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Arsenic cycling in areas with sulphidic metasediments, N. Sweden



G. Jacks 1), Z. Slejkovec 2), J. Toivonen 3), M. Mörth 4) & E. Nilsson 5)

1) Land & Water Resources Eng., KTH, SE-100 44 Stockholm, Sweden

2) Josef Stefan Institute, 1000 Ljubljana, Slovenia

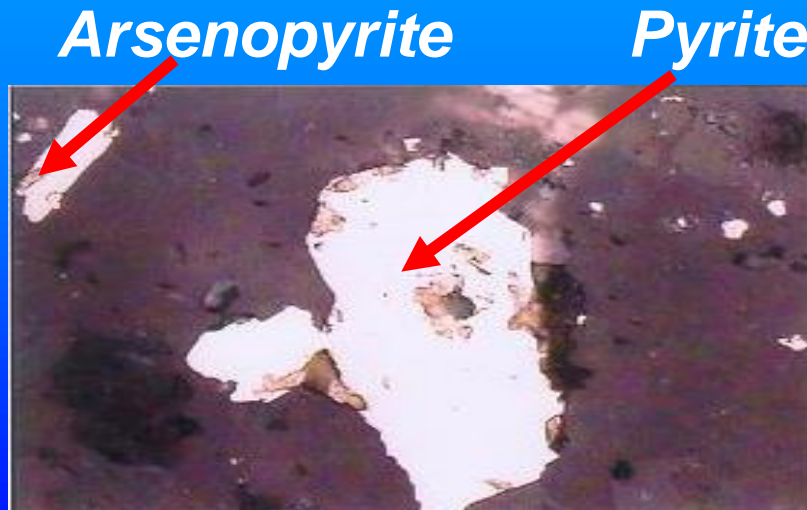
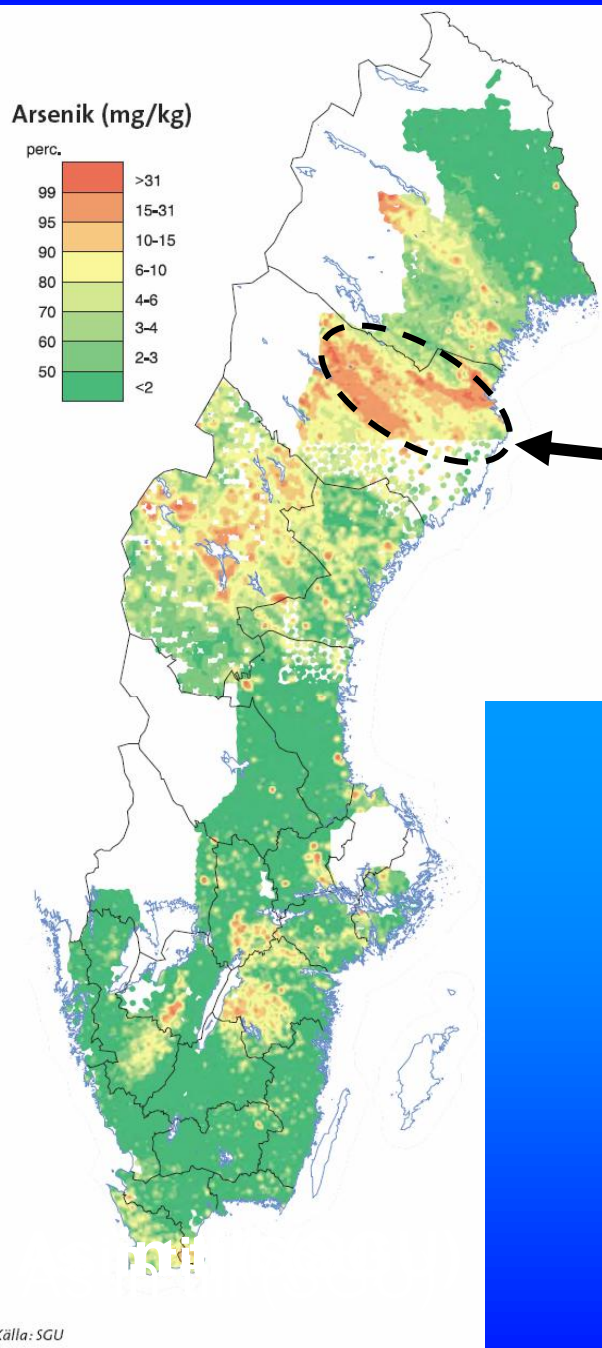
3) Dept. of Geology and Mineralogy, Åbo Akademi, FI-20500 Turku, Finland

4) Stockholm University, SE-106 91 Stockholm, Sweden

5) Norsjö community, SE-935 81 Norsjö. Sweden

As in bedrock and till

The Västerbotten county hosts a large number of sulphide orebodies but the imprint in the till of arsenic is largely derived from black sulphidic shales underlying 5000 sqkm :
”fossil acid sulphate soils”



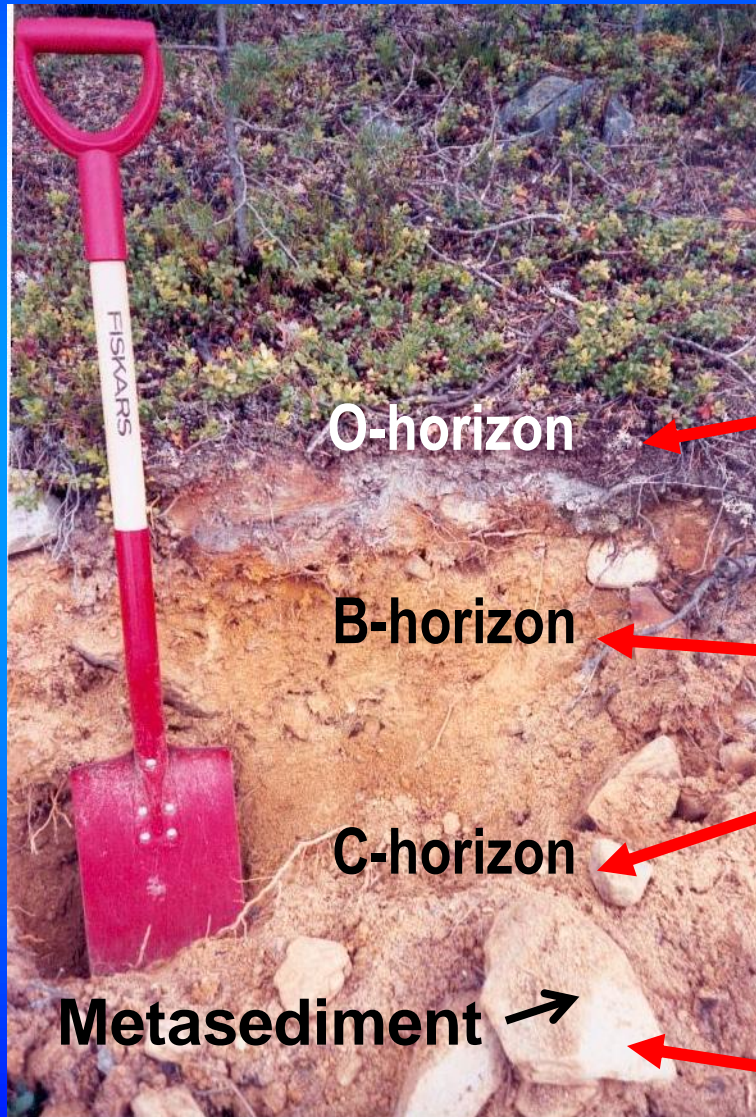
The sulphides weather and most of the arsenic is retained in the podzolic B-horizons

pH 4,5

pH 5,1

pH 5,7

2012-09-25



O-horizon

B-horizon

C-horizon

Metasediment

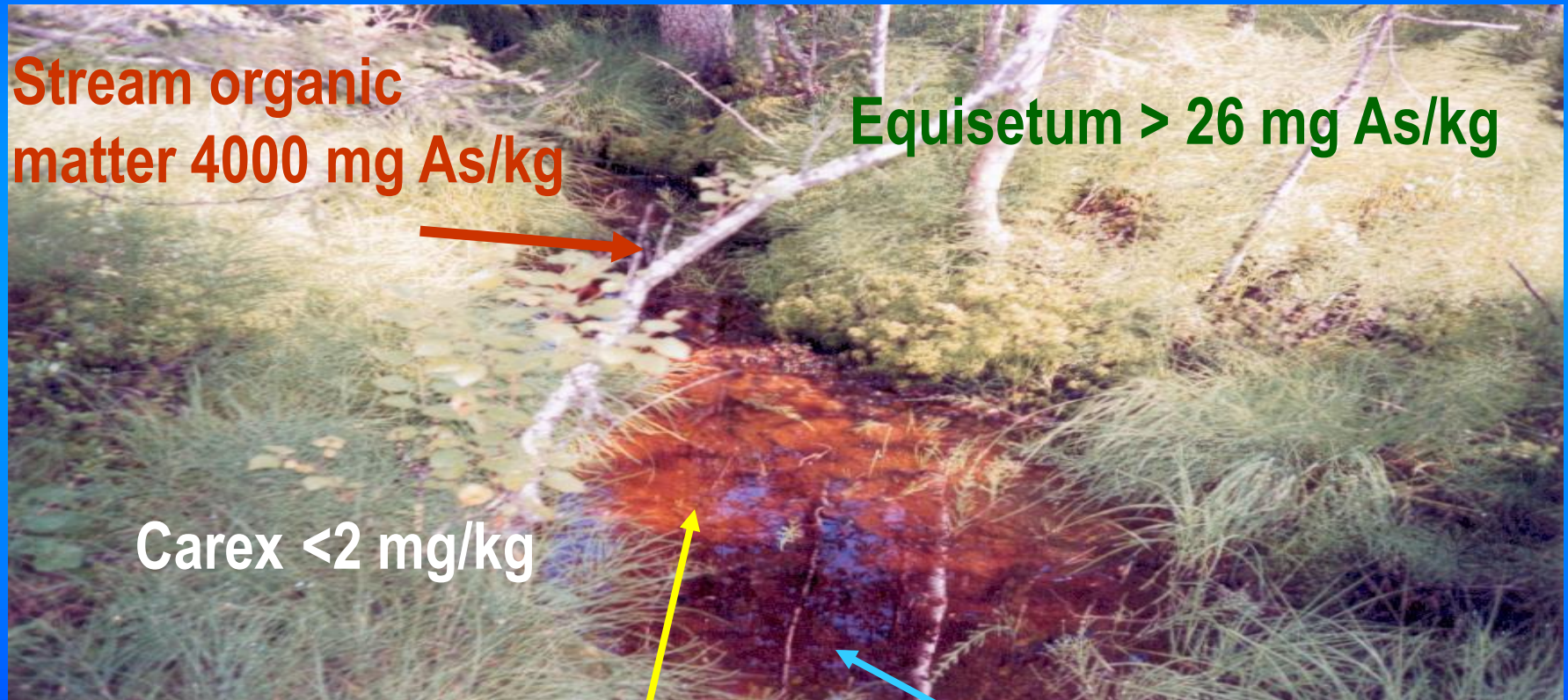
45 mg/kg As

260 mg/kg As

170 mg/kg As

210 mg/kg As

Fe and As are remobilised in wetlands under anoxic conditions and reprecipitated in drains

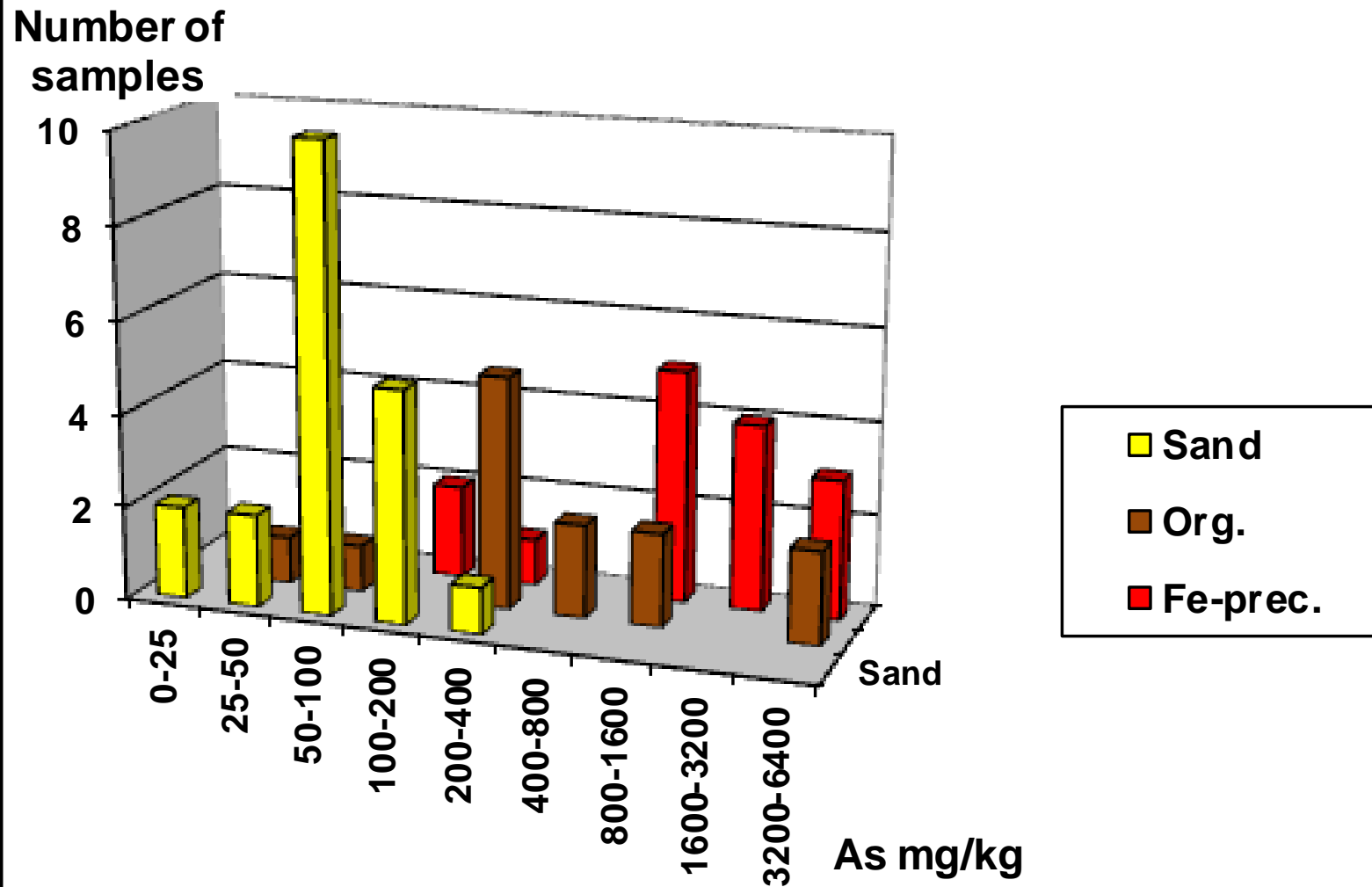


Fe-prec. 1 700-5 600 mg As/kg

2012-09-25

Water 70 µg/L

Arsenic in stream sediments



Background level of arsenic is generally < 10 mg/kg

As-retention in the streams

Most of the arsenic is retained in stream sediments with several hundred mg/kg in sandy sediments (up to 0.5 % As in Fe precipitates).

However, the levels still left in water is about three times the national background and some lakes have up to 20 $\mu\text{g/l}$

Assessment of the bioavailability

An effort to assess the bioavailability is made by:

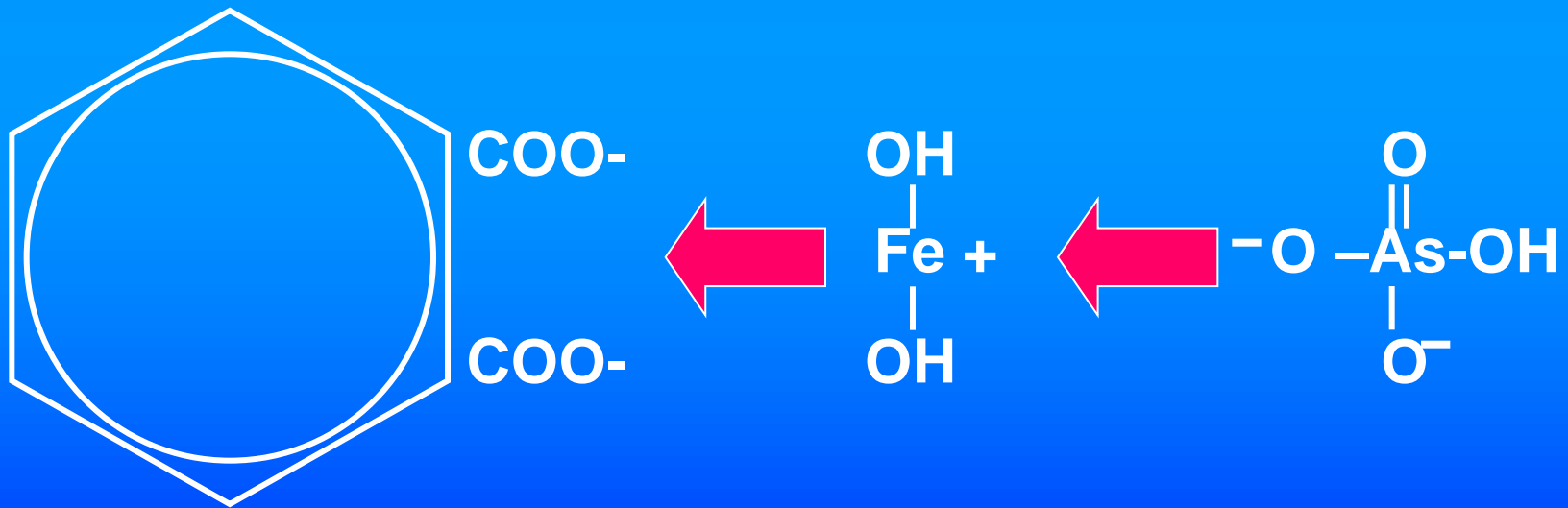
- Separating water in unfiltered, filtered (0.2 μm) and dialysis by using 10 and 1 kDa membranes.
- Analysis of macroinvertebrates and fish for organic (MMA, DMA, arsenobetaine) and inorganic arsenic (As(III) & As(V)).

Example of speciation of As and Fe in Lake Nyängstjärnen

<i>Sample</i>	<i>As $\mu\text{g/l}$</i>	<i>Fe $\mu\text{g/l}$</i>
Unfiltered	8.2	2450
Filtered 0.2 mm	5.2	1340
Dialysis < 10 kDa	3.2	325
Dialysis < 1 kDa	2.1	49

Arsenic in lakes

- Fe-hydroxides in suspended or colloidal sizes are likely to be adsorbed onto TOC and arsenic tied to the ferrihydrate
- Preliminary tests with dialysis indicate that little As is in bioavailable form



As in macroinvertebrates

Species	As(III) +As(V) mg/kg	DMA + MA mg/kg	Arseno- betaine mg/kg	Tot As mg/kg
Mixed macroinv.	3.05	0.24	b.d.	12.9
Mixed macroinv.	1.22	0.49	0.005	5.3
Pond-skater	0.33	0,28	b.d.	1.23

Difficulties in extraction of the arsenic in macroinvertebrates are experienced resulting in differences between species and tot-As

As species in fish

<i>Specie</i>	<i>As(III)+ As(V) mg/kg</i>	<i>DMA+ MMA mg/kg</i>	<i>Arseno- betaine mg/kg</i>	<i>Tot As mg/kg</i>
Pike 1	<0.05	0.49	0.71	1.84
Pike 2	b.d.	0.59	0.50	1.26
Trout 1	0.07	b.d.	0.14	0.68
Trout 2	0.07	b.d	0.52	0.58

b.d. = below detection limit

Conclusions

- ✘ Fe and As are mobilized in wetlands under reducing conditions
- ✘ Reprecipitation of Fe and readsorption of As is swift in draining water courses under low pH ~ 5-6
- ✘ Stream sediments are highly enriched in As and stream biota show moderately elevated contents of organic arsenic – in fish mostly non-toxic arsenobetaine
- ✘ Most of the arsenic in lakes is attached to Fe-hydroxides varying in size from suspended to colloidal
- ✘ In spite of so far limited data it seems that the bioavailability of arsenic is low, mirrored in low contents in fish

Acknowledgements

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- ⌘ We are also thankful for access to data on till geochemistry from Swed. Geol. Survey, kindly supplied by Dr Kaj Lax

THANKS for Attention!