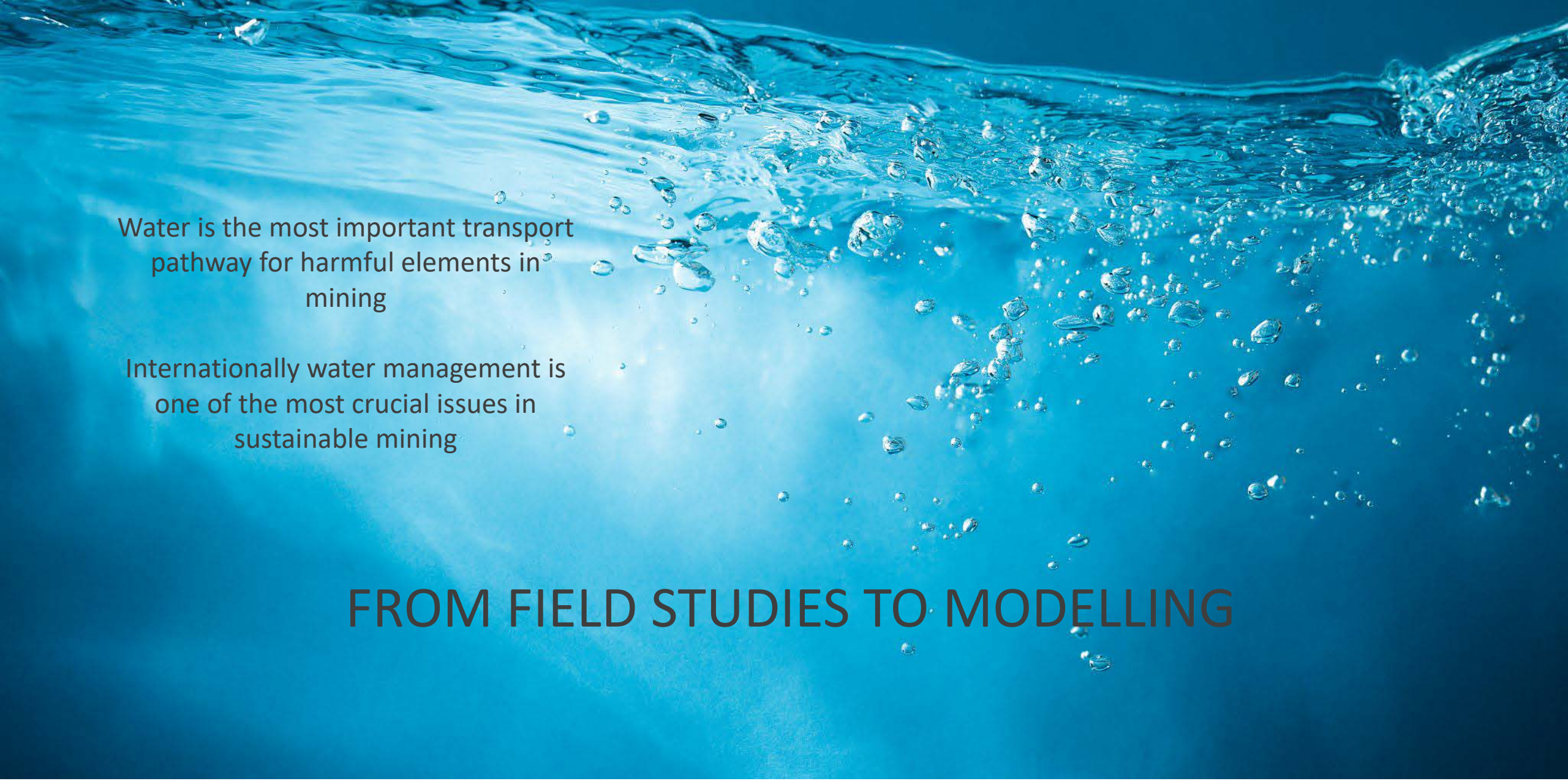
MINE WATER SERVICES

Ms. Kaisa Turunen, MSc. Research Scientist

March 11th 2021



Water is the most important transport pathway for harmful elements in mining

Internationally water management is one of the most crucial issues in sustainable mining

FROM FIELD STUDIES TO MODELLING

MINE WATER SERVICES AND RESEARCH

Services

- *Flow, conservative and reactive transport modelling*
- *Research on groundwater balances and management*
- *Water quality and modelling in mining waste areas*
- *Modelling the effects of mine closure*
- *Development of groundwater and surface water monitoring and monitoring strategies*
- *Development of water treatment and recovery of valuables from water, on-site piloting*
- *Training and capacity building*

Research

- *Solving demanding mine water issues on-site*
- *Developing methods, tools, knowledge, strategies and guidebooks*
- *Scientific research and publishing*

GTK

EQUIPMENT FOR MINE WATER STUDIES

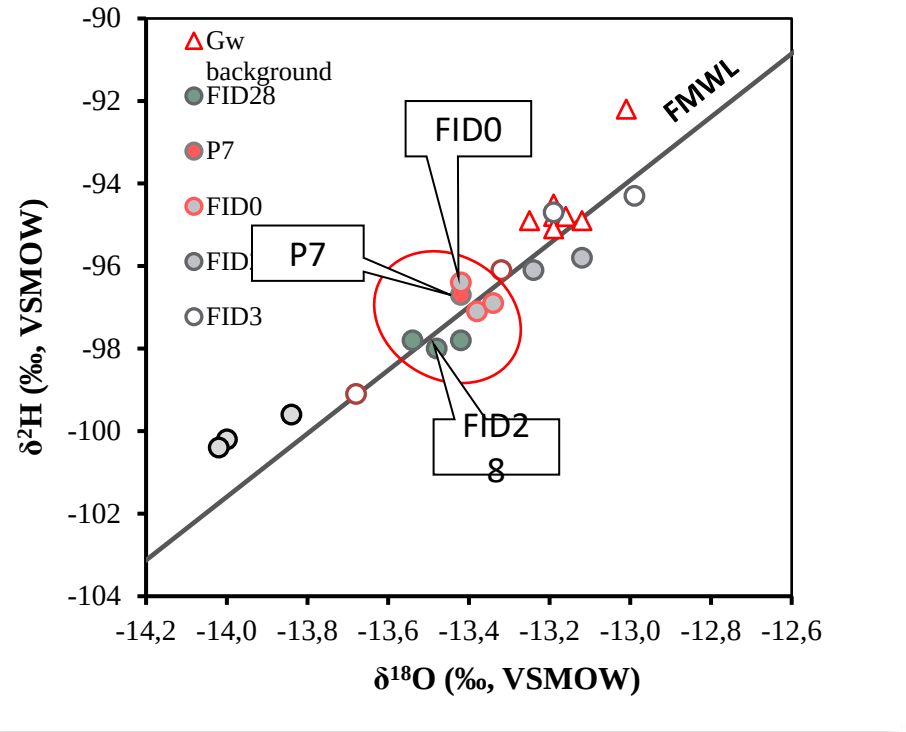
- Large array of geophysical equipment, *e.g.* Seismic, Electric resistivity tomography, EM-methods
- Hydrogeological field equipment, *e.g.* Packers, Slug, Deep pumping protype, Advanced sampling, Open channel hydraulics
- Drone and automatic drone water sampler
- Mobile water treatment and recovery pilot installation including real-time analysis capability (online-XRF June/2021)
- Modelling server and software e.g. Leapfrog, GMS, FeFlow, Comsol, Phreeqc, Min3P, and in-house modelling tools (AMD-PhreeqcPy, MMIT-Clay)

Walkera V1100 Pro

Drosens drone-borne water sampler

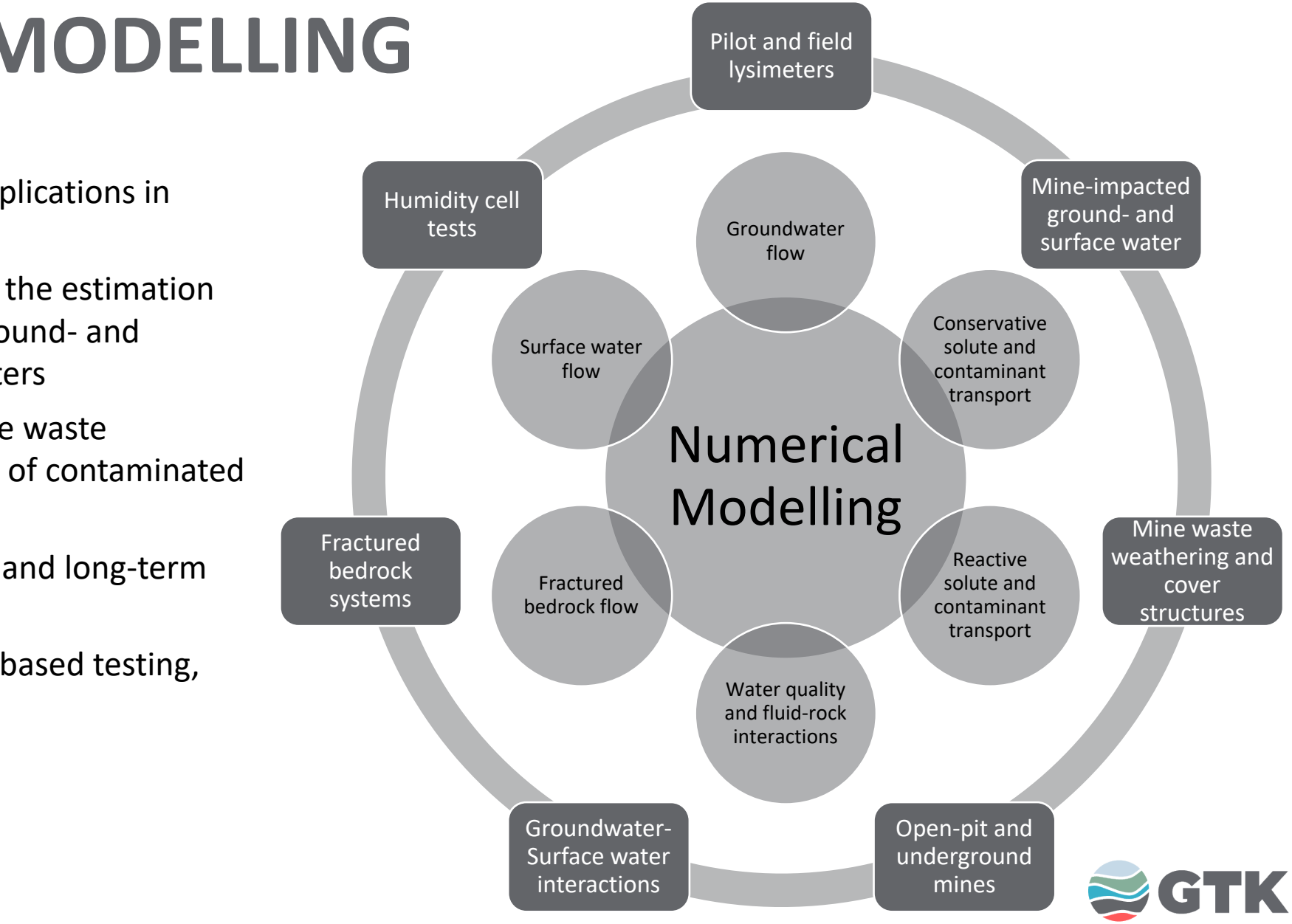
NATURAL AND ANTHROPOGENIC TRACERS

- Natural and anthropogenic tracers have been used in mining areas to detect
  - *Hydraulic connections and interaction*
  - *Emission sources and pathways*
  - Attenuation and mobility mechanisms
- Main natural tracers used are conservative $\delta^2H/\delta^{18}O$ and $^{87}Sr/^{86}Sr$ isotopes. Geochemical tracers are also used for verification
- Development on the use of $^{7}Cl/^{35}Cl$ and δ^6Li, among others

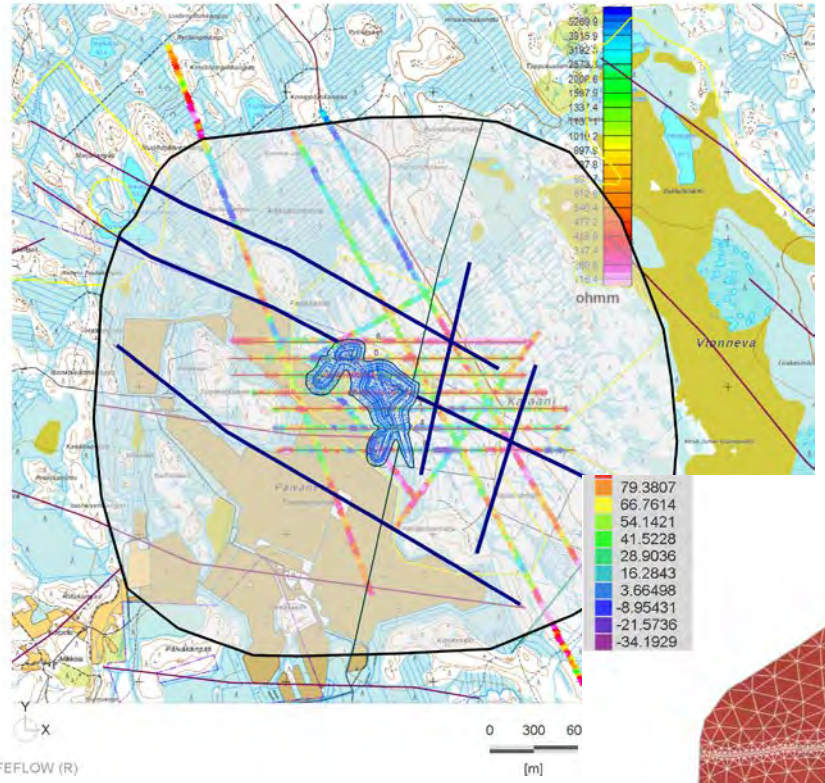


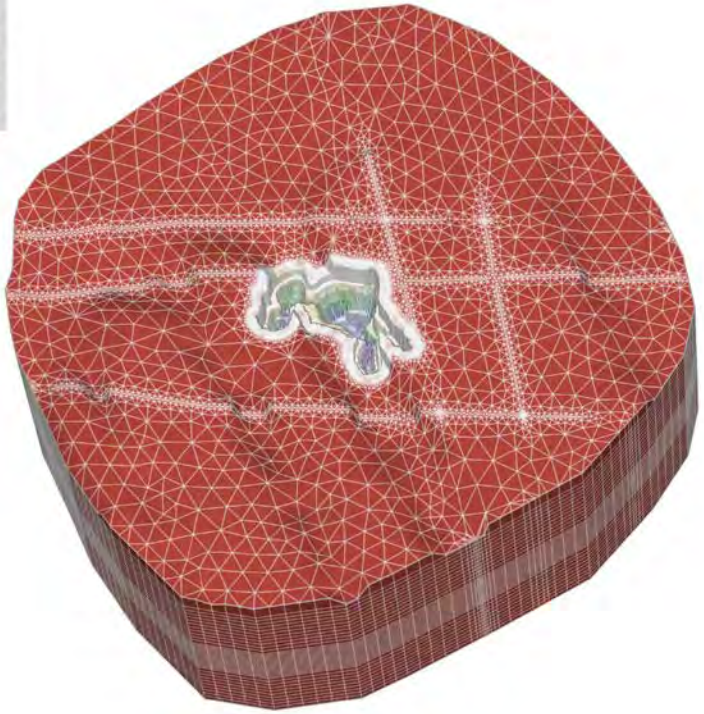
FLOW, CONSERVATIVE, AND REACTIVE TRANSPORT MODELLING

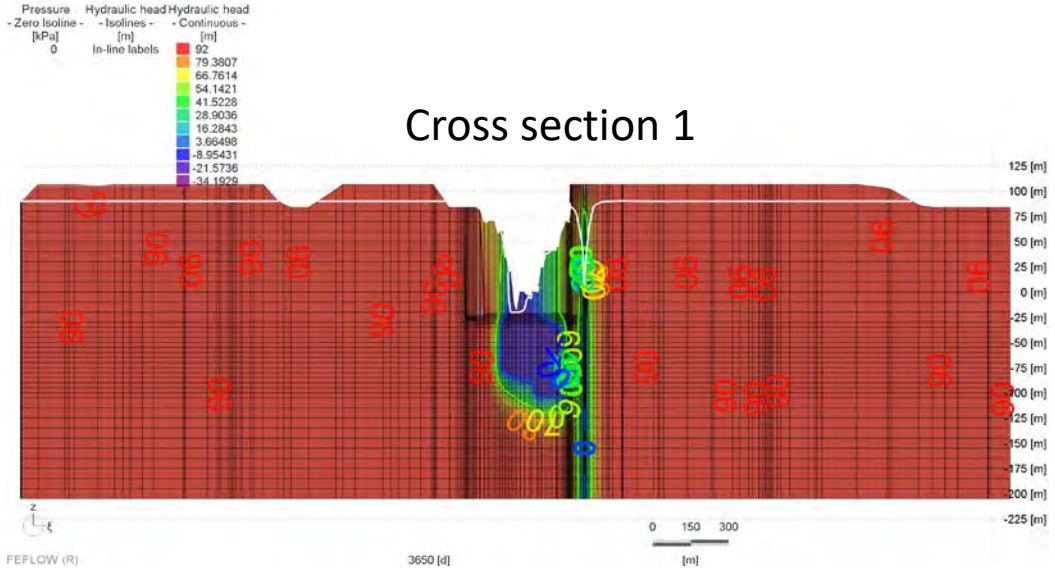
- Broad range of modelling applications in mining systems
- Process-based modelling for the estimation of quantity and quality of ground- and surface waters in mining waters
- Long-term prediction of mine waste weathering and propagation of contaminated drainage in water bodies
- Analyses of cover structures and long-term effects during mine closure
- Interpretation of laboratory-based testing, e.g., humidity cell tests



WATER BALANCE MODELLING



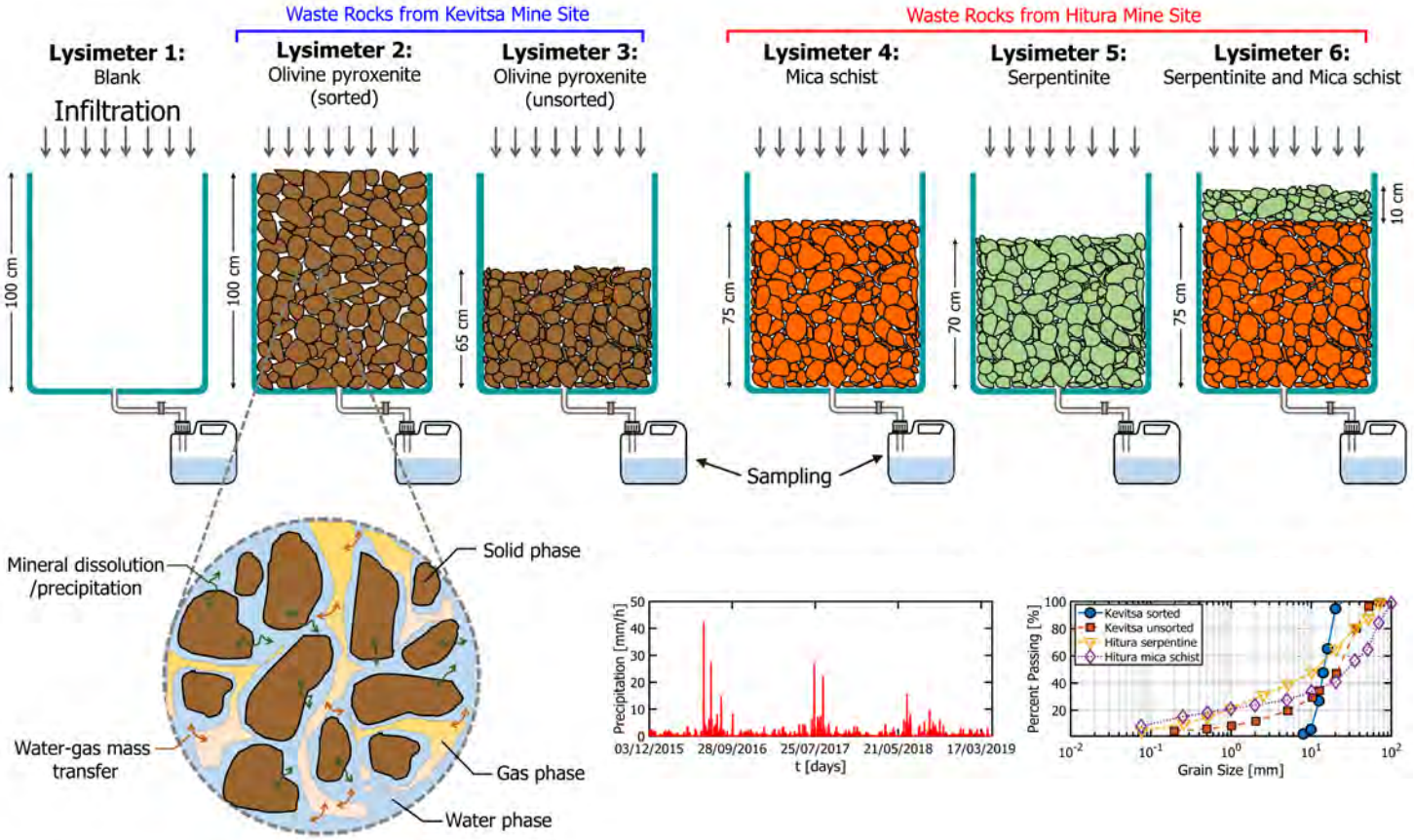




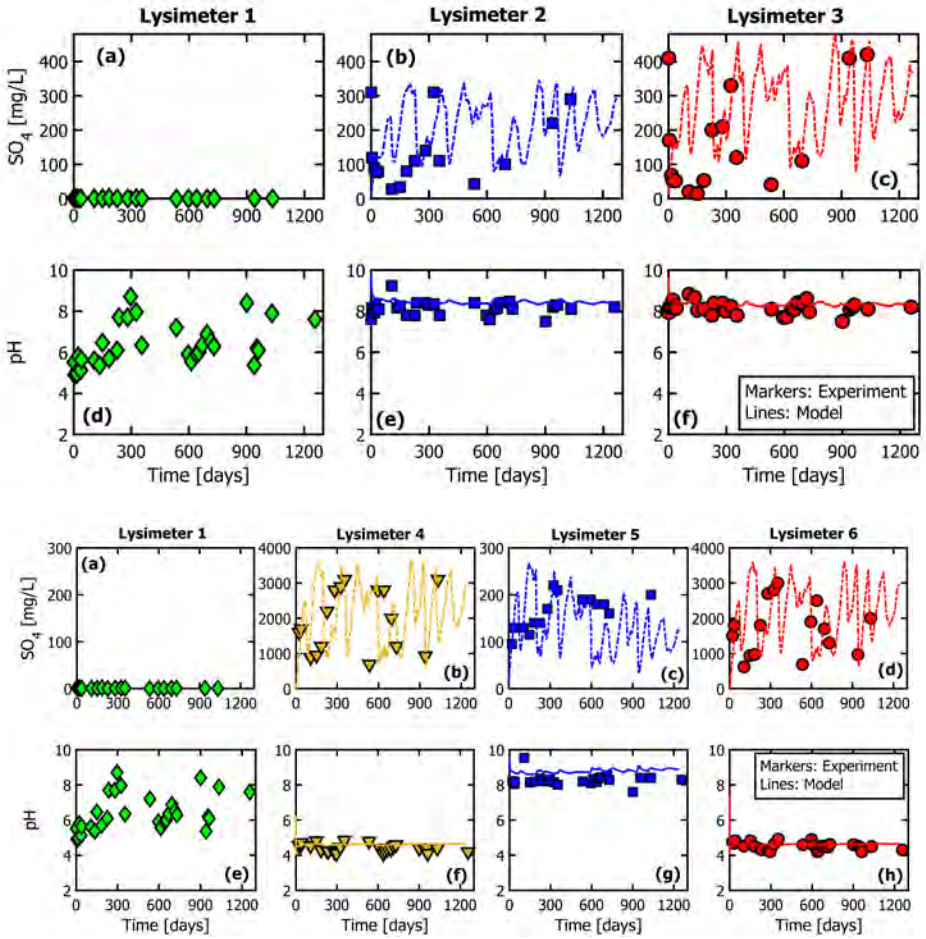
Cross section 1

Cross section 2

LYSIMETERS MODELLING



Drainage Concentrations

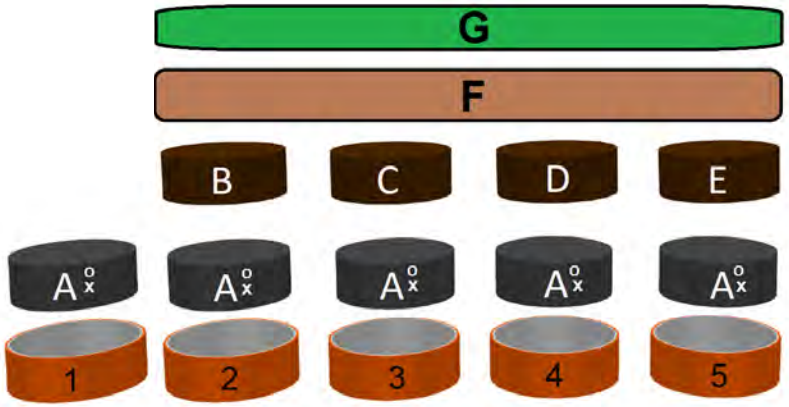


Muniruzzaman et al. (2021)
Appl. Geochem. (under review)

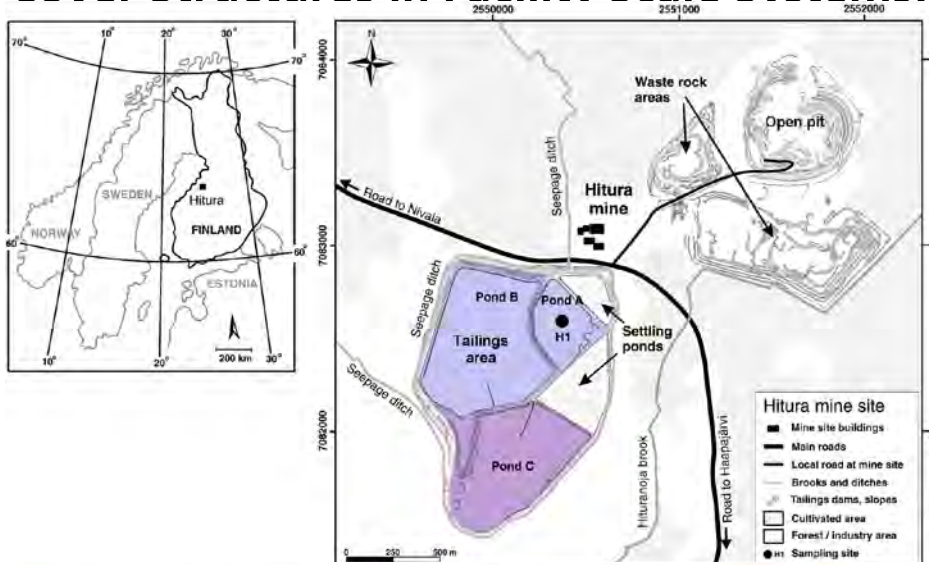
COVER STRUCTURE MODELLING

Study of Cover Structures in Field Lysimeters:

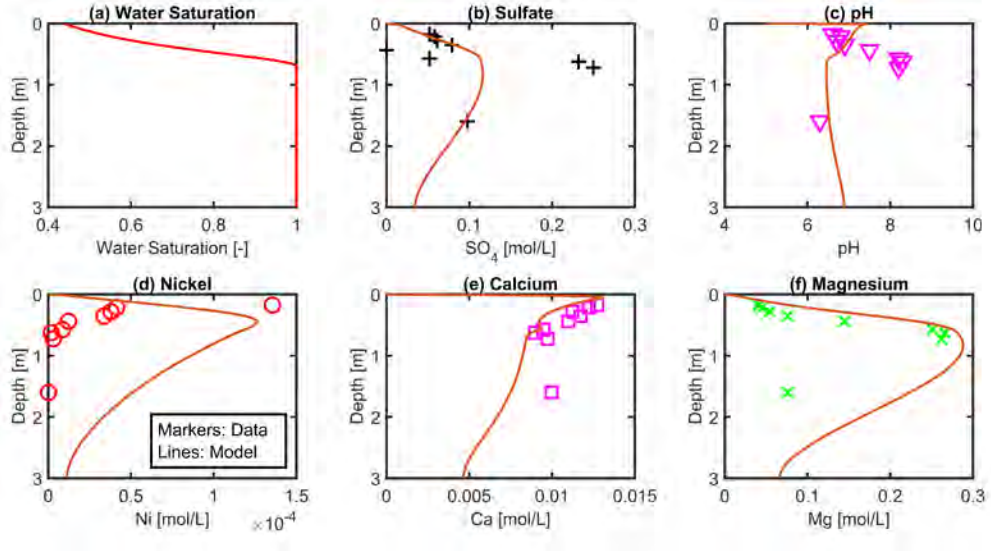
Sensors



Cover Structures in Facilitv Scale Svstems:



Porewater concentrations



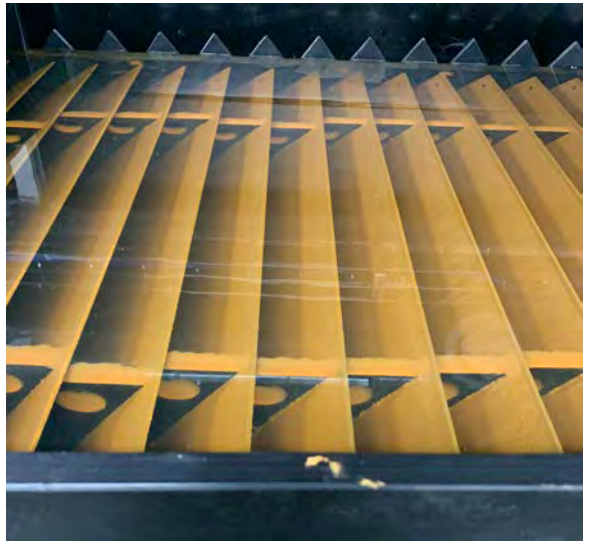
SURFACE WATER MODELLING

- Modelling of subarctic river and lake water conditions, including transport, resuspension and deposition of metal contaminated sediments.

- Mobile field methods that support model building and calibration
  - Decades of experience in lake sedimentology and use of bathymetric data.
  - State of the art equipment for open channel hydraulics.

WATER TREATMENT AND RECOVERY

- Implementation of state-of-the-art technologies for water treatment
- Development of strategies for increasing the recycling rate of the process water and reducing makeup water and effluents discharge
- Developing methods for recovery of critical raw materials (CRMs) from mining effluents and side streams
- Testing technological solutions in the laboratory, upscaling studies and validation methods at the pilot-scale

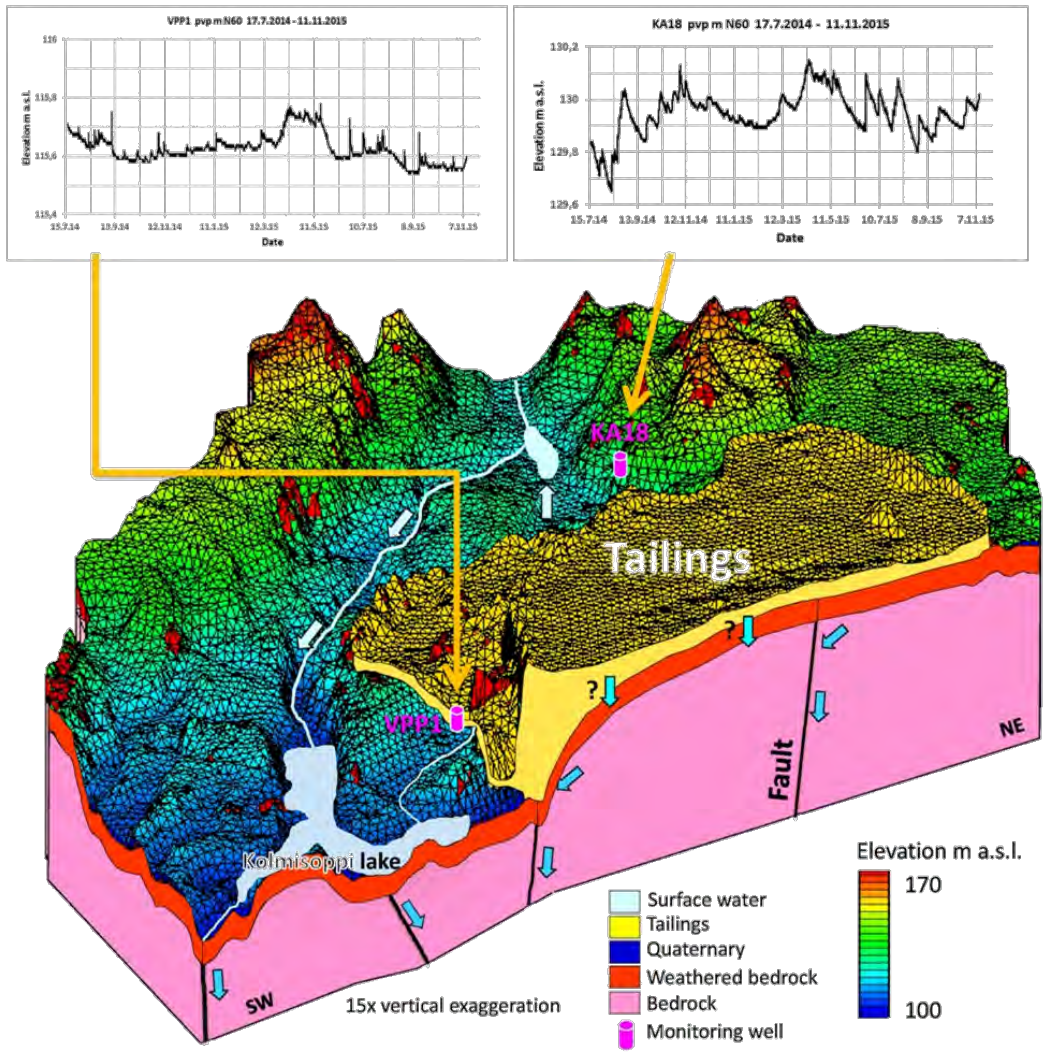


WATER TREATMENT AND RECOVERY PILOT

- The technical development of a pilot-scale industrial water treatment and metals recovery system
- A sea container used to house the pilot installation. The pilot designed to be a continuous process with a nominal capacity of 1 m^3/h, full automation and online process monitoring
- Recovery technologies demonstration up to TRL 7. Implementation tested for recovery REE, Ni and Co

PREDICTIVE MINE WATER MANAGEMENT

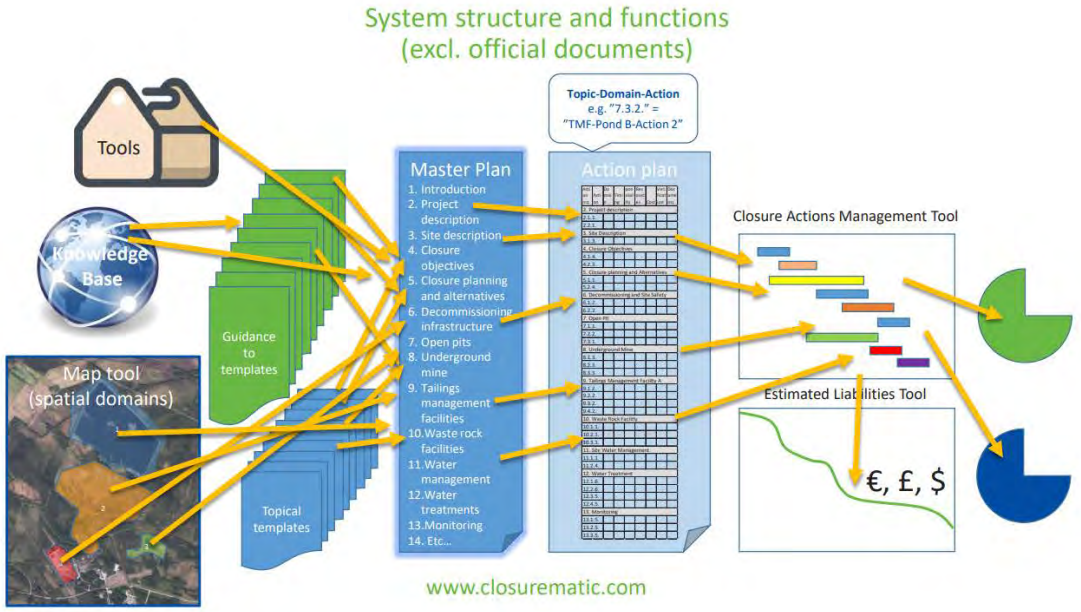
- Development of predictive water balance model based on Finnish Environment Institute's VEMALA watershed model.
- Coupling groundwater transport models to VEMALA model and application to site scale.
- Monitoring development for autonomous early warning and control system for environmental water



WATER MANAGEMENT IN MINE CLOSURE

- **Mine Closure website** (mineclosure.gtk.fi) is an open internet resource on technologies and approaches used in mine closure.
- Provides guidance and tools for **planning, executing and monitoring of mine closure:**
  - *Systematic evaluations of key methods and technologies for mine water management and treatment, wastes and waste facilities and environmental monitoring*
  - *Case studies of performance of closure technologies*
  - Results of research and development studies

- **CLOSUREMATIC** is an advanced digital planning and management tool for continuous mine closure.



CURRENT AND UPCOMING RESEARCH THEMES

- Optimizing groundwater monitoring and novel data interpretation and presentation, incl. AI
- Holistic pit lake modelling, incl. coupling groundwater reactive transport modelling, pit lake reactive modelling and recipient waters modelling
- Effect of high salinity groundwater to mine water management
- Sediment groundwater – bedrock groundwater interaction

THANK YOU

kaisa.turunen@gtk.fi

www.gtk.fi

Photo: Orijärvi mine mainframe and the pit.