

Artificial Intelligence in Mineral Exploration - AIMEX

Vesa Nykänen
Information Solutions
Geological Survey of Finland

ARTIFICIAL INTELLIGENCE IN MINERAL EXPLORATION – A CO-INNOVATION PROJECT

- Adding value to exploration data with AI

The primary goal of the AIMEX project is to develop mineral exploration by making it more efficient, by conserving both time and financial resources expended during the exploration stage. The project is dedicated to advancing the application of artificial intelligence in supporting mineral exploration methods and concepts.

Partners

[GTK](#), [SYKE](#), [University of Turku](#)

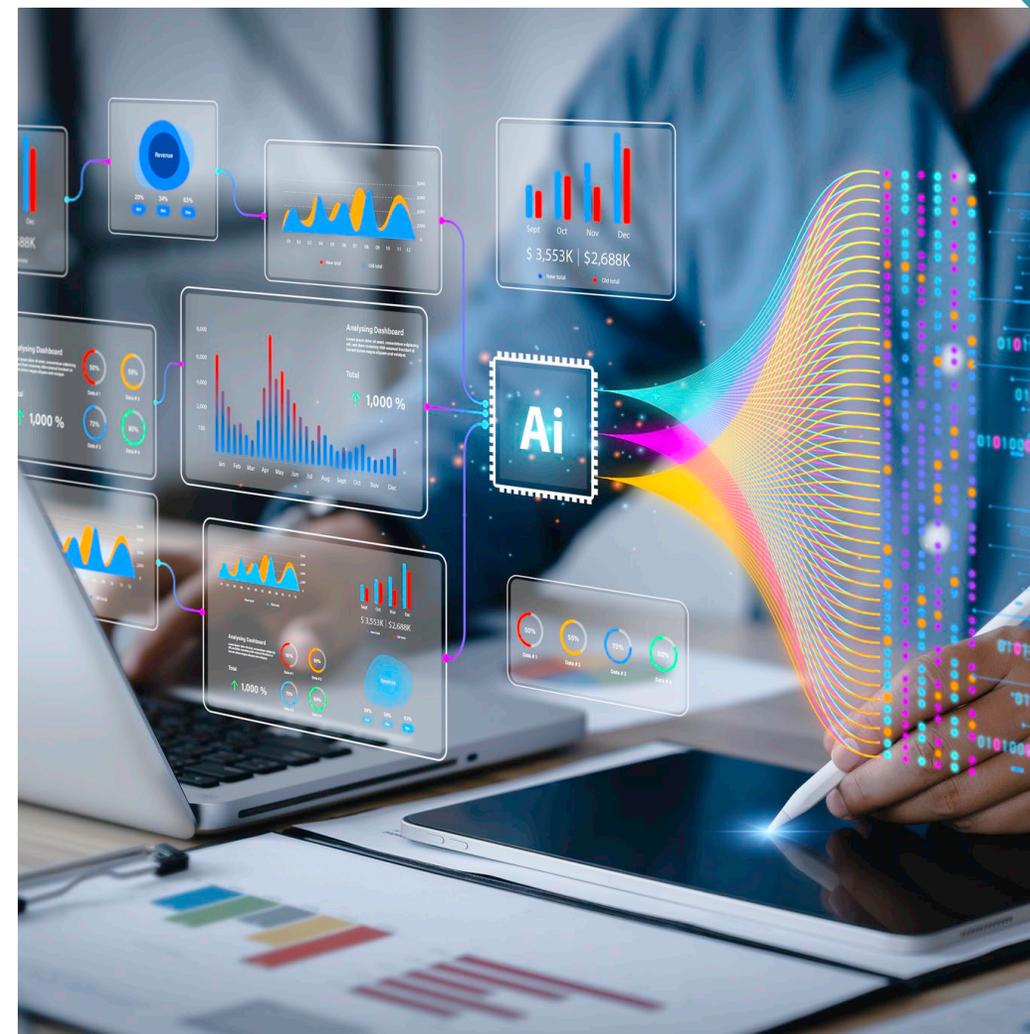
[Astrock Oy](#), [CRS Laboratories Oy](#), [Geopool Oy](#), [Mawson Oy](#),
[Muon Solutions Oy](#), [Radai Oy](#), [Rovjok Oy](#), [Sokli Oy](#)

Duration: 2023-2025

Funding from Business Finland: EUR 3 million

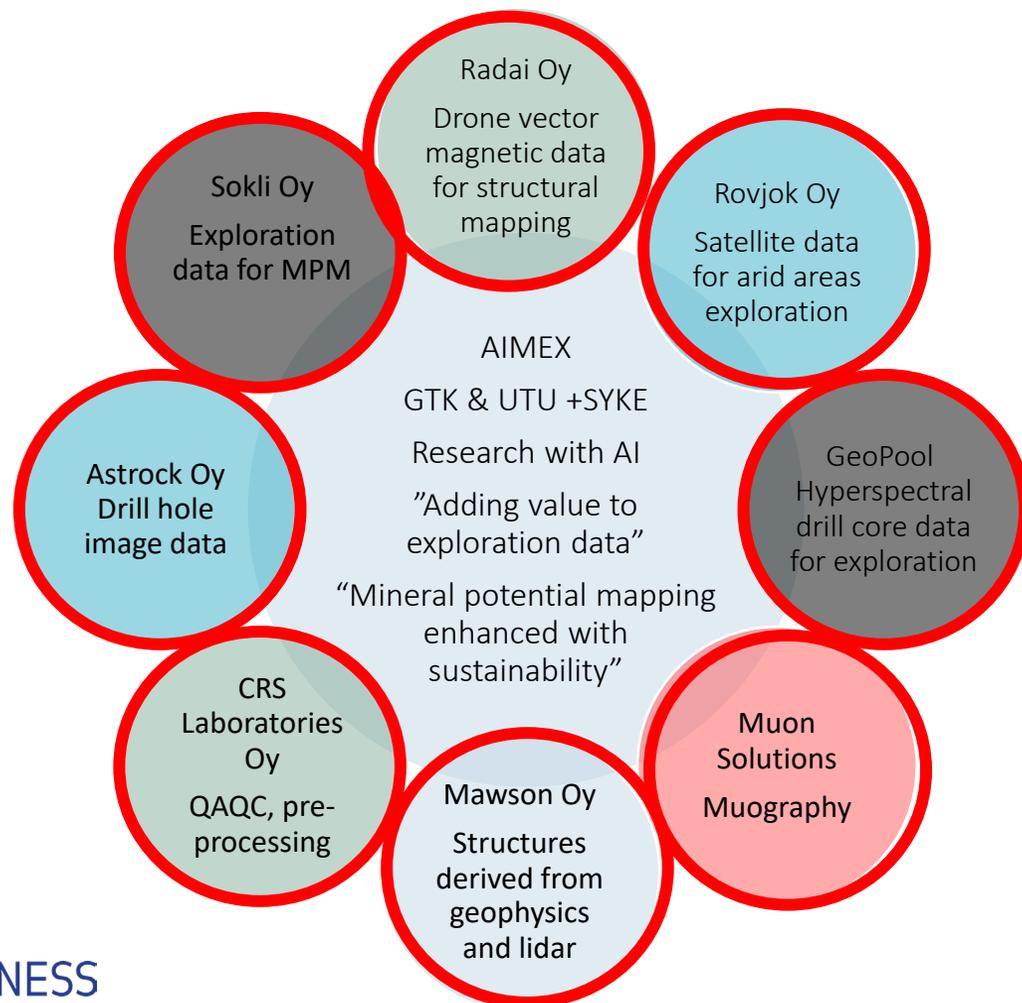
Total expenses 5.6 M€

[Read more](#)



Public research project supports company projects

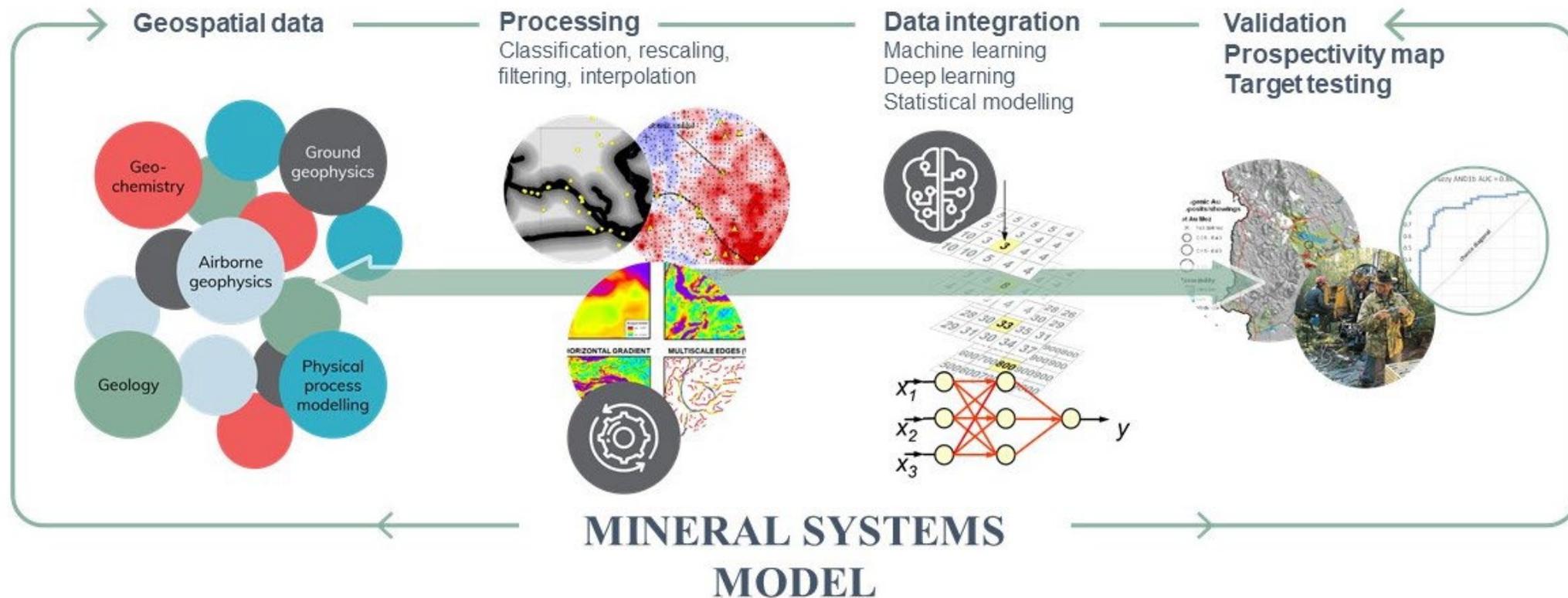
3 research partners, 8 industry partners



- **GTK, UTU and SYKE** will undertake a public R&I project exploring different ways to use AI to enhance mineral exploration data, aiming to provide deeper insights into mineral prospectivity mapping. *MPM procedure will be enhanced with sustainability*
- **Sokli Oy** provides the entire consortium with the opportunity to test novel technology in real mineral exploration.
- **Radai Oy** will evolve its business model from data acquisition to integrating and refining drone and other exploration data using AI techniques developed in the public AIMEX R&D project.
- **Rovjok Oy** will focus on using satellite data for arid areas exploration and applying AI techniques.
- **GeoPool Oy's** project is on a Machine Learning framework for target-scale 3D mapping of geological features with special emphasis on hyperspectral data.
- **Muon Solutions Oy** develops muography for mineral exploration.
- **Mawson Oy** is developing tools to make structures derived from geophysics and lidar
- **CRS Laboratories Oy** – AI and ML for quality control of laboratory data
- **Astrock Oy** – Drill hole image data and testing the usability of developed methods in business applications.

GTK's main task in AIMEX: Machine learning in mineral prospectivity mapping “enhanced with sustainability” i.e., considering other land-use

- Mineral prospectivity mapping or analysis can be divided into 1) Definition of the mineral system type, 2) Data selection and preprocessing, 3) Prospectivity modelling and 4) Model testing



Company projects – brief descriptions

- **Sokli Oy aims to make mineral exploration more efficient and thus save time and money spend in exploration phase by this project.**
 - Machine learning in exploration data integration, pattern recognition from geophysical data, drill core image enhancing, or hyperspectral data processing
 - Smart software applications for mineral potential and mining feasibility mapping for exploration.
 - Sokli Oy gives the possibility for the entire project consortium to test the modern technology in real mineral exploration and as a partner company we make this project a common effort.
- **Mawson Oy is developing tools to make structures derived from geophysics and lidar.**
 - Company also provides exploration data from Rajapalot target area including drill core assays, geological mapping, geophysical data, geochemical survey data.
- **Muon Solutions Oy is developing muography as a tool for mineral exploration.**
 - Expertise in a novel branch of geophysics (i.e., particle geophysics) that utilizes the penetrating power of cosmic-ray muons for detecting and imaging density variations and structures in bedrock.
- **Geopool Oy**
 - A machine learning framework for **target-scale 3D mapping of geological features with special emphasis on hyperspectral data**
 - Definition of ESG inputs in MPM and evaluation of the effects of the European Union Critical Raw Materials Act on ESG in exploration.
- **Rovjok Oy will focus on using satellite data in exploration and applying AI techniques.**
- **CRS Laboratories OY**
 - Information about commercial laboratory procedures from which geochemical data is produced. Information of commercial laboratory **Quality Assurance / Quality Control (QAQC) processes** used in exploration. Information of exploration companies' QAQC processes
 - Developing ways of automatically collecting big data from analysis procedures
 - Tool to evaluate sample preparation and analysis process.
- **Radai Oy will develop its business model from data acquisition into drone** and other exploration data integration and processing/refinement using the AI techniques developed in the public AIMEX R&D project
- **Astroek Oy will be providing realistic drill hole image data** and testing the usability of developed methods in business applications.

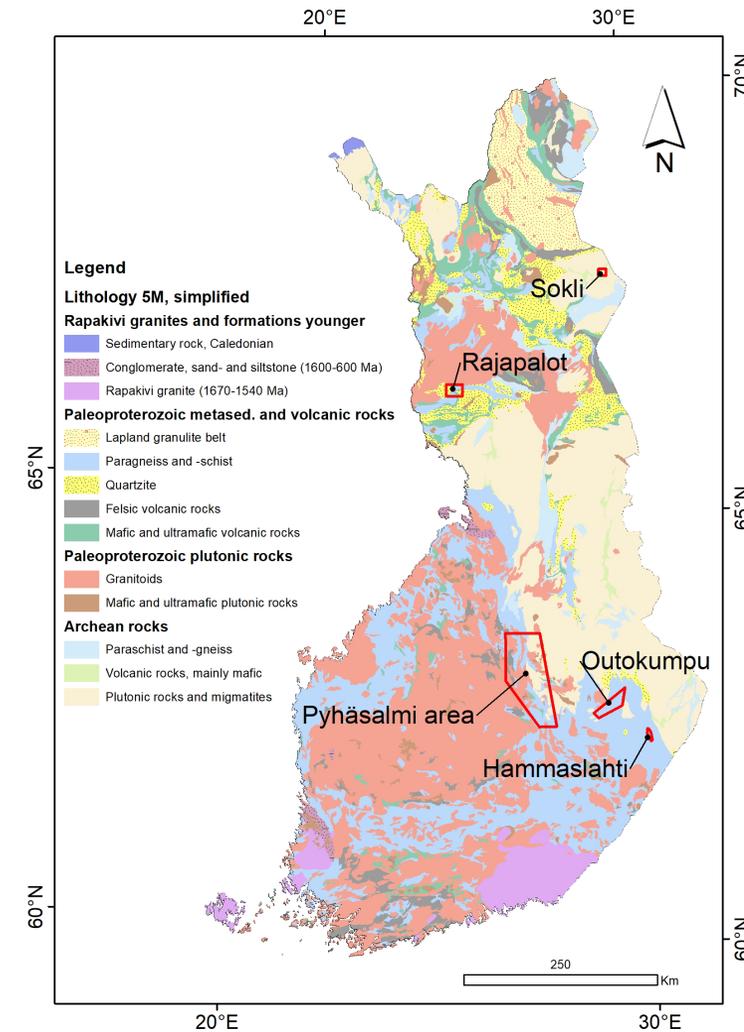
Project coordination and management

- **GTK** is responsible for project coordination.
- Close co-operation between the research partners **UTU**, **SYKE** and **GTK**.



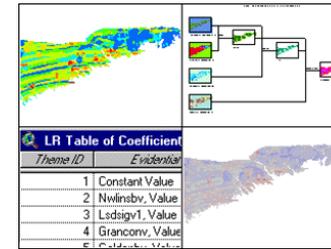
Mineral prospectivity mapping target test sites

- The test sites and preparing existing geospatial data for prospectivity analysis is main task of GTK.
- We have five target areas in Finland and one in Australia:
- Targets:
 - *Rajapalot camp scale gold exploration, Mawson Oy*
 - *Belt scale Hammaslahti (Zn-Cu-Au), Outokumpu (Cu-Co-Zn-Ni-Ag-Au), FinnAust Mining Finland Oy*
 - *Pyhäsalmi belt scale VMS, Boliden Kevitsa Mining Oy*
 - *Sokli area by Sokli Oy (camp scale)*
 - *Australia REE deposits by Kenex Ltd. (regional): rare earth elements (REE)*



Tools developed for public use

- ArcSDM: <https://github.com/gtkfi/ArcSDM>
 - *Spatial Data Modeller*
 - *Weights of Evidence, Logistic regression*
 - *Boosting, Random Forest, Support Vector Machine*
 - *Receiver Operating Characteristics (ROC) validation*
- Originally developed by USGS and GSC and developed by University of Campinas, Sao Paulo, Brazil, <http://www.ige.unicamp.br/sdm/>

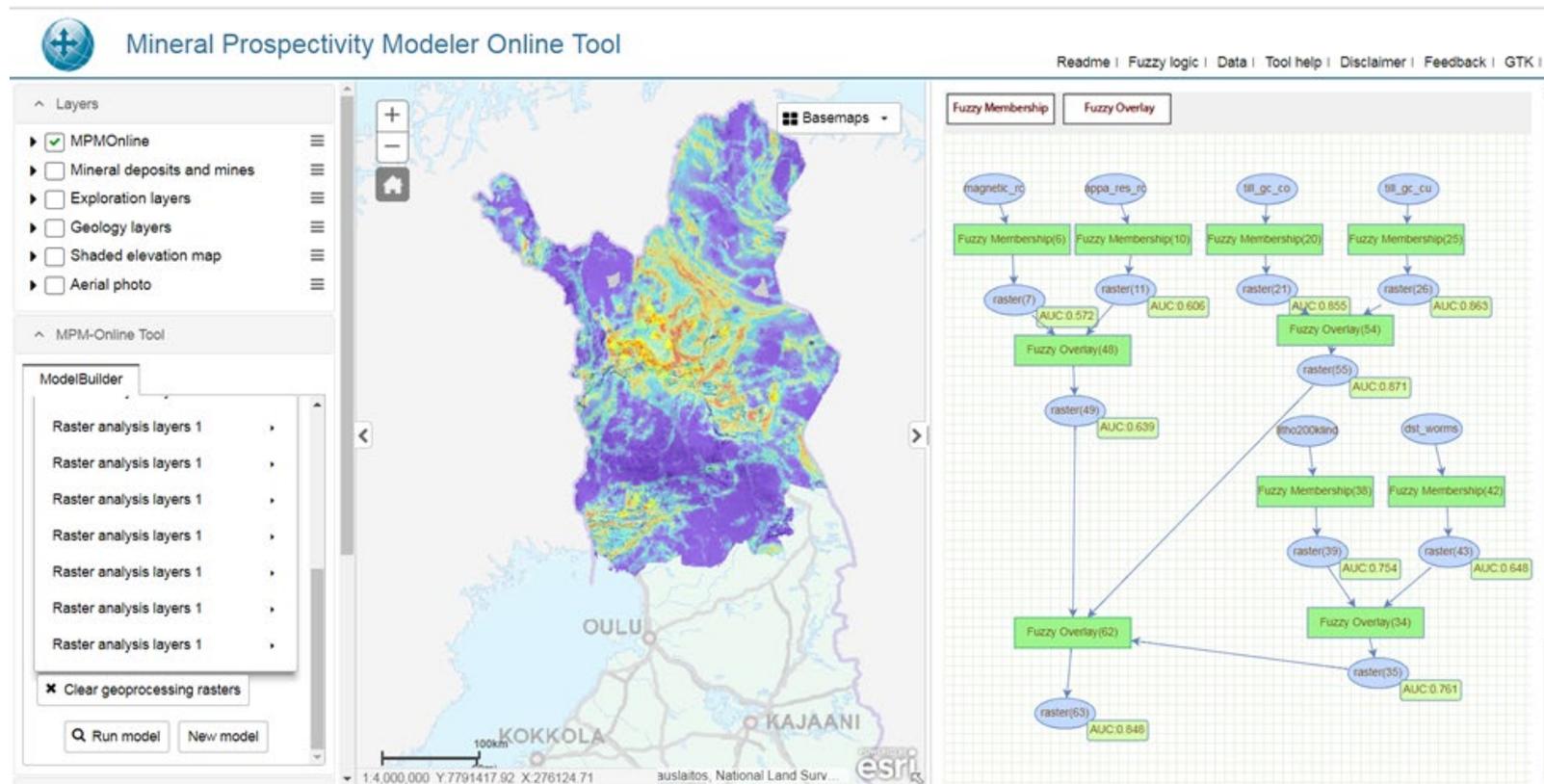


- ArcToolbox
 - 3D Analyst Tools
 - Analysis Tools
 - ArcSDM Tools
 - Fuzzy Logic
 - Neural network
 - ROC Tool
 - Utilities
 - Weights of Evidence
 - Agterberg-Cheng CI Test
 - Area Frequency Table
 - Calculate response
 - Calculate Weights
 - Grand WOFE
 - Logistic regression
 - Training sites reduction
 - Cartography Tools
 - Conversion Tools
 - Data Interoperability Tools
 - Data Management Tools
 - Editing Tools
 - Experimental SDM toolbox
 - Modelling
 - Preprocessing
 - SOM
 - Utilities
 - Model Validation



Tools developed for public use

- MPM on-line can be used to build simple Fuzzy logic overlay models using public geodata from Northern Finland on a web browser-based platform: <https://gtkdata.gtk.fi/mpm/>
- This tool will be updated in AIMEX project so that it covers the entire country



International collaboration

- International collaboration includes scientific collaboration, mobility visits and co-authored scientific papers. Collaborative institutions are:
 - *The University of Free State, South Africa (GTK)*
 - *The University of Applied Sciences, Würzburg-Schweinfurt, Germany (GTK)*
 - *The University of Queensland, Australia (GTK)*
 - *Geological Survey of Canada, Canada (GTK)*
 - *Barents euro-arctic co-operation Nordic network (Syke)*
 - *Network of the Heads of European Environmental Protection Agencies (EPA), Green Finance Interest Group (Syke)*
 - *Svemin (Swedish Association of Mines, Mineral and Metal Producers) (Syke)*
 - *University of Parma, Italy (UTU)*
 - *Joint Research Centre (JRC) of the European Commission (EC), Italy (UTU)*



FOR EARTH AND FOR US

The Geological Survey of Finland (GTK) produces impartial and objective research data and services in support of decision-making in industry, academia, and wider society to accelerate the transition to a sustainable, carbon-neutral world. GTK employs more than 400 experts specializing in the mineral economy, circular economy, solutions related to energy, water and the environment, as well as digital solutions. GTK is a research institution governed by the Finnish Ministry of Employment and the Economy, operating in Finland and globally.

gtk.fi



@GTK.FI



@GTK



@GTK_FI



@geologicalsurvey_fi

