



Metal species in an extremely acidic Boreal river system*

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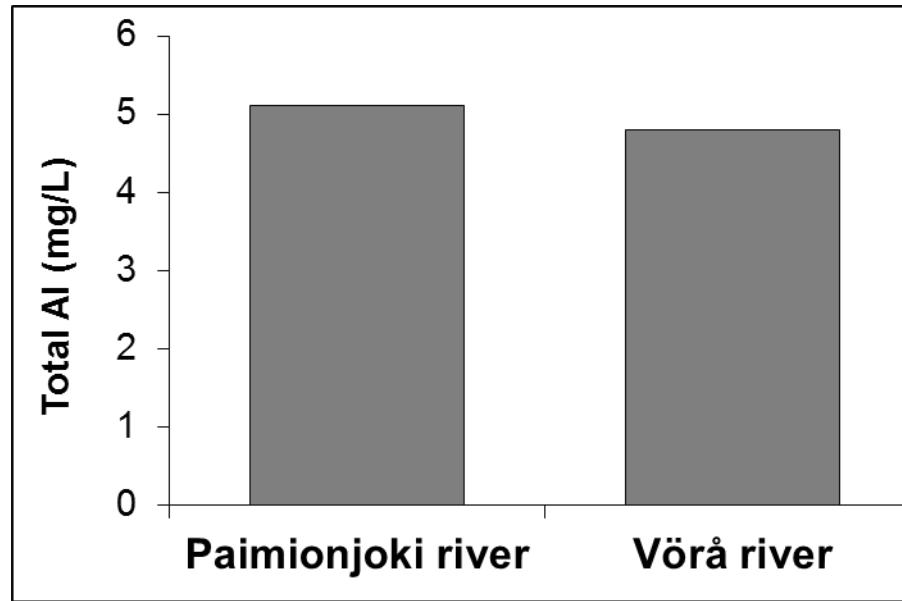
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* The results are from Nystrand, M.I., Österholm, P., (submitted). Metal species in a Boreal river system affected by acid sulfate soils. Submitted to Applied Geochemistry.

Introduction

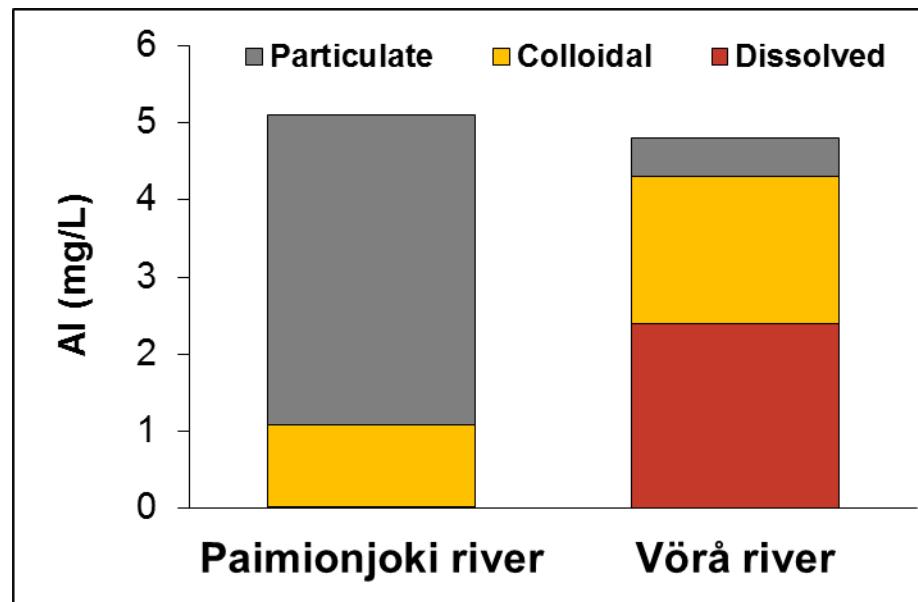
- Dissolved (<1 kDa)
 - most mobile and bioavailable → **most toxic fraction**
- Colloids (1 kDa-0.45 µm)
 - Behaving in some respects as soluble matter → **toxic**
 - In others as particles
 - Important in the distribution, transport and fate of metals in aquatic environments
- Particles (>0.45 µm)
 - Generally progressively concentrated in the sediments → not available for the biota

Introduction

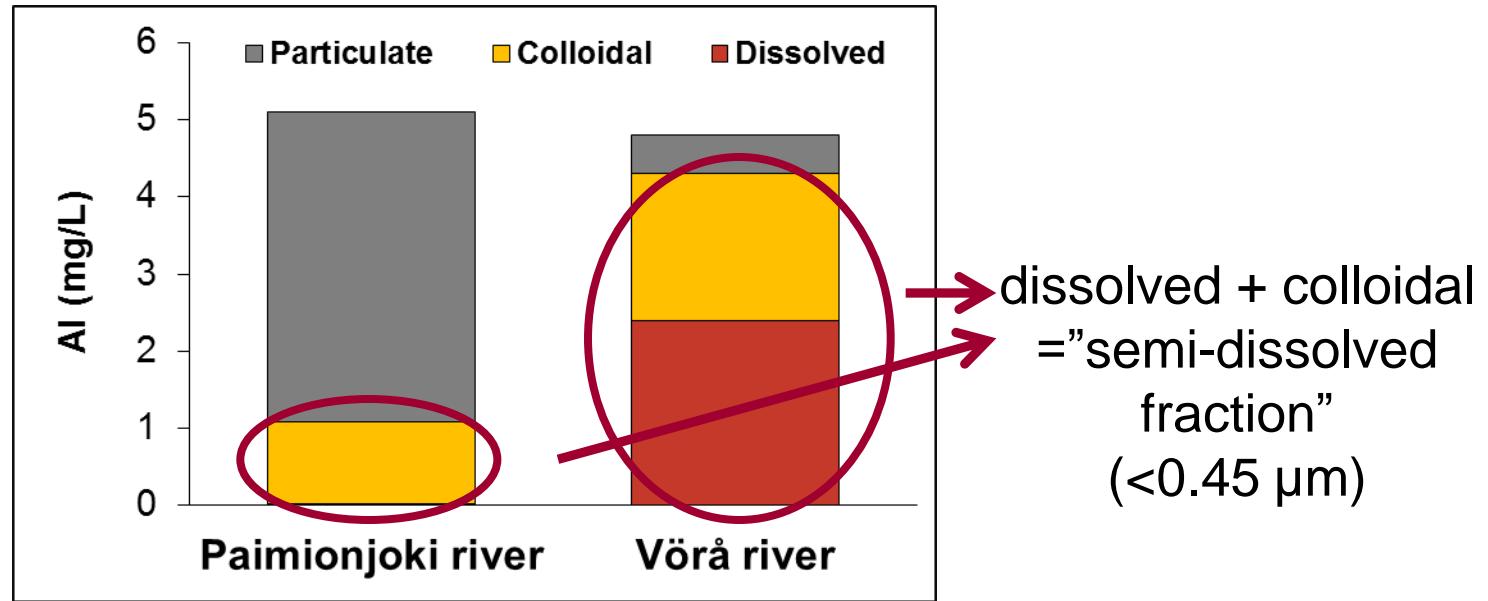


- Erosion
- pH ~ 7
- Acid sulfate soils
- pH ~ 4.3

Introduction



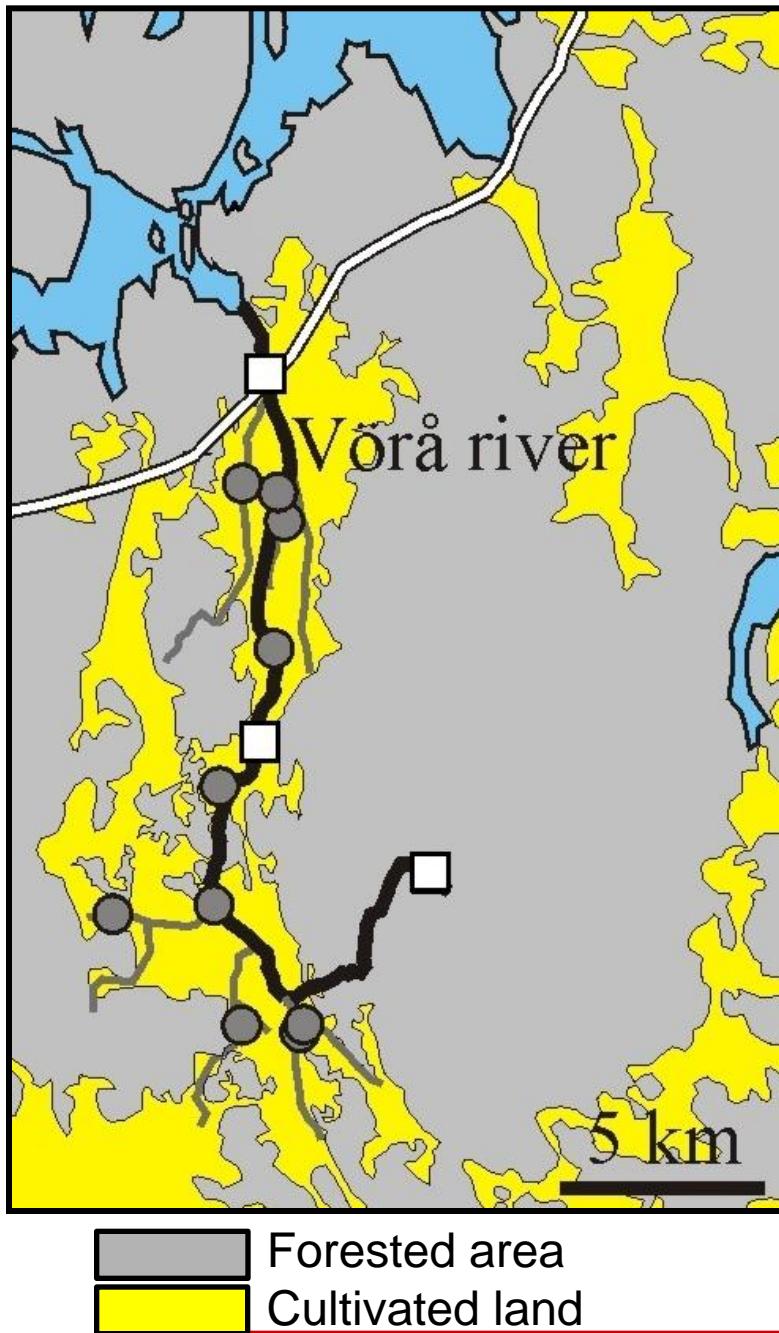
Introduction



- The "semi-dissolved" fraction might overestimate the toxicity of several elements
- The bioavailability of metals does not simply depend on the total concentration → **but on its chemical form**

Aim of the study

- knowledge about metal concentrations in rivers in Finland has increased, but little is known about the actual size distribution of these metals.
- The overall aims of this study are to examine:
 - the size distribution and species of metals in a river system heavily polluted by AS soils
 - the bioavailability (i.e. toxicity) of elements
 - the role of organic matter (OC) and Fe in affecting the fate of elements



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Study



	Vörå river
Drainage area (km^2)	223
Cultivated land (%)	31
Forest (%)	54
Mires (%)	15

Methodology

Filtration:

- conventional filtration → 0.45 µm filter
- frontal ultrafiltration → 1 kDa membrane

Chemical analyses:

- Water temperature, pH, electric conductivity and acidity
- Analyses for 20 elements with ICP/MS and ICP/OES
- Analyses for organic carbon (OC) with a Shimadzu Organic Carbon 5050 analyzer

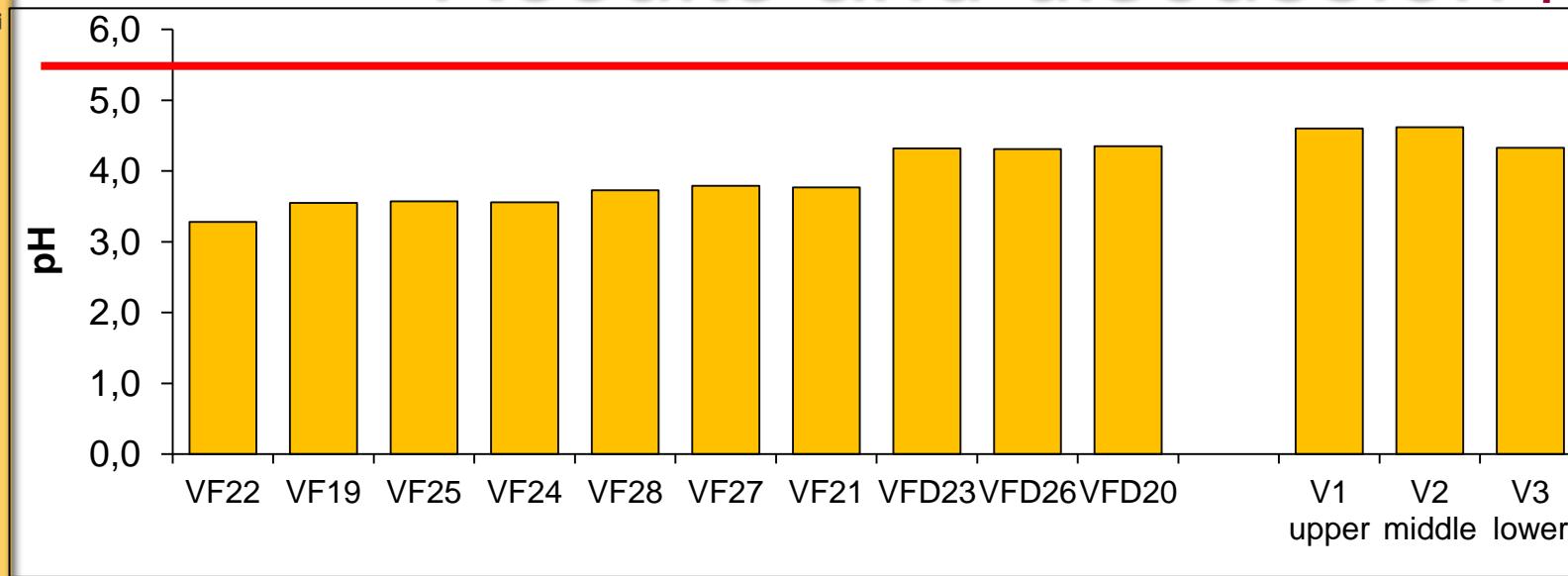
Modelling with Visual MINTEQ:

- used to predict element complexation

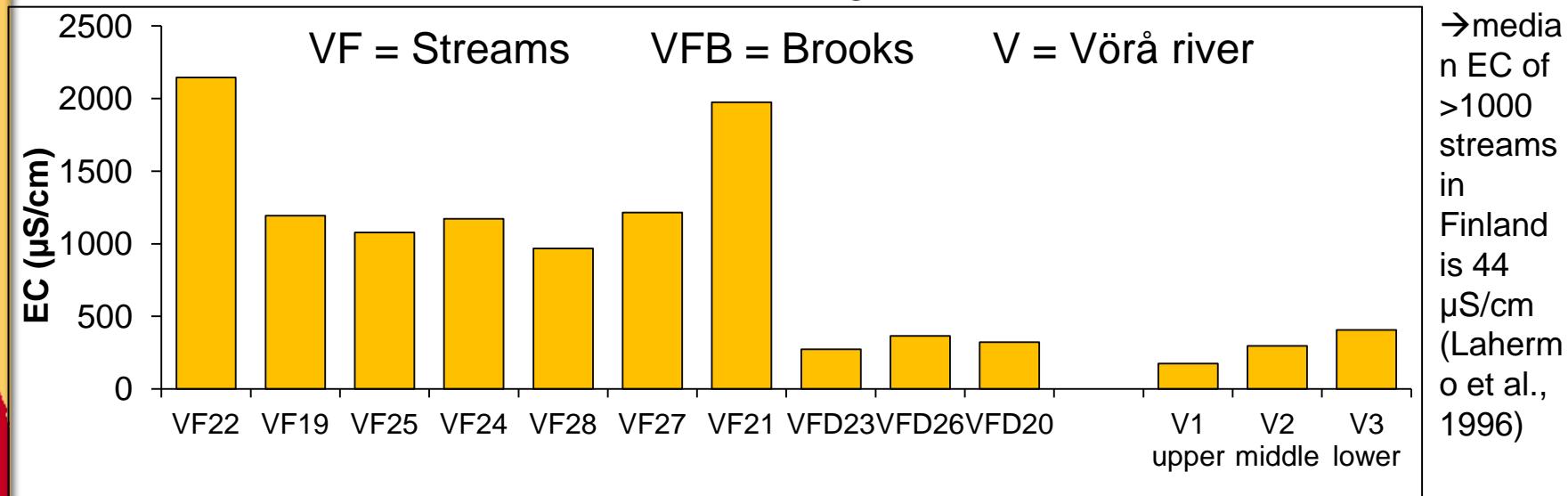


Results and discussion

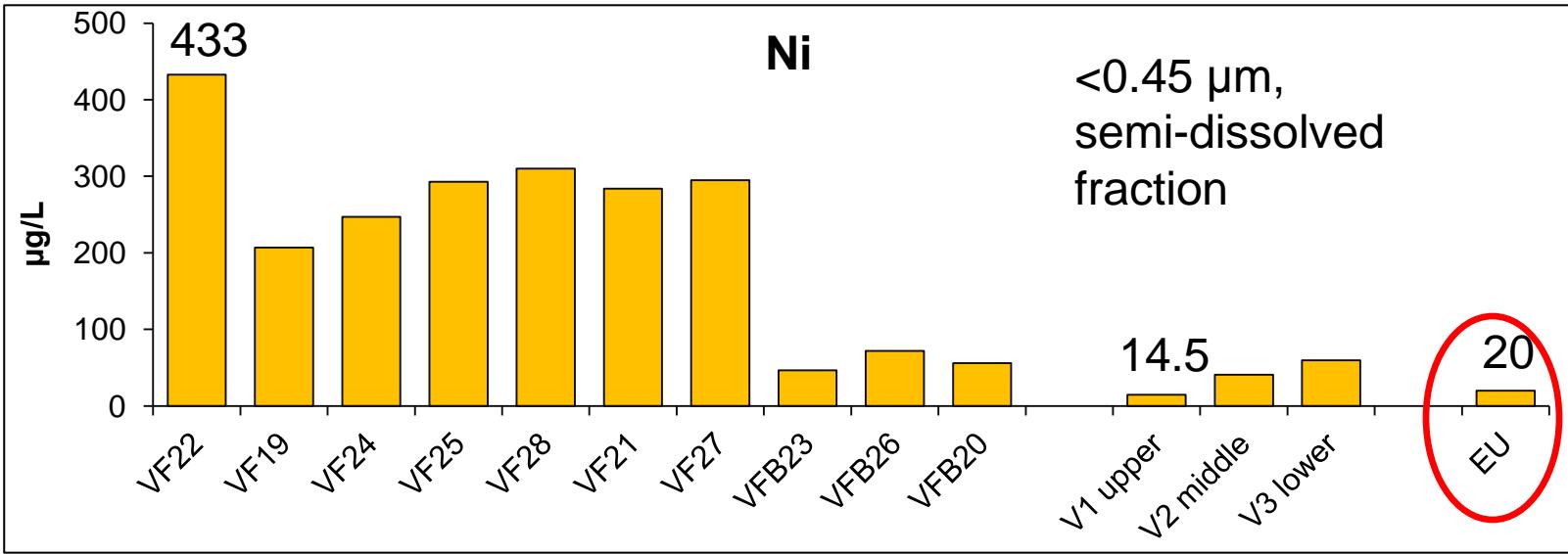
pH of 5,5
critical



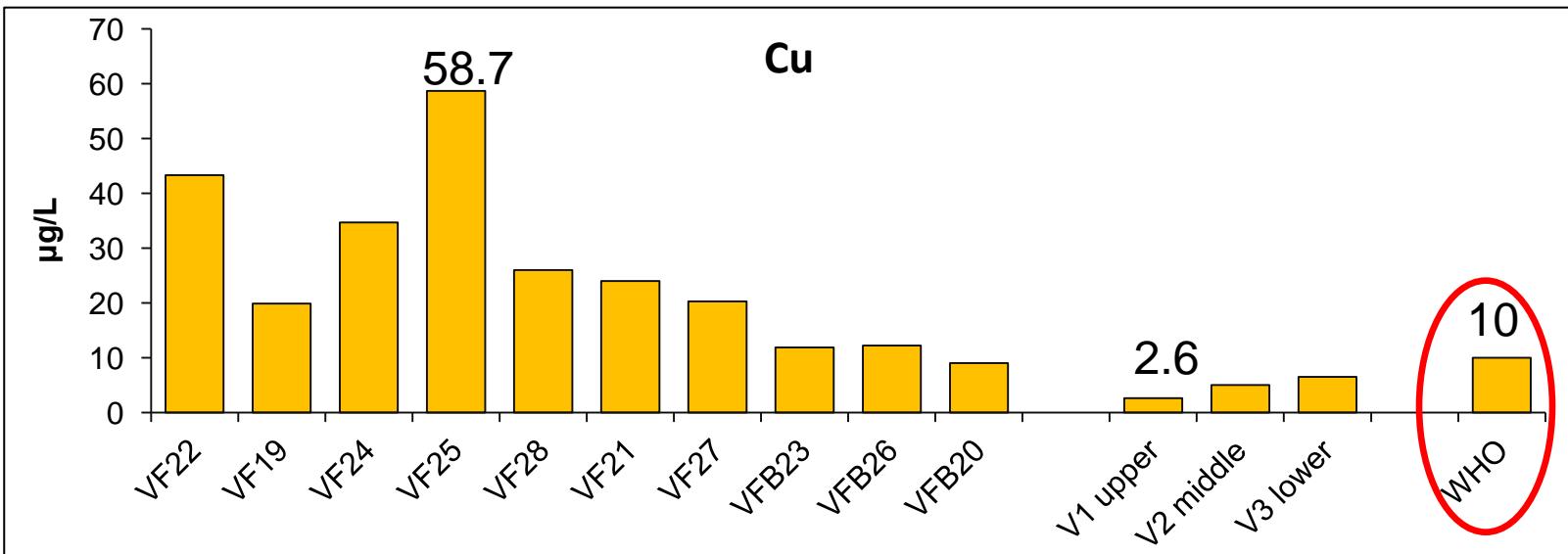
Lowest pH → highest pH



Results and discussion

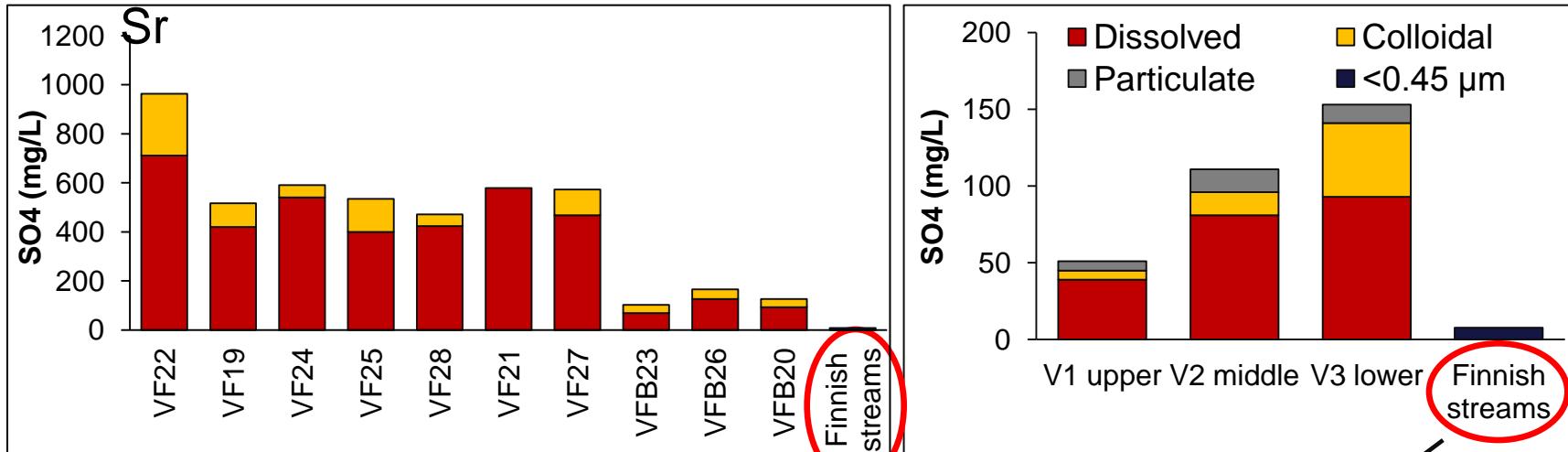


Lowest pH → highest pH



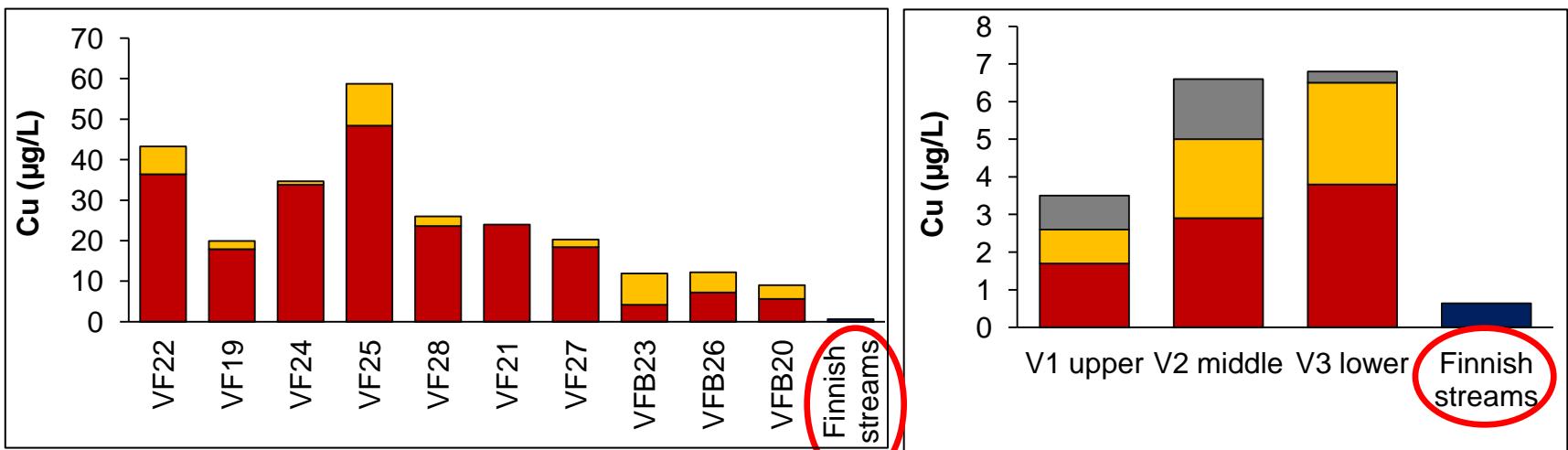
Results and discussion

→ Ba, Ca, Cd, Co, K, Mg, Mn, Na, Ni, REE, SO₄, Si and



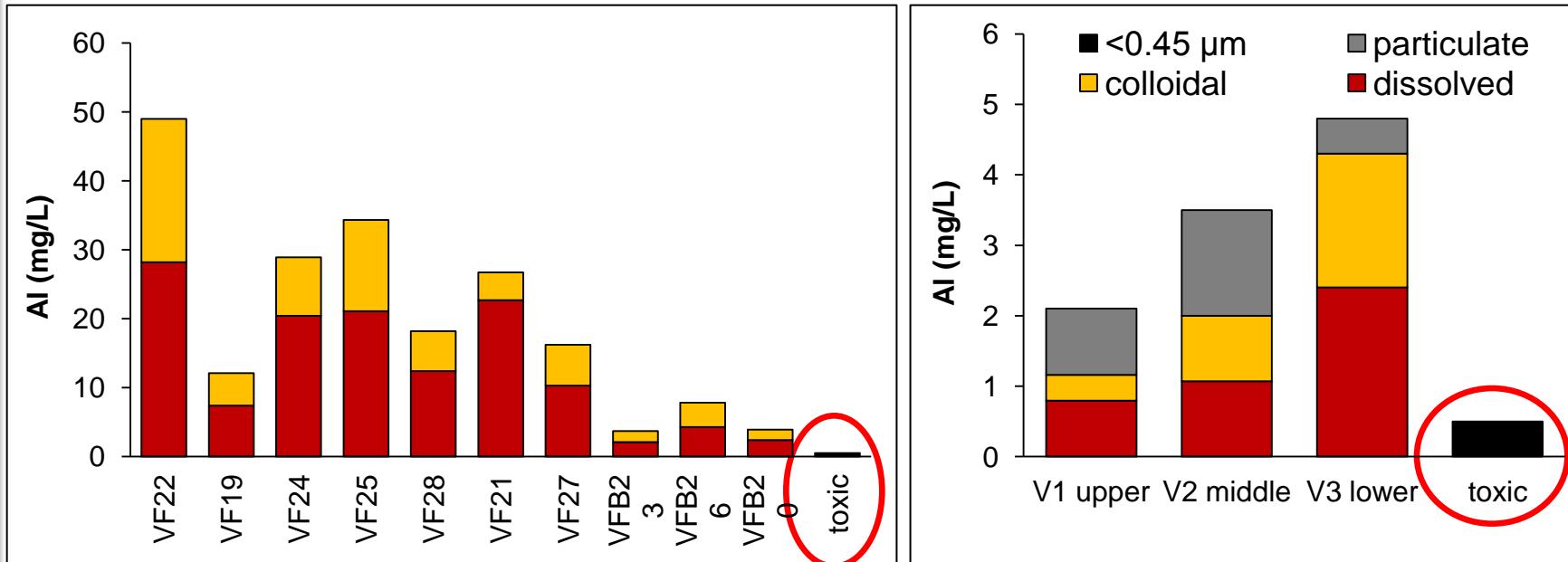
→ Al, Cu and U

(Lahermo et al., 1996)



Results and discussion

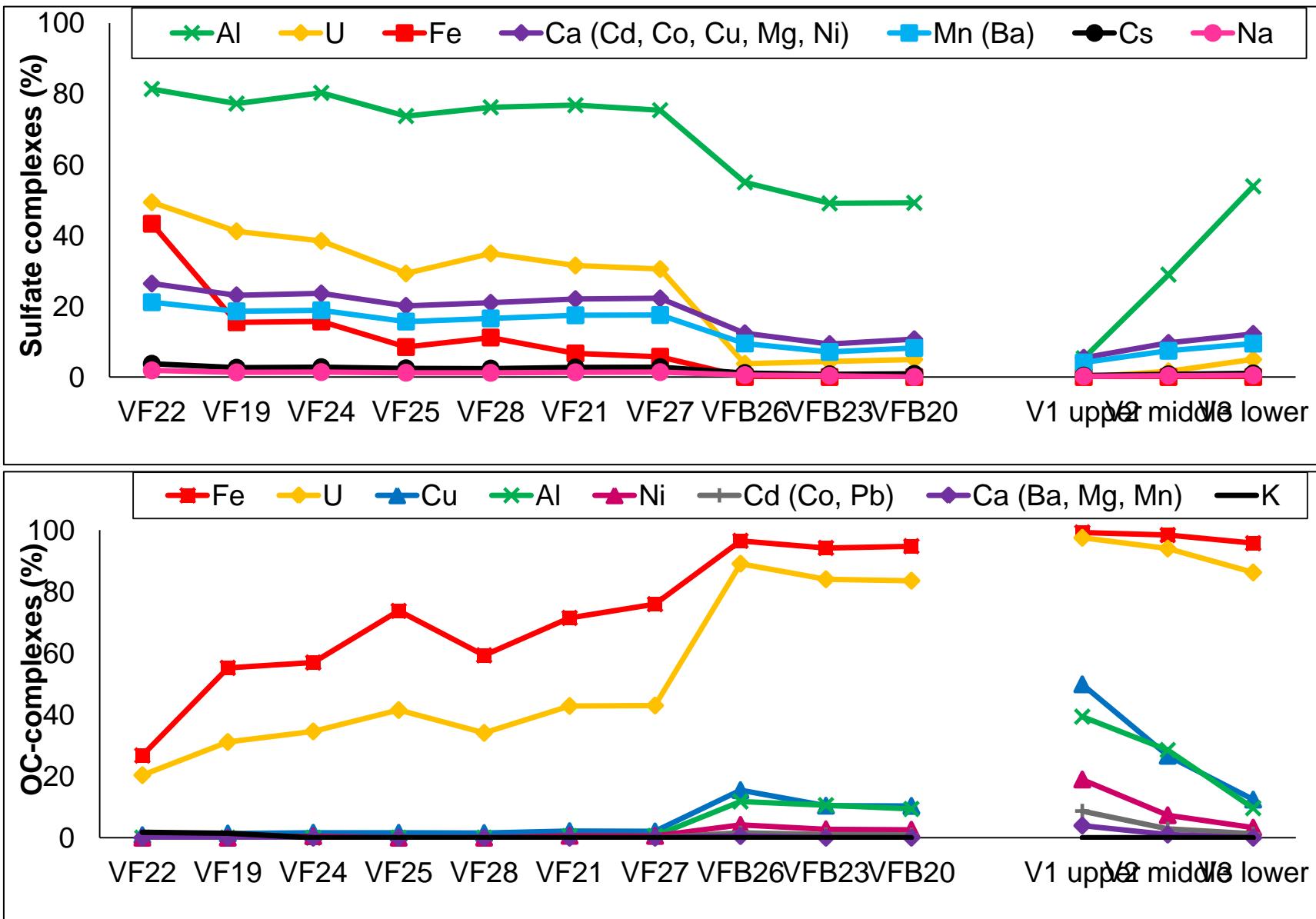
A "semi-dissolved" fraction ($<0.45 \mu\text{m}$) of around 0.5 mg/L will generally start to eliminate fishes and other organisms in acidic waters (Early and Callaghan, 1998).



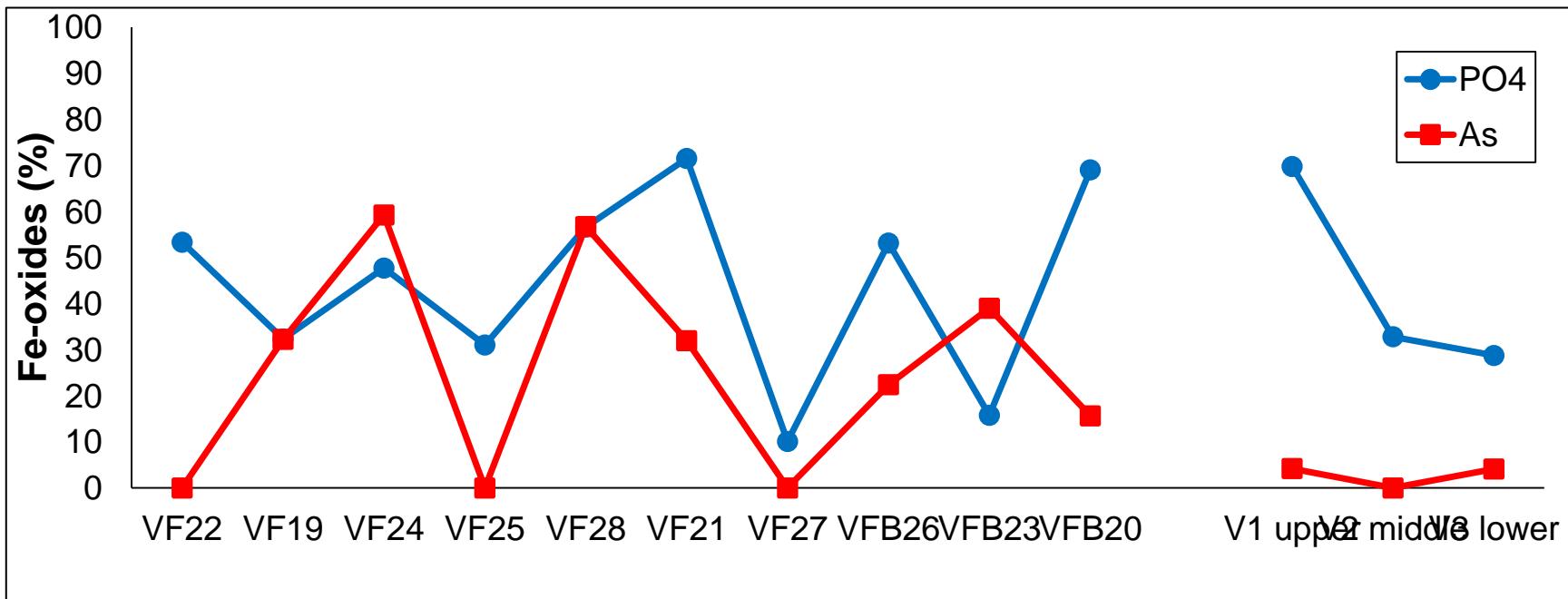
Results and discussion



Results and discussion



Results and discussion



Conclusion

- Toxic element concentrations were generally extremely high
- Metals known to be released in large amounts from AS soils are also released in the most toxic form: as free ions and/or sulfate-complexes, and can, moreover, prevail mainly in toxic forms throughout acidic river systems
 - serious effects on the biota
- only the forested upstream area (higher pH and contents of OC) had significant amounts of less bioavailable elements due to complexation with OC



Thank you!

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