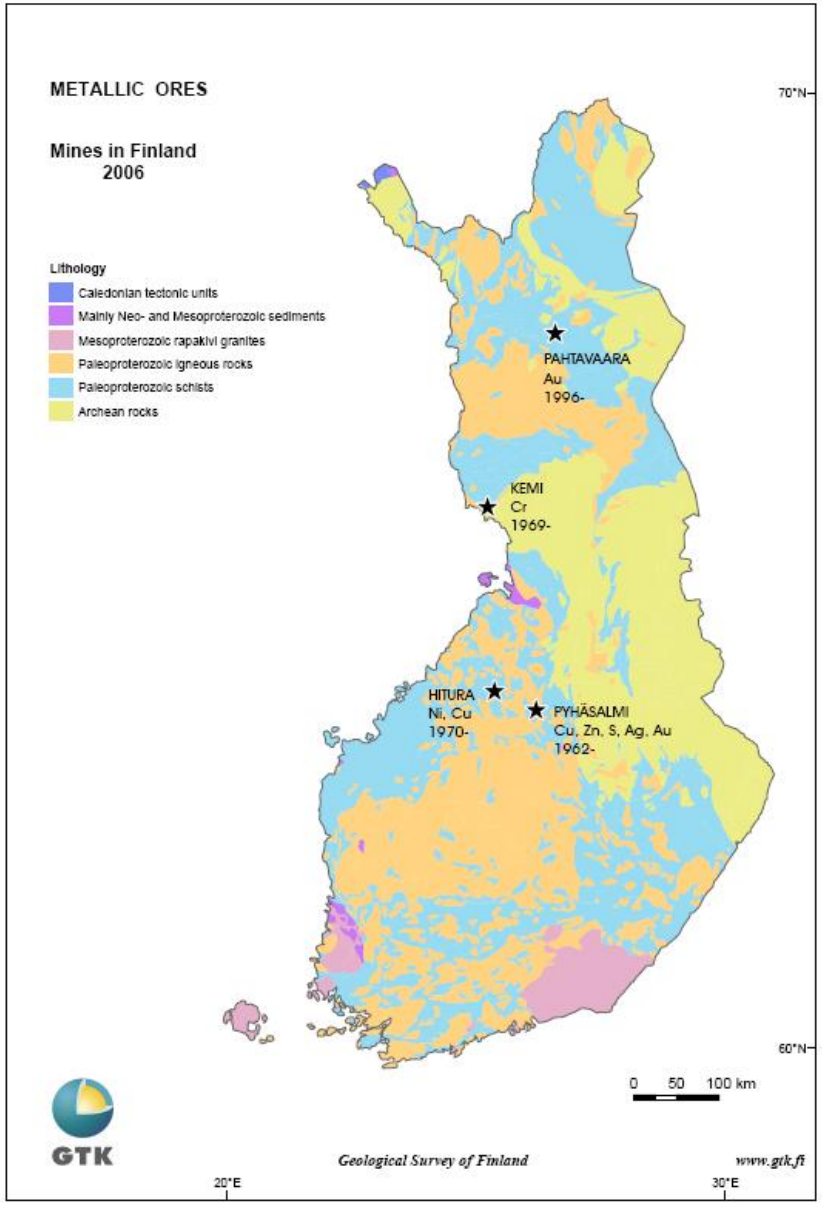
Fast, selective and ecological ion-exchange materials for hydrometallurgy (FSE-IX)

by

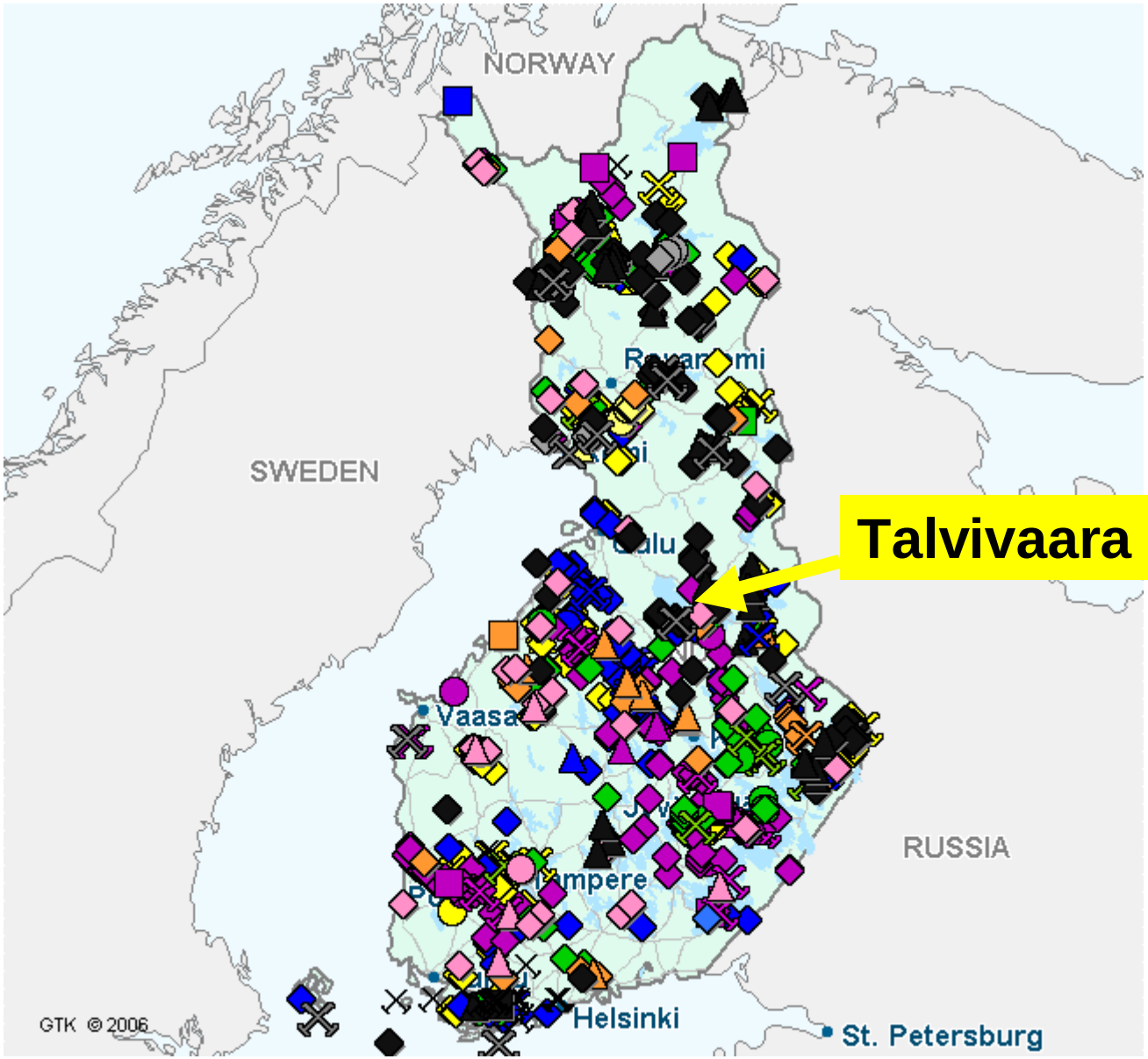
Erkki Paatero (LUT) and ***Risto Harjula*** (HY)

Sustainable Production and Products KETJU-research programme
17th January 2007, 10 a.m. – 7 p.m.

Background


METALLIC ORES
Mines in Finland
2006
Lithology
Caledonian tectonic units
Mainly Neo- and Mesoproterozoic sediments
Mesoproterozoic rapakivi granites
Paleoproterozoic igneous rocks
Paleoproterozoic schists
Archean rocks
PAHTAVAARA
Au
1996-
KEMI
Cr
1969-
HITURA
Ni, Cu
1970-
PYHÄSALMI
Cu, Zn, S, Ag, Au
1962-
70°N
60°N
20°E
30°E
0 50 100 km
GTK
Geological Survey of Finland
www.gtk.fi

Background


NORWAY
SWEDEN
RUSSIA
Talvivaara
Vaasa
Helsinki
St. Petersburg
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Use of IX in hydrometallurgy

The largest applications are today in water purification.
The technology is very established and uses mostly standard polymeric resins.

Examples of important industrial metal separations:

- Uranium as $[UO_2(SO_4)_3]^{4-}$ or UO_2^{2+}
- PGM, Au and Ag
- Applications in plating industry
- Purification of electrolytes
- Environmental applications, tailings, closed mines

IX is a potentially a sustainable production technology.

The task

To remove and recover minor metals from complex hydrometallurgical process streams by ion-exchange. Metal recycling.

<u>We need ion-exchange materials that</u>

- are selective for the minor metal
- have high capacity and fast kinetics
- can be easily eluted and regenerated
- chemically and mechanically stable

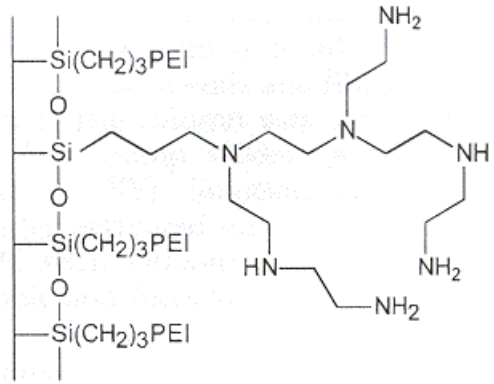
<u>We need new</u>

“Fast, selective, economical and ecological ion-exchange materials for hydrometallurgy”

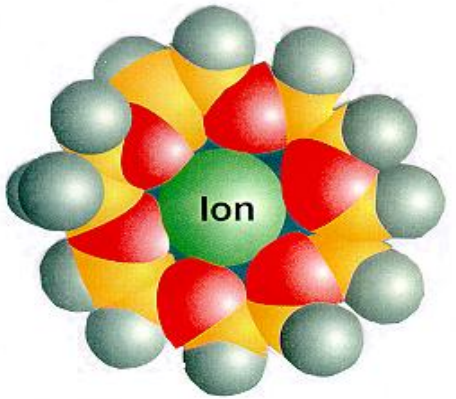
Composite ion-exchange materials

Ligands bonded onto SiO_2 are used in biotechnology, e.g. as stationary phase in chromatography, - very expensive!

Now these sorbents have been commercialized for metal separations



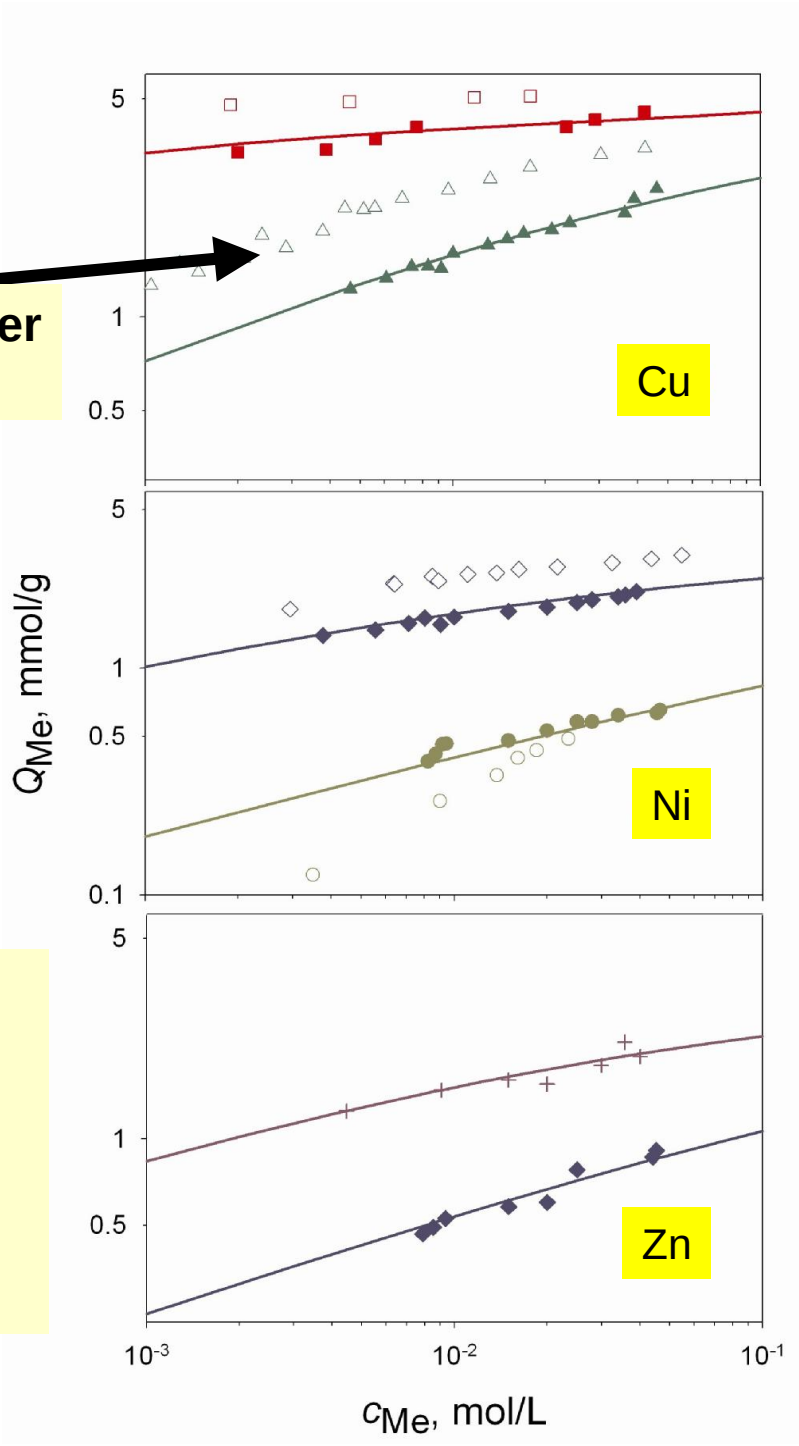
Polyethylene imine (PEI) on silica



Crown ether ligand on silica
”Molecular Recognition Technology”
by IBC Advanced Technologies

Competitive binding of proton and metal ions on PEI on silica

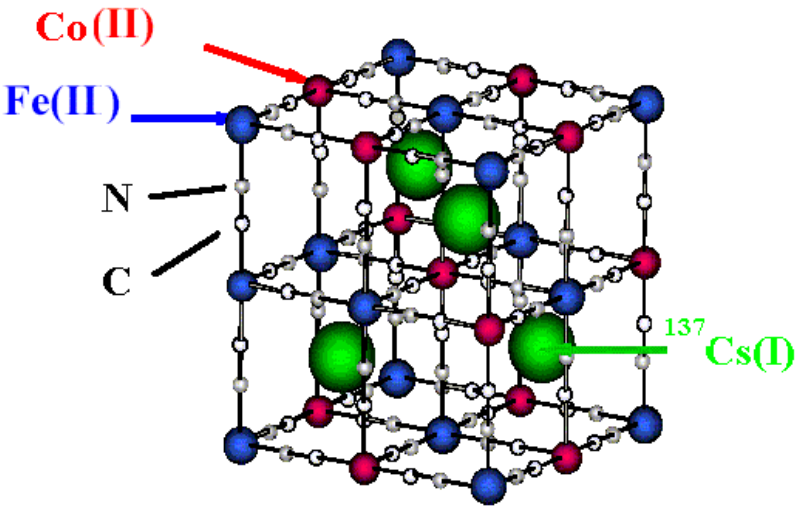
soluble PEI polymer as reference



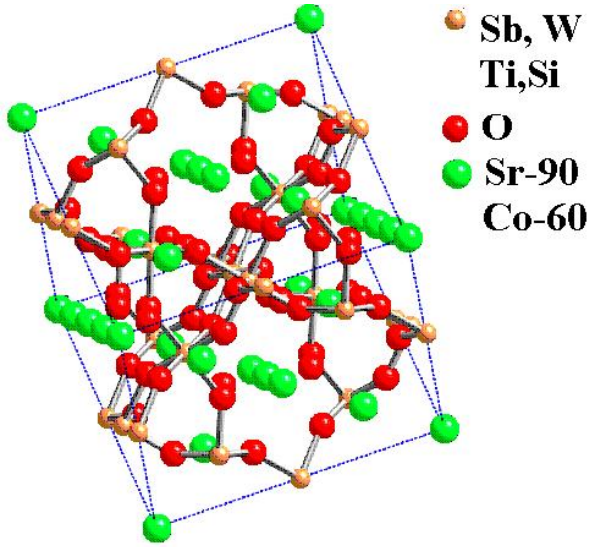
LUT:

- complex multimetal seprations
- modelled binding equilibria by the non-ideal competitive adsorption model (NICA)
- kinetic modelling
- dynamic modelling of IX-column operation

Univ. of Helsinki: Inorganic IX materials ”ion sieves” for highly selective radionuclide separations



Hexacyaniferrates: Extreme selectivity for radiocaesium
$K_{Ca/Na} = 1.5 \cdot 10^6$



Pyrochlores: Selectivity tuned by adjustment of crystal window size via substitution of different metals in the framework

Selion - Selective Ion Exchange Technologies

Would you like to reduce your liquid rad waste volume from thousands of cubic meters into very small volume?

See how it is possible, and check our absorbents' performance compared with conventional treatment methods.

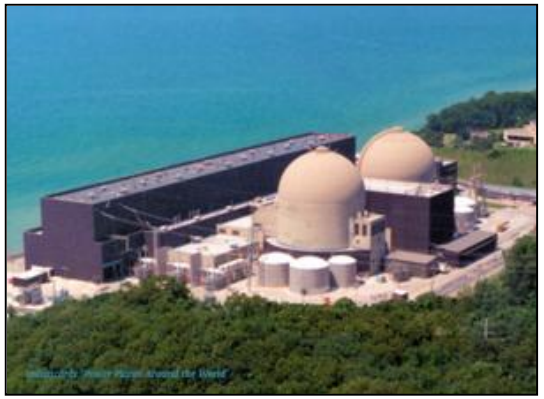
CsTreat in Loviisa Nuclear Power Plant since 1991

Recent industrial applications

- THORP, Sellafield, UK
  - removal of Co-60 from pond water

- DC COOK Nuclear Plant, USA
  - removal of Co-60 from floor drain water

- COMANCHE PEAK Nuclear Plant; USA
  - removal of Co-60 from floor drain water



The research gap

Existing polymeric resins do not tolerate oxidizing conditions and they swell and shrink

Existing inorganic ion-exchangers are too slow and have too low capacity for hydrometallurgical applications. Often irreversible binding.

Existing composite materials are mechanically and chemically too weak. Often too expensive.

The plan

is to combine the good sides of ion-exchangers based on organic polymers with those of inorganic ion-exchangers

we choose

minor metal in hydrometallugical processes

organic a functional group on SiO_2, TiO_2, ZrO_2 or MnO_2 as support

or

inorganic exchanger in a porous polymeric matrix