

Behaviour of radionuclides in sulphide-ore tailings in Rautuvaara, Finland

Antti Kallio*, Radiation and Nuclear Safety Authority, Finland

Marja-Liisa Räisänen, Geological Survey of Finland

Netta Jousi, University of Helsinki, Finland

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- Geological information
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Rautuvaara tailings

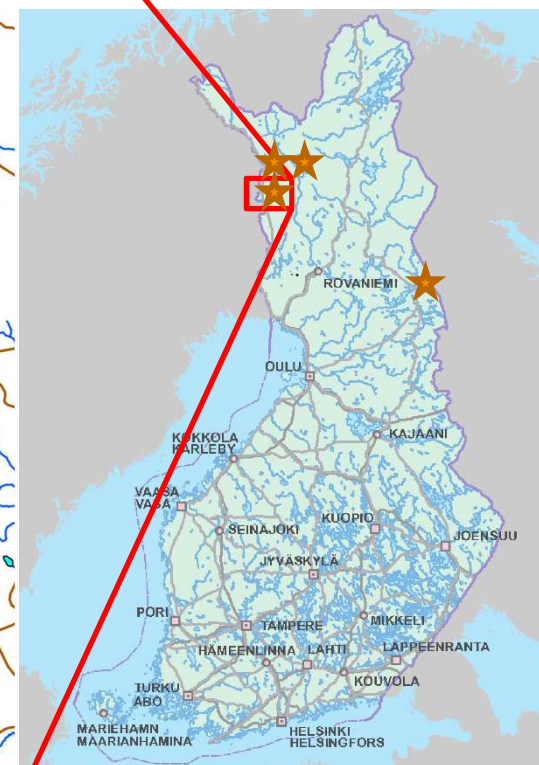
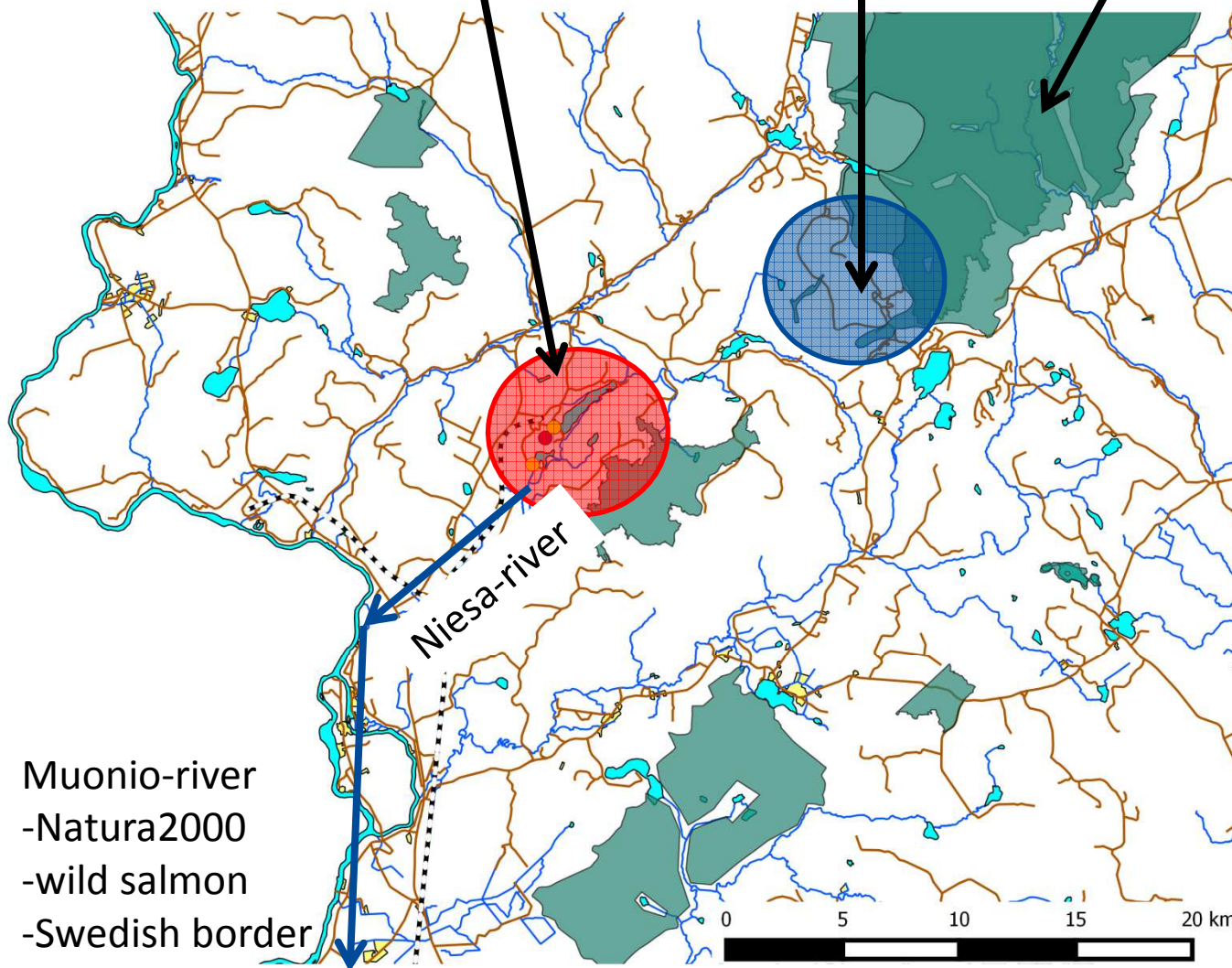
- Situated in Kolari, Northern Finland
- Used 1975-1996 by multiple companies, possibly used again
- Tailings area: 1 km² (2000m x 500m)
- Tailings depth: 3-15 m
- Tailings mass: ca. 10 Mt
- Contains tailings from several Fe-oxide-, Cu-sulphide- and Au-ores
- Tailings deposited directly into a river bed that had partial peat coverage, river flow was diverted
- Peat has acted as a reasonably good barrier, but in some parts of the pond the tailings rest directly on till, which allows some seepage into groundwater

Rautuvaara

Ylläs Ski Resort

National Park

★ Ores enriched at Rautuvaara



Muonio-river
-Natura2000
-wild salmon
-Swedish border

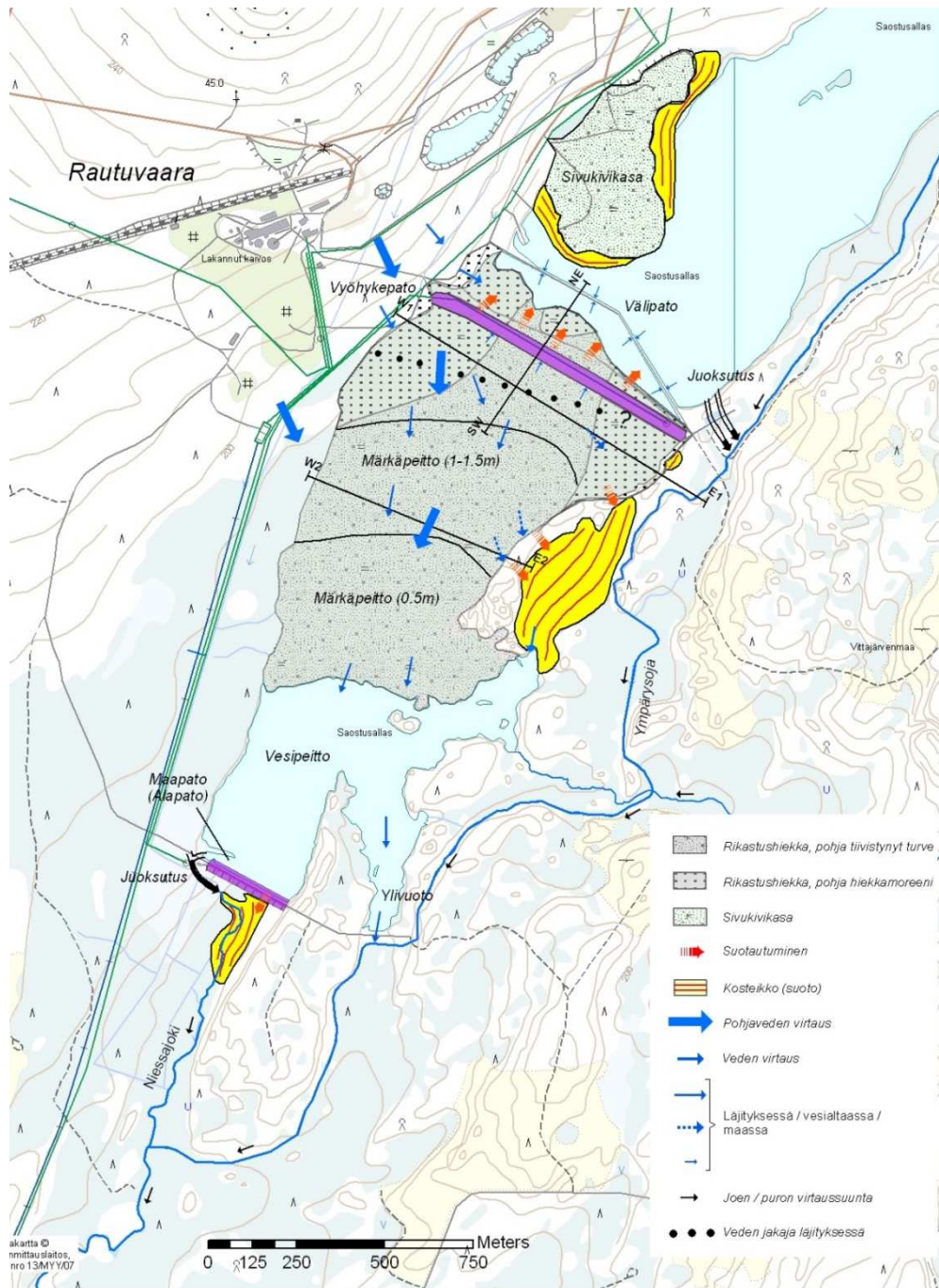
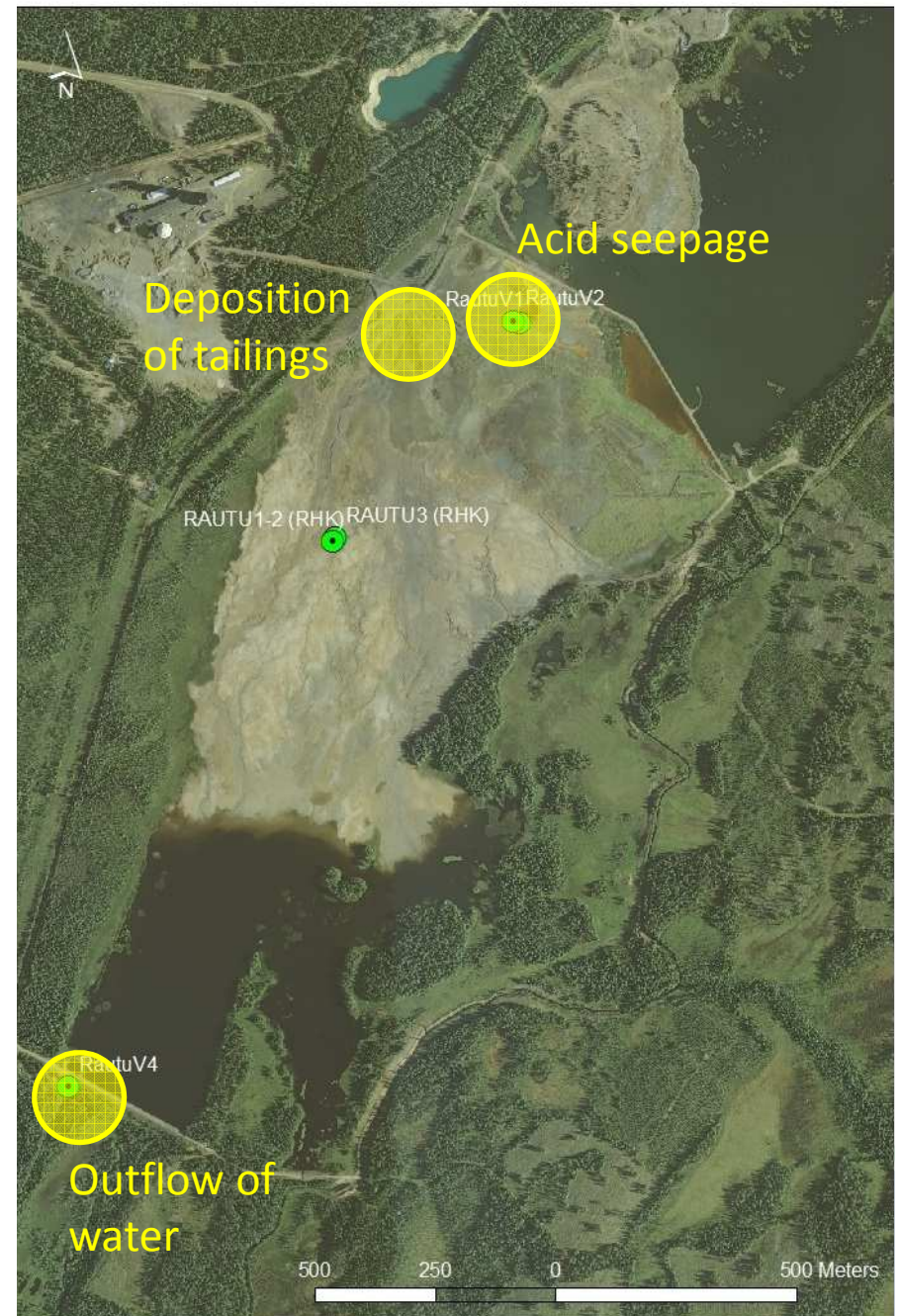
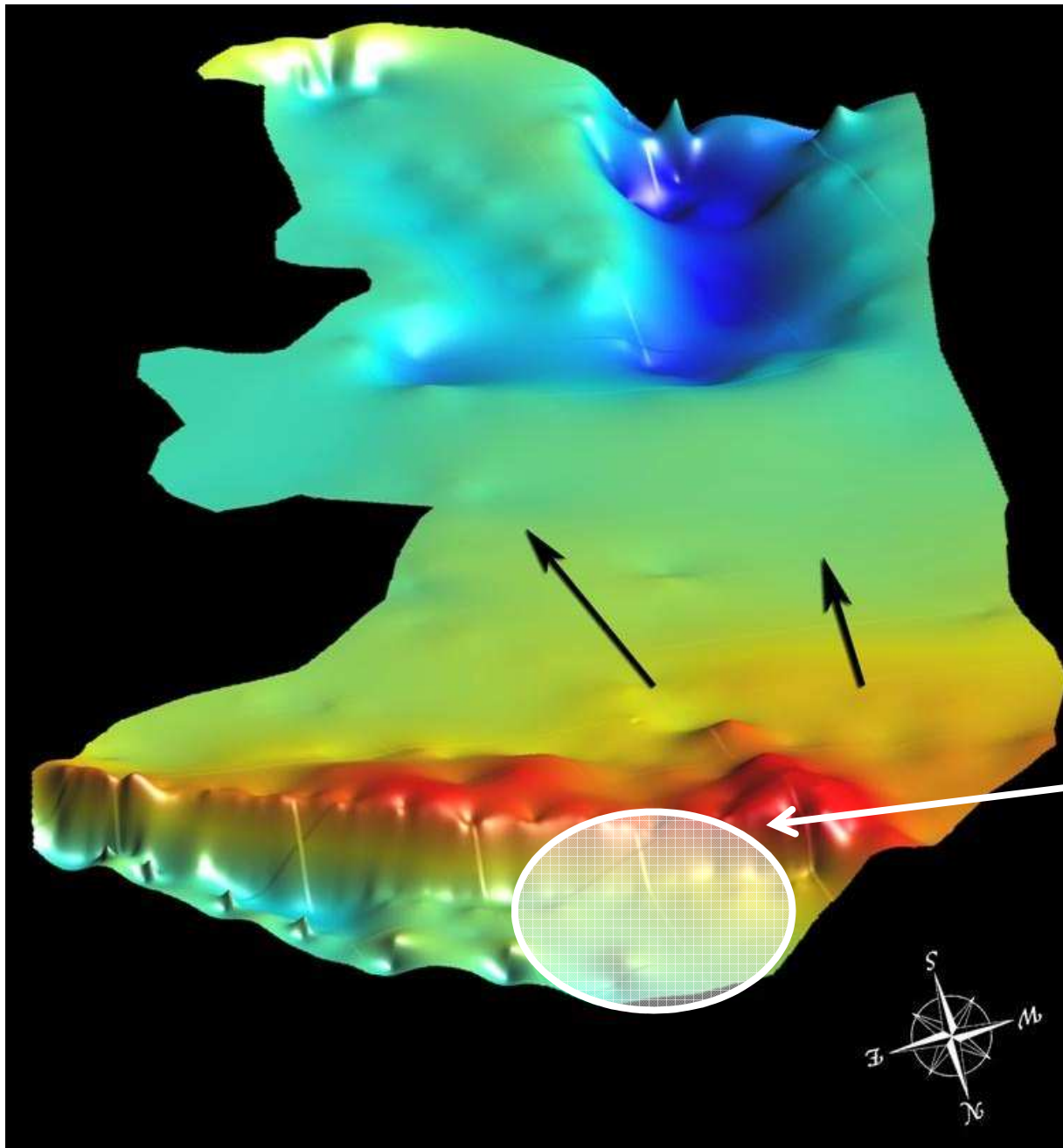


Figure: Geological Survey of Finland





Main body of tailings is moving slowly southwards from the depositional area according to topography
 -lowest areas are covered in water and not oxidizing

Northern part of the tailings is behind a topographic barrier
 -This section has a separate ground water flow regime
 -> oxidation and formation of acid seepage

Rautuvaara – view South from deposition area



Rautuvaara – view North from deposition area



Northern part of
tailings has
started oxidizing

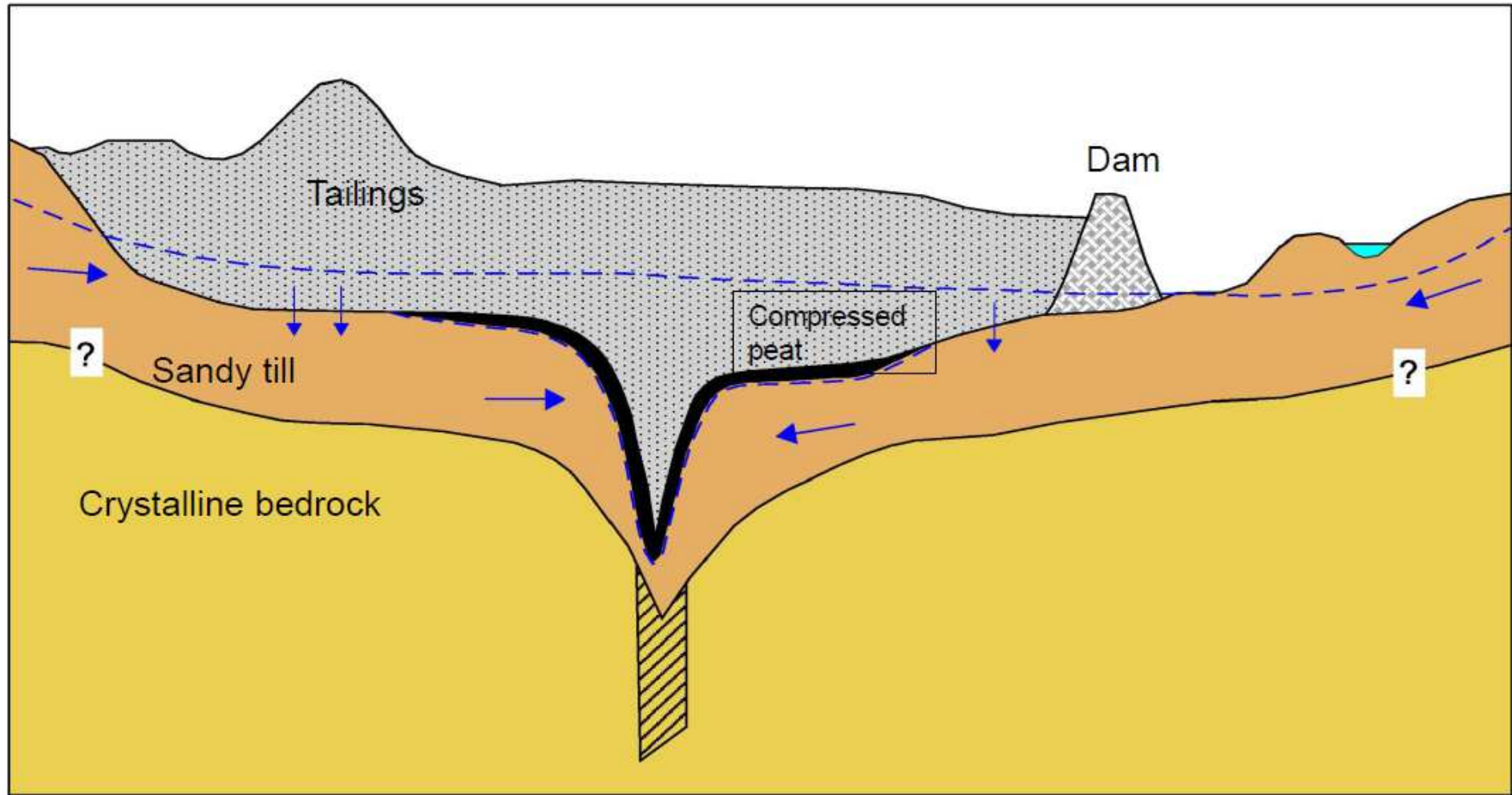
Settling pond for
water treatment
of local ski resort
(Ylläs)

Seepage water
pond (pH < 3),
heavy metals and
100 µg/l soluble
uranium

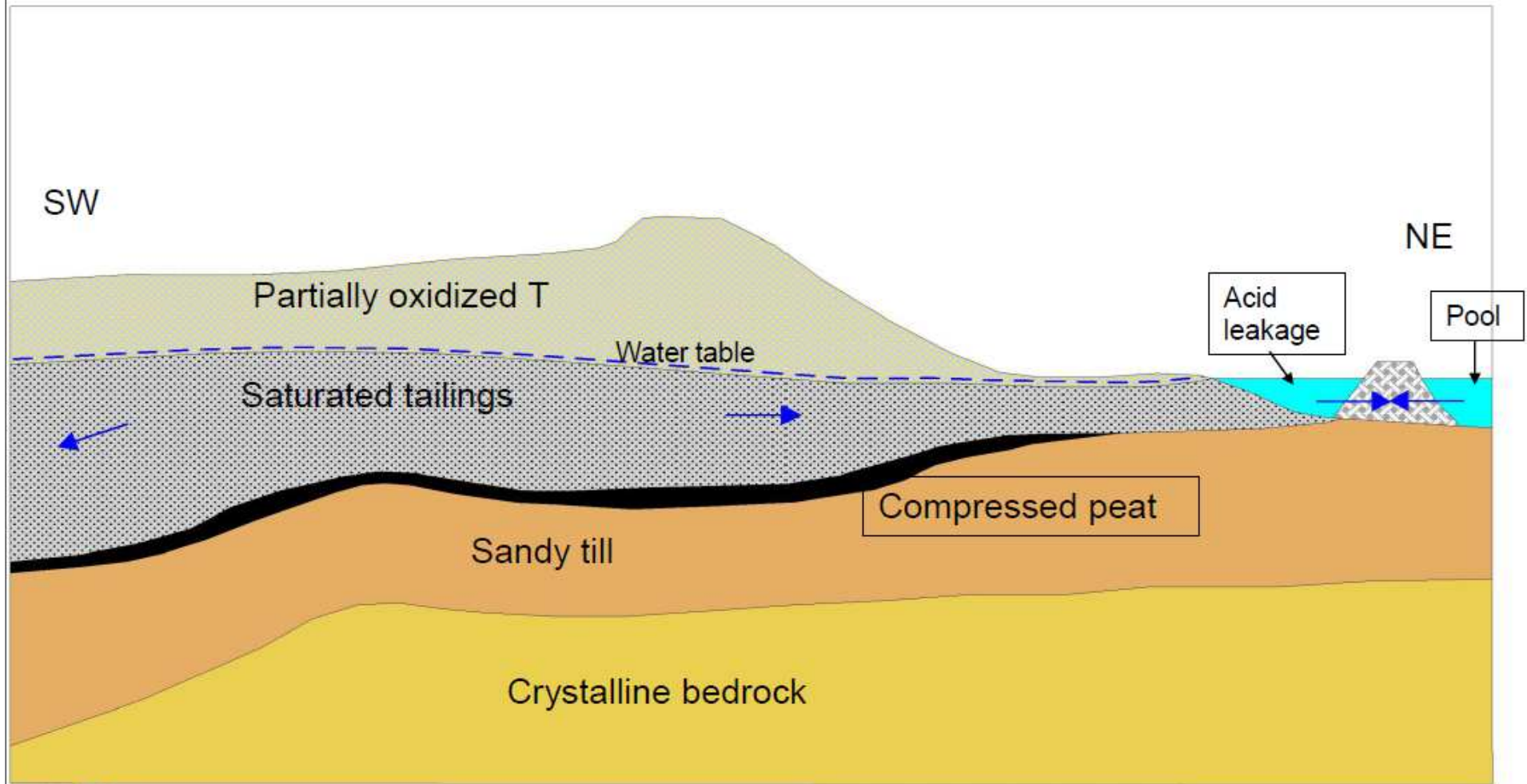
Rautuvaara tailings: Cross-section (2) W1-E1

W1

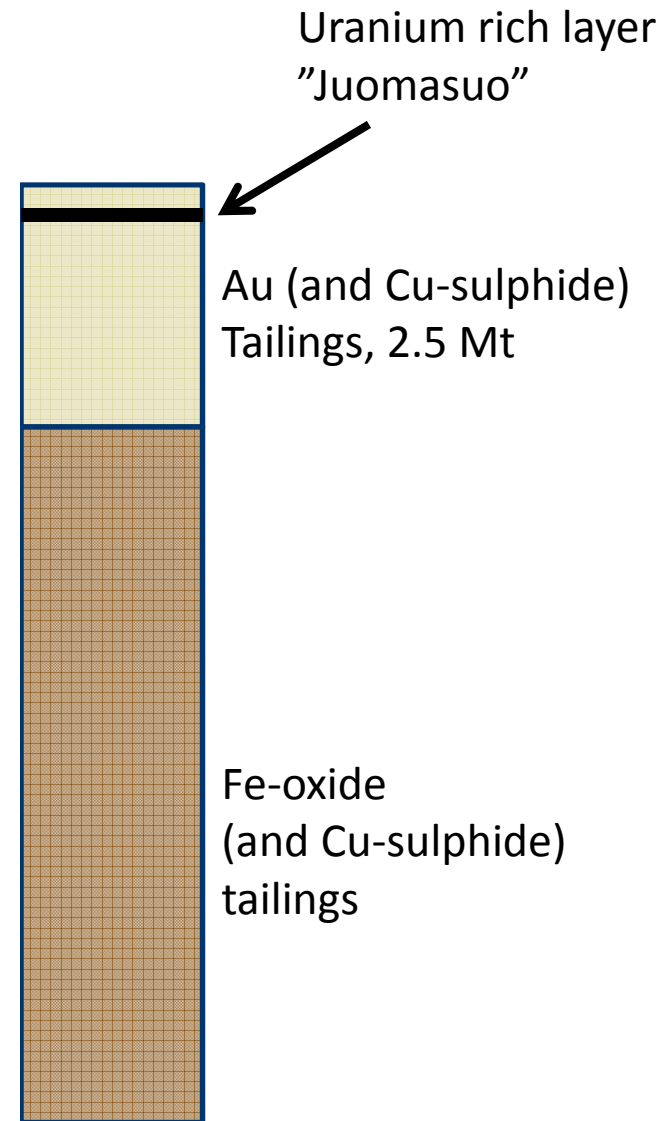
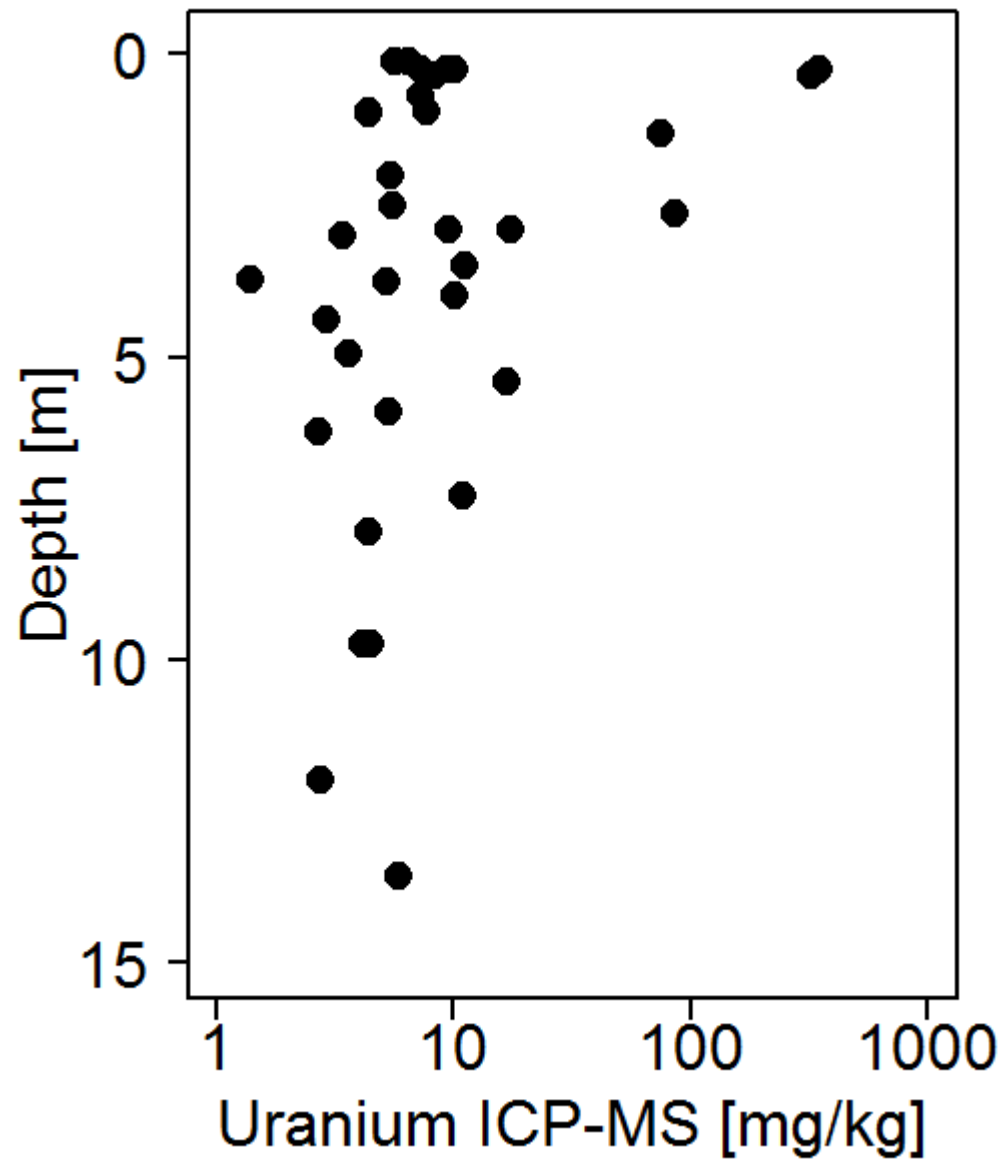
E1



Rautuvaara tailings: CROSS-SECTION (1) SW-NE



Rautuvaara tailings



Rautuvaara tailings – mass movements

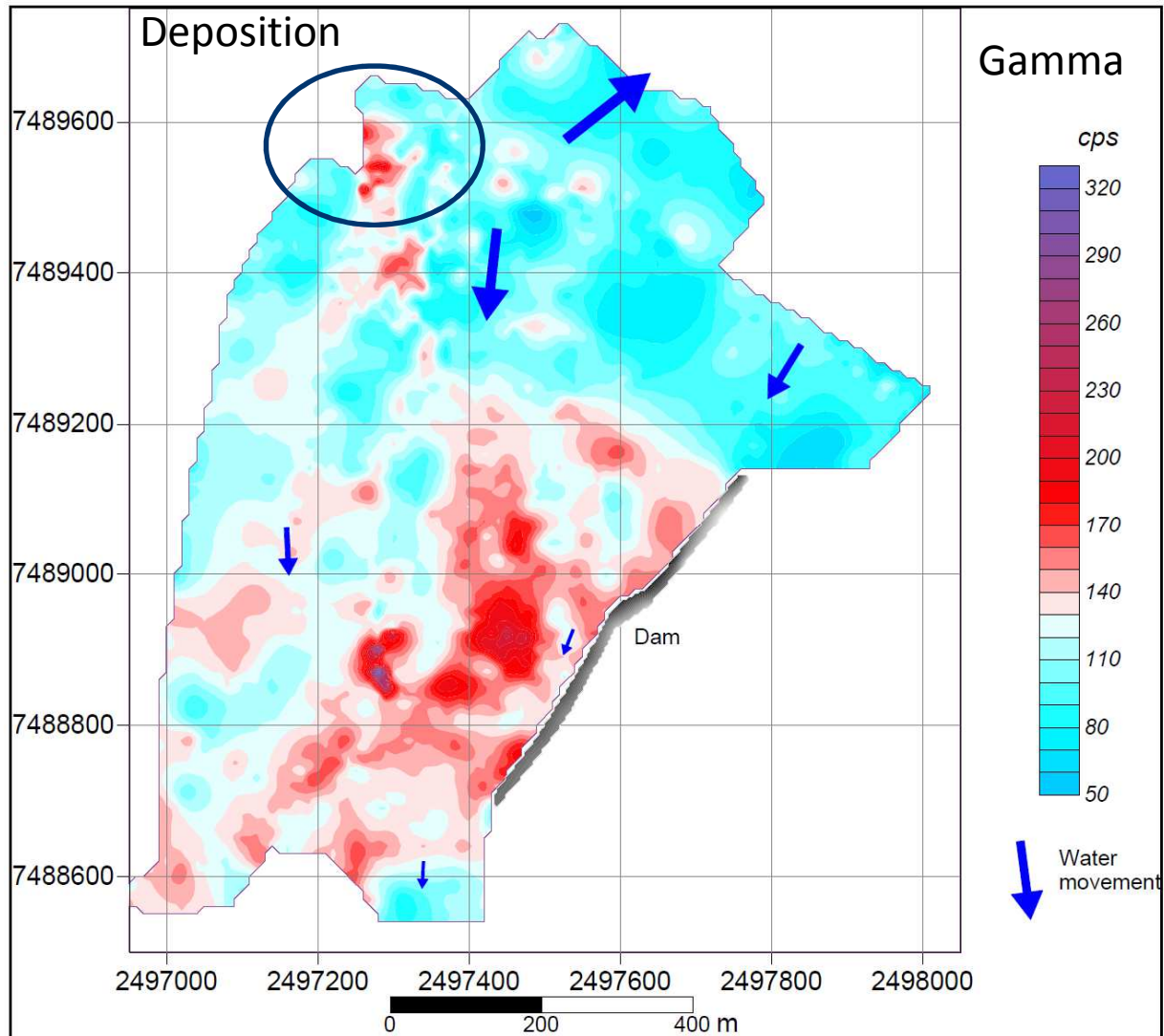


Figure: Turunen and Lanne (2006),
Geological Survey of Finland

Analytical

- Geological Survey of Finland/LabTium: ICP-MS and ICP-OES
- STUK: Gamma (HPGe), radiochemistry, liquid scintillation

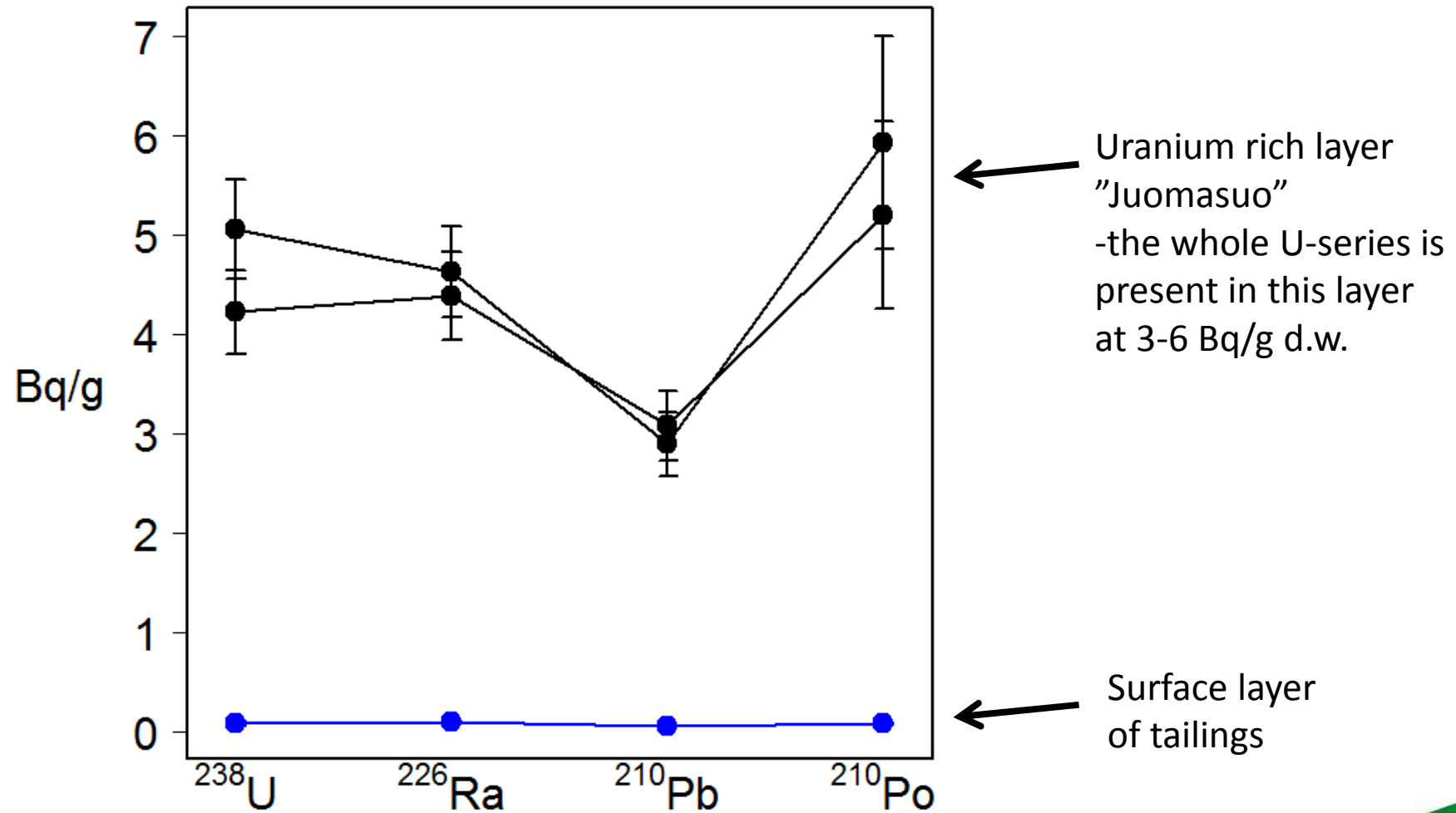
- Geochemical fractions – solids
 - Ammonium-acetate soluble: "adsorbed"
 - hot aqua regia soluble: "acid soluble"

- Geochemical fractions – water
 - Untreated: "total"
 - Filtered: "soluble"

- Water quality measurements in the field (pH, redox, oxygen, conductivity)

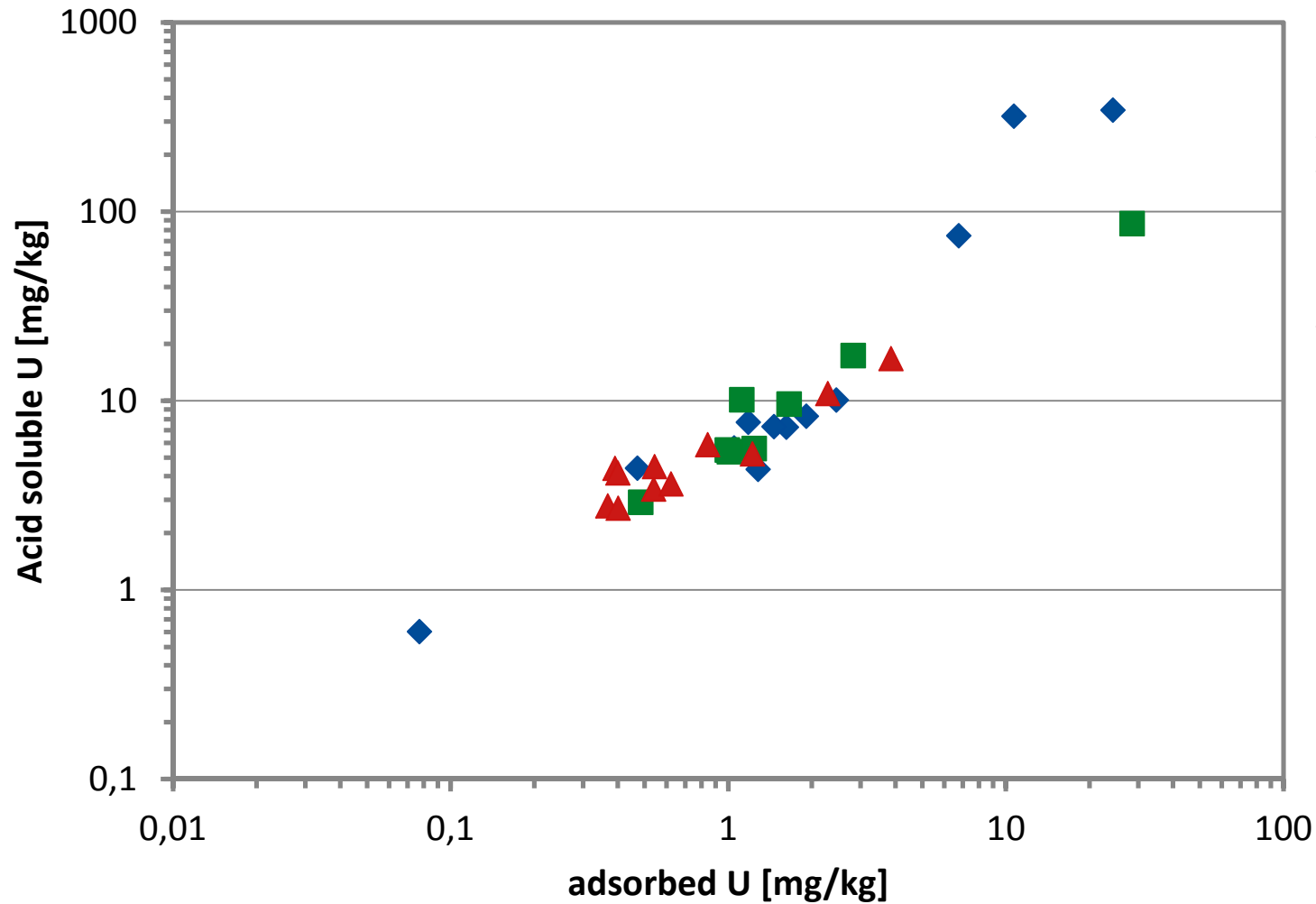


Rautuvaara - Radionuclides in tailings



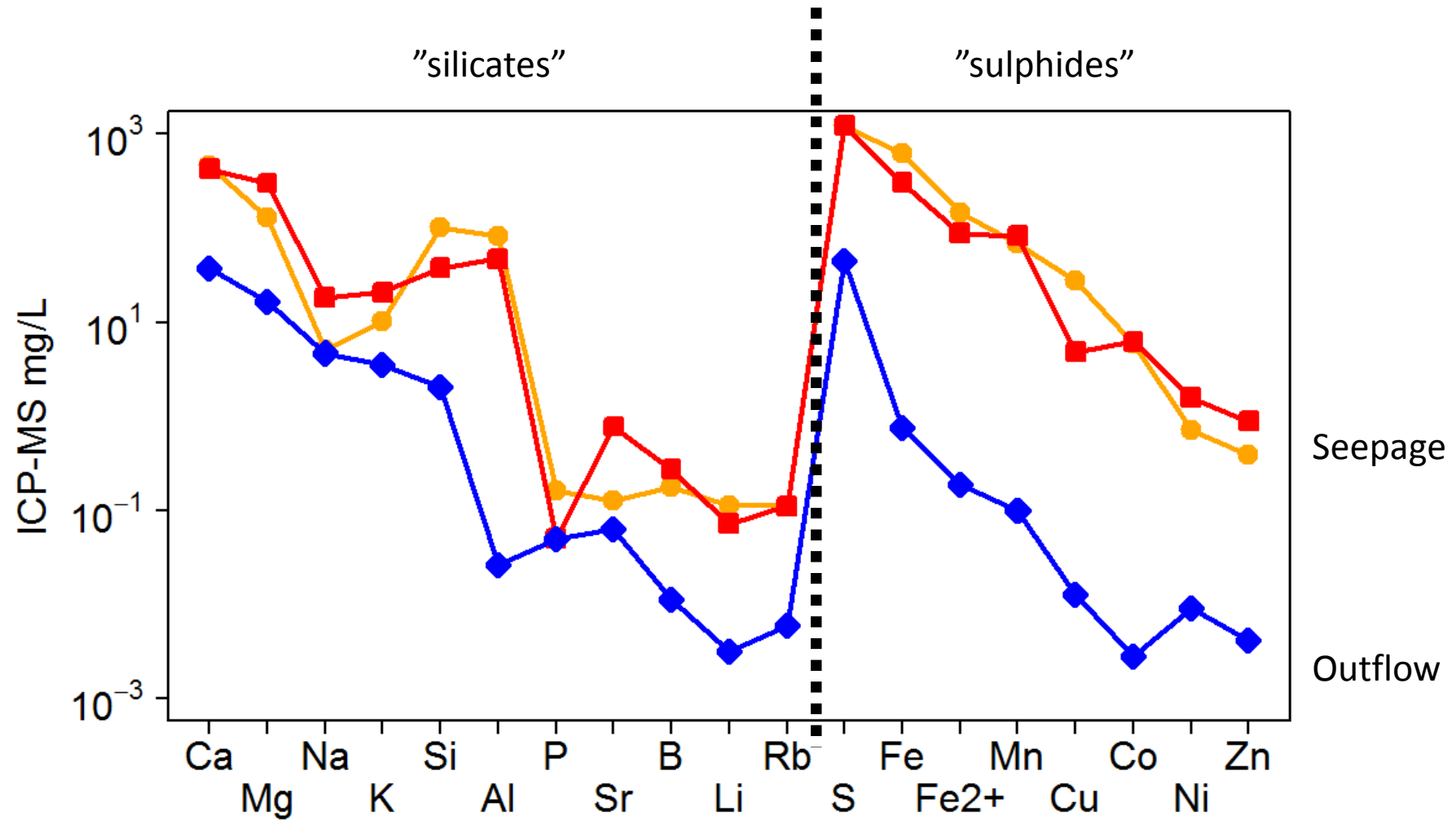
Rautuvaara – uranium in tailings

◆ Surface layer ■ middle layer ▲ bottom layer

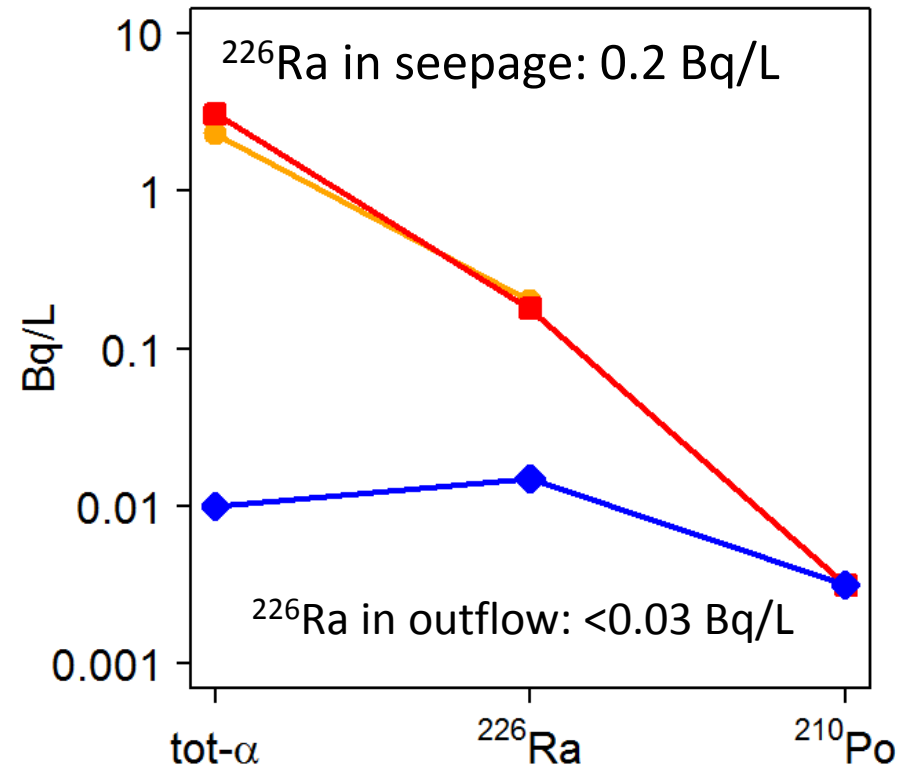
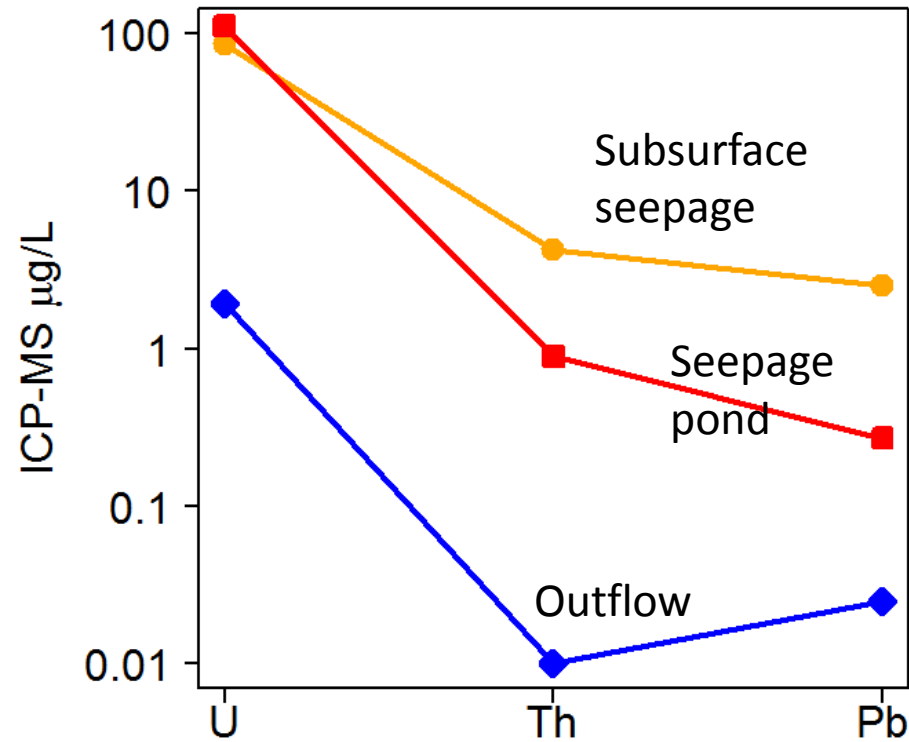


Adsorbed uranium fraction is about 10% of total
-> proportion is fairly constant regardless of concentration level

Rautuvaara – geochemistry of water – soluble fraction



Rautuvaara – radionuclides in water



Seepage water: pH = 2.7-3.8, redox = 350-500 mV, $\text{SO}_4 = 3000 \text{ mg/L}$

Issues and questions

- Northland Resources plans to re-open Rautuvaara as a tailings pond for the Hannukainen FeOx-Cu-Au – project
 - Application for environmental permit 2014-?
- Legal requirements for previous mining companies for the remediation/rehabilitation of Rautuvaara? –open question
- Niesä-river flows into Muonio-river, which is one of the most important breeding areas for the Baltic Sea Salmon
 - Proximity to Swedish border means that the "Border River Commission" has a say
- Necessary to establish long-term monitoring of surface-water and groundwater
- Currently reindeer and other animals have free access
 - Should restrictions to access be established while decisions are made for the long term?

Conclusions

- Sulphide oxidation of Rautuvaara tailings has begun, but also weathering and breakdown of silicates
 - Low-pH seepage water, mobilisation of uranium and other heavy metals
- At the moment the "outflow" water released to the environment is not a big concern, but there is evidence of seepage into groundwater
- Target is to understand what will happen to the main body of tailings in the future, and how it should be countered
- Work is not finished due to a challenging research budget...
 - More data needed for e.g. groundwater
- New EU-BSS means Rautuvaara will get more attention from regulators



Thank you!