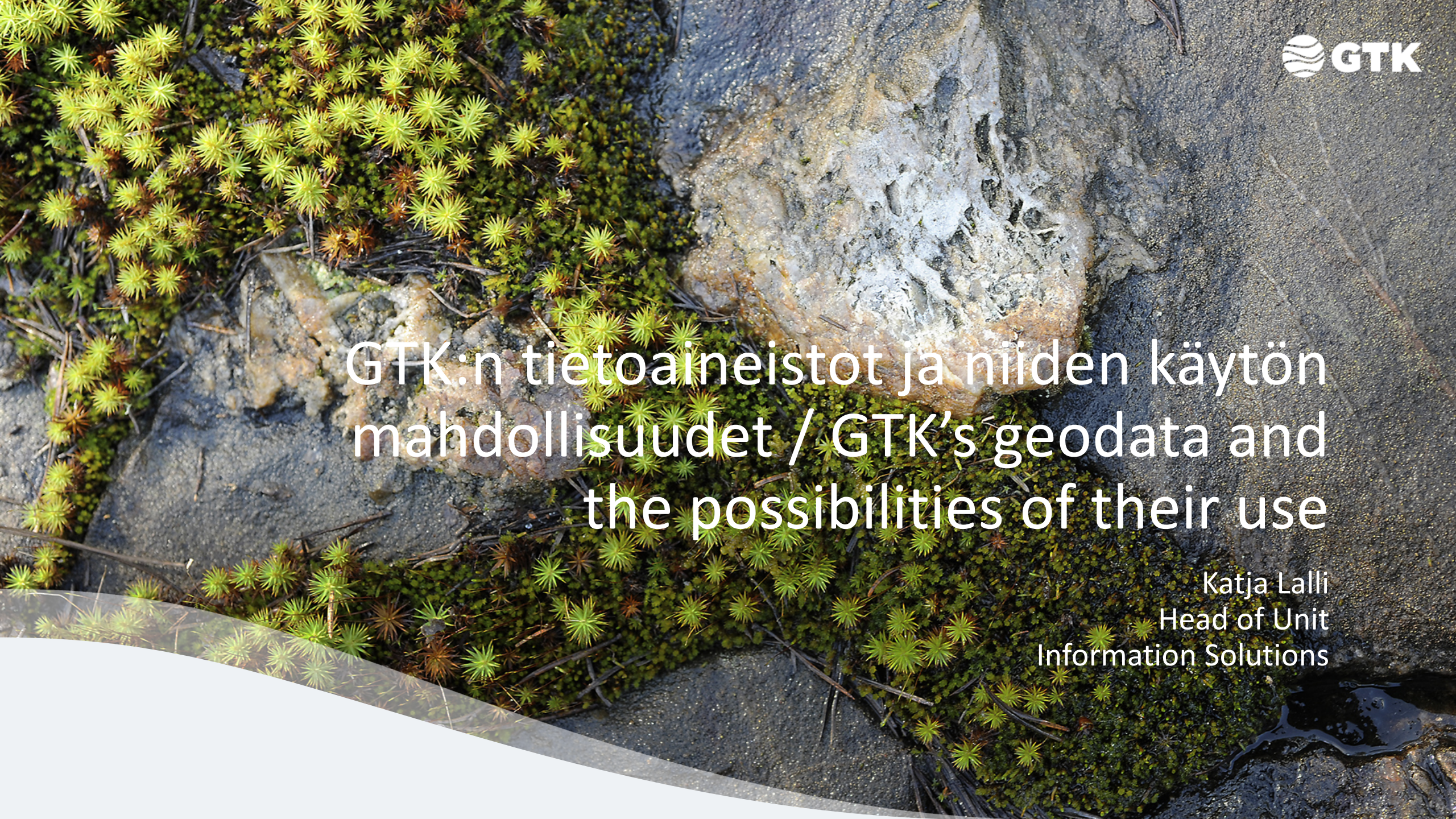
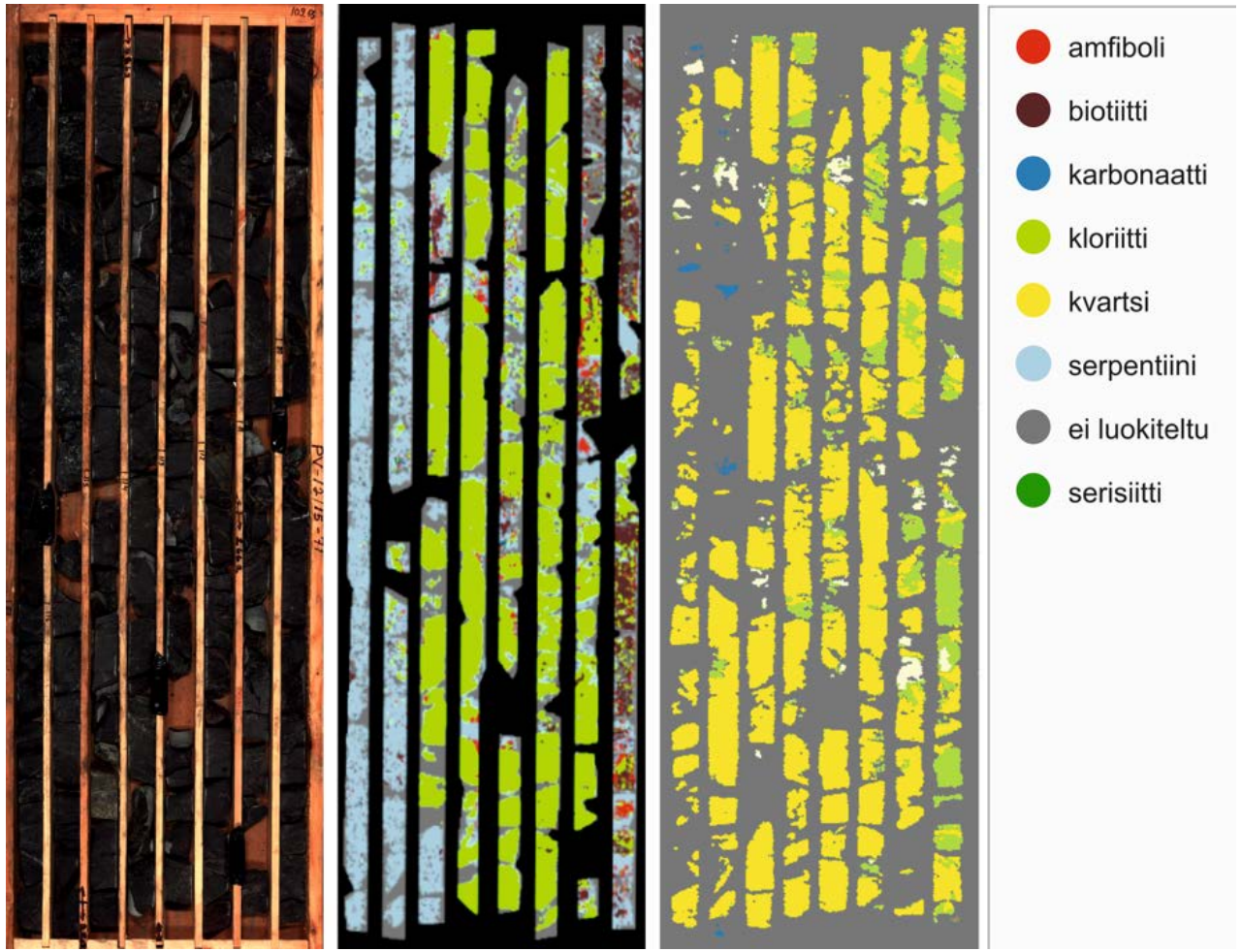


GTK:n tietoaineistot ja niiden käytön mahdollisuudet / GTK's geodata and the possibilities of their use

Katja Lalli
Head of Unit
Information Solutions

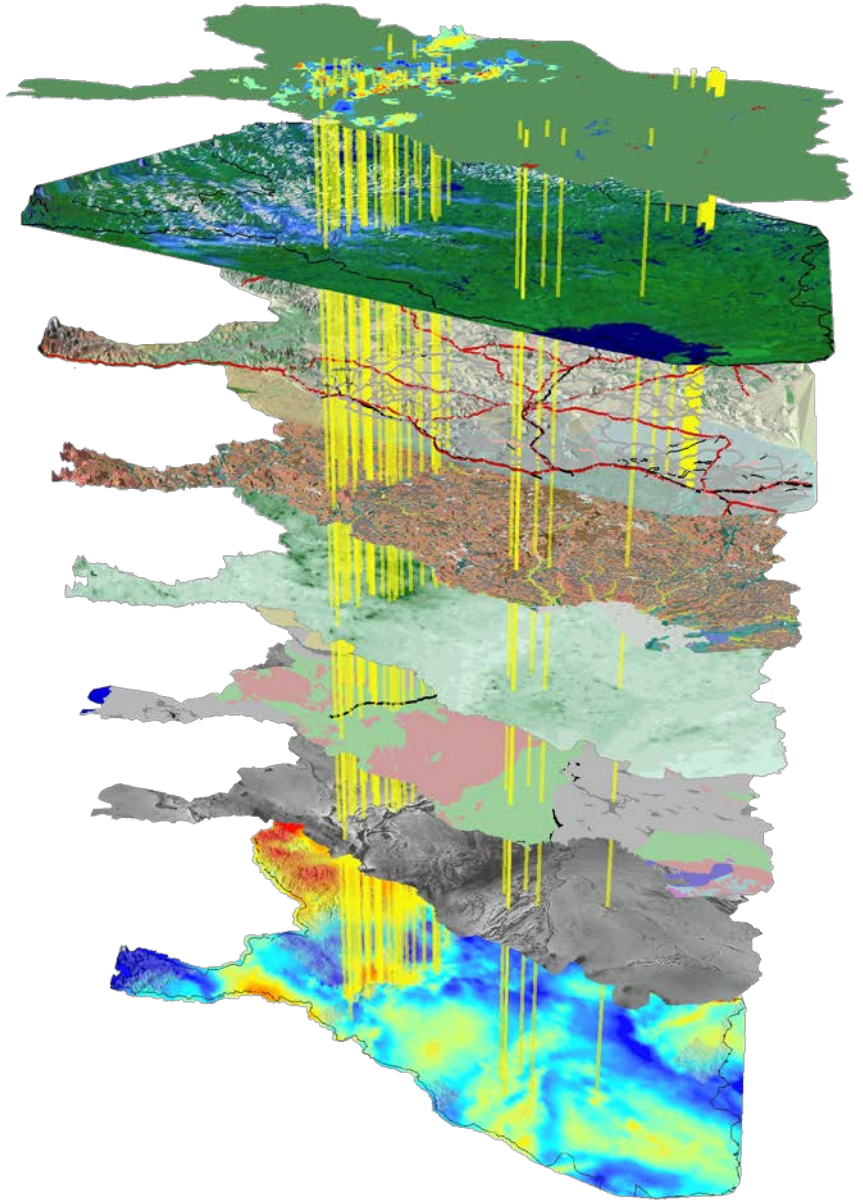
Content

- Examples of GTK’s geodata
- Mineral prospectivity mapping
- Hyperspectral drill core image data
- Regional geological data and 3D



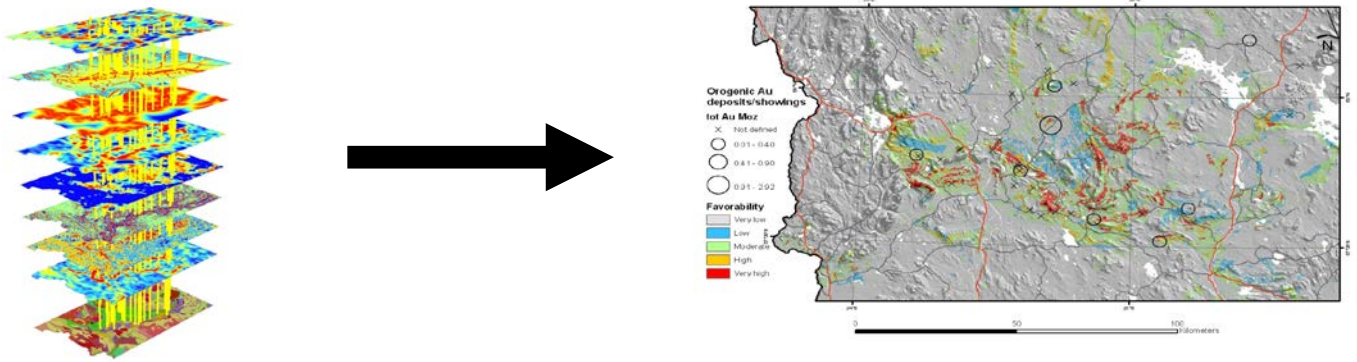
Examples of GTK's spatial data

- Geological maps in different scales
- Geological observations/mineral indications
  - *Drilling*
  - *Mapping: lithology, alteration etc.*
  - *Boulders*
- Mineral resources
  - *Mineral deposits*
  - *Metallogenic belts*
- Airborne and ground geophysics
  - *Gravity*
  - *Magnetics*
  - *Electromagnetics*
  - *Radiometrics*
- Geochemistry
  - *Till*
  - *Bedrock*
  - *Boulder samples*
  - *Drilling data*
  - *Ore showings*
- All this data is publicly available (https://hakku.gtk.fi/en)



Exploration potential mapping/ mineral prospectivity mapping

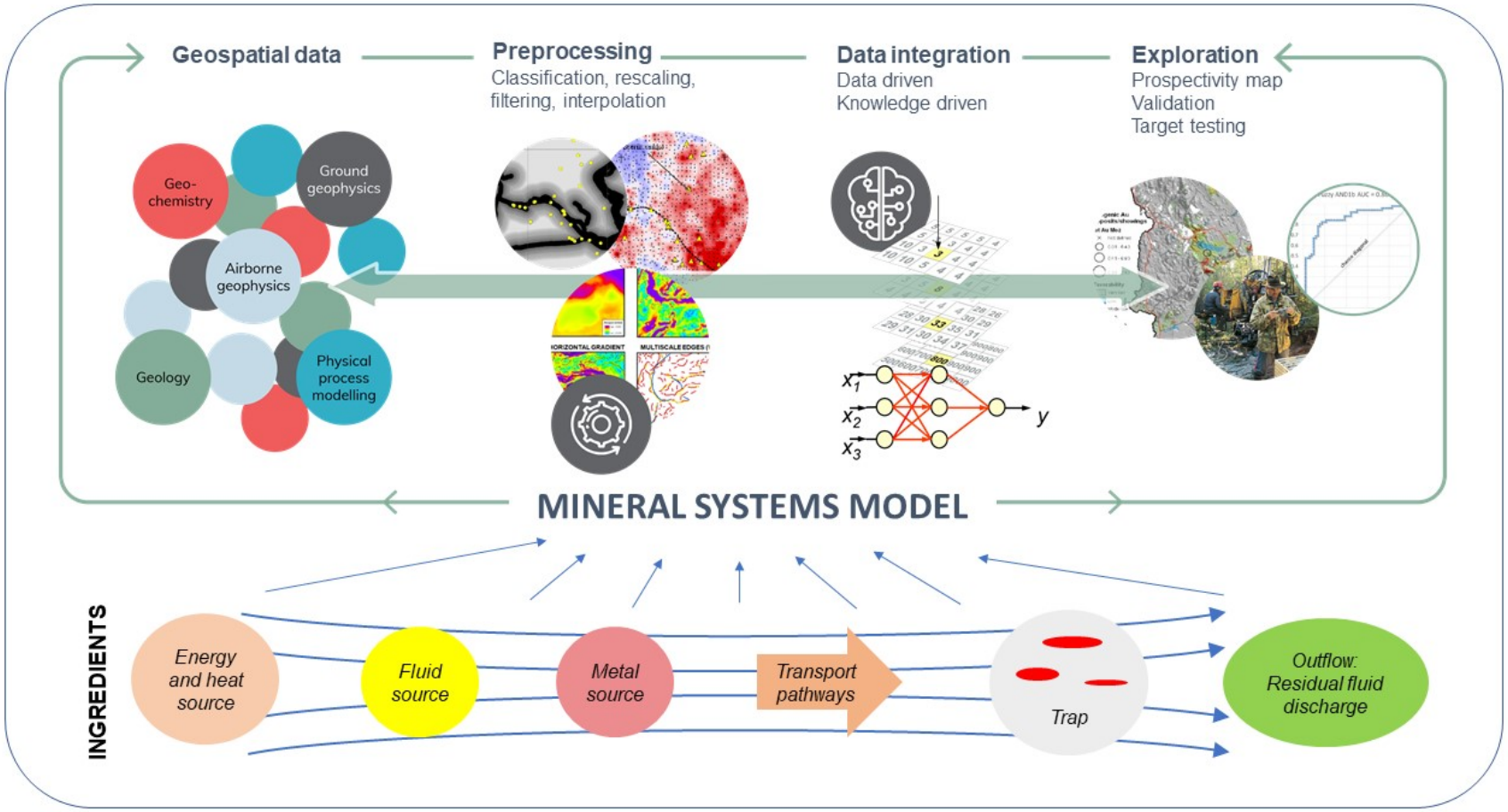
- Traditionally based on expert opinions on potential areas for a certain deposit type
- Digital maps allow quantitative analysis of data and numerical modeling for mineral prospectivity mapping (also known as mineral potential mapping) -> Vast exploration data requires GIS based data-analysis and spatial data mining techniques
- Aim is to delineate areas favorable for mineral exploration, being time-saving, cost effective and environmentally neutral exploration technique



Dynamic mineral prospectivity mapping and mineral systems

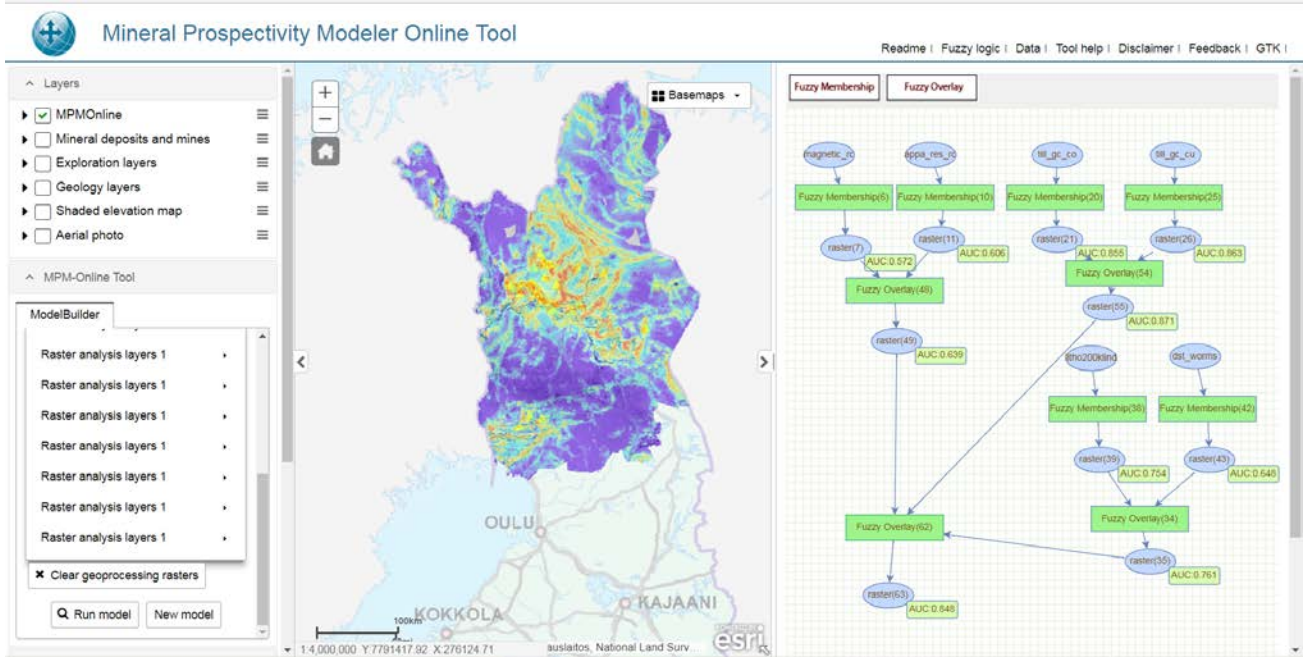
The mineral prospectivity mapping workflow includes the following steps:

1. *Mineral system model*
2. *Selecting primary data*
3. *Creating the proxies to the mappable critical parameters*
4. *Data integration using appropriate methods*
5. *Model validation*



MPM online tool

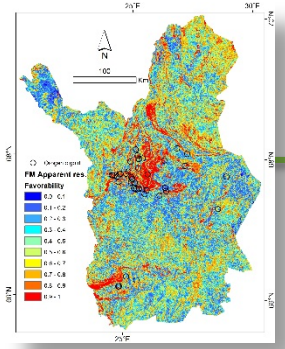
- Conceptual fuzzy logic prospectivity modelling tools using the geological, geophysical and geochemical data provided by web map applications -> http://gtkdata.gtk.fi/mpm/



Knowledge driven (fuzzy logic) regional scale orogenic gold prospectivity model

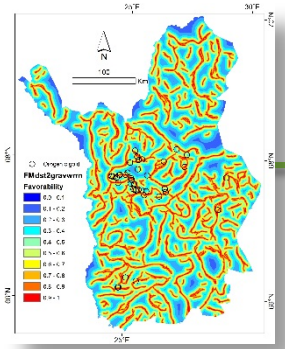
AUC = 0.67

Apparent resistivity

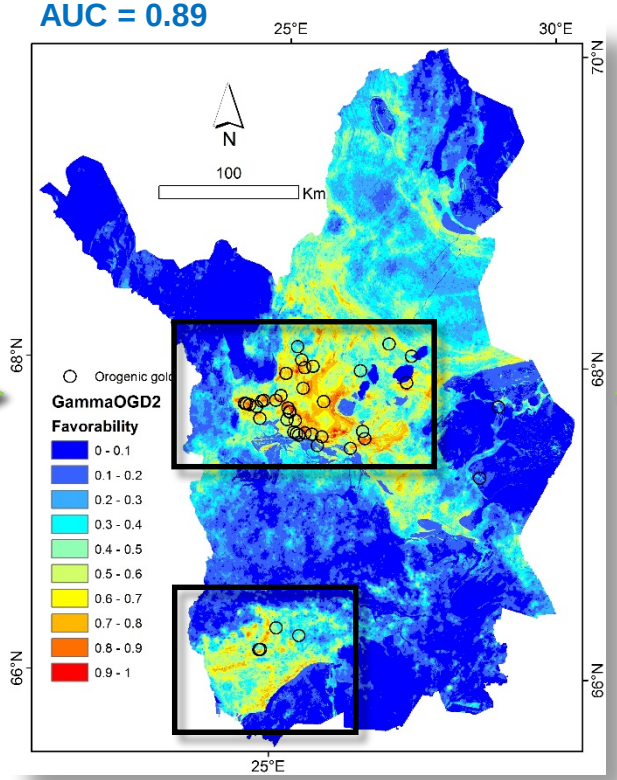


AUC = 0.68

Gravity gradient

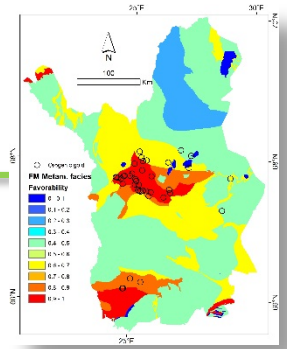


AUC = 0.89



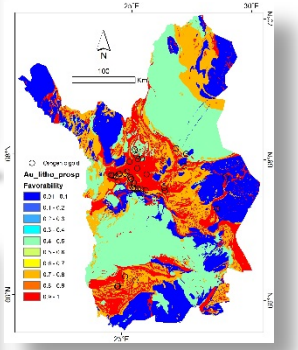
Fuzzy Gamma (γ=0.75)

AUC = 0.90



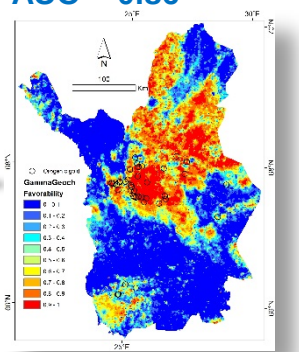
Metamorphic grade

AUC = 0.86



Lithology/ permissive tracts

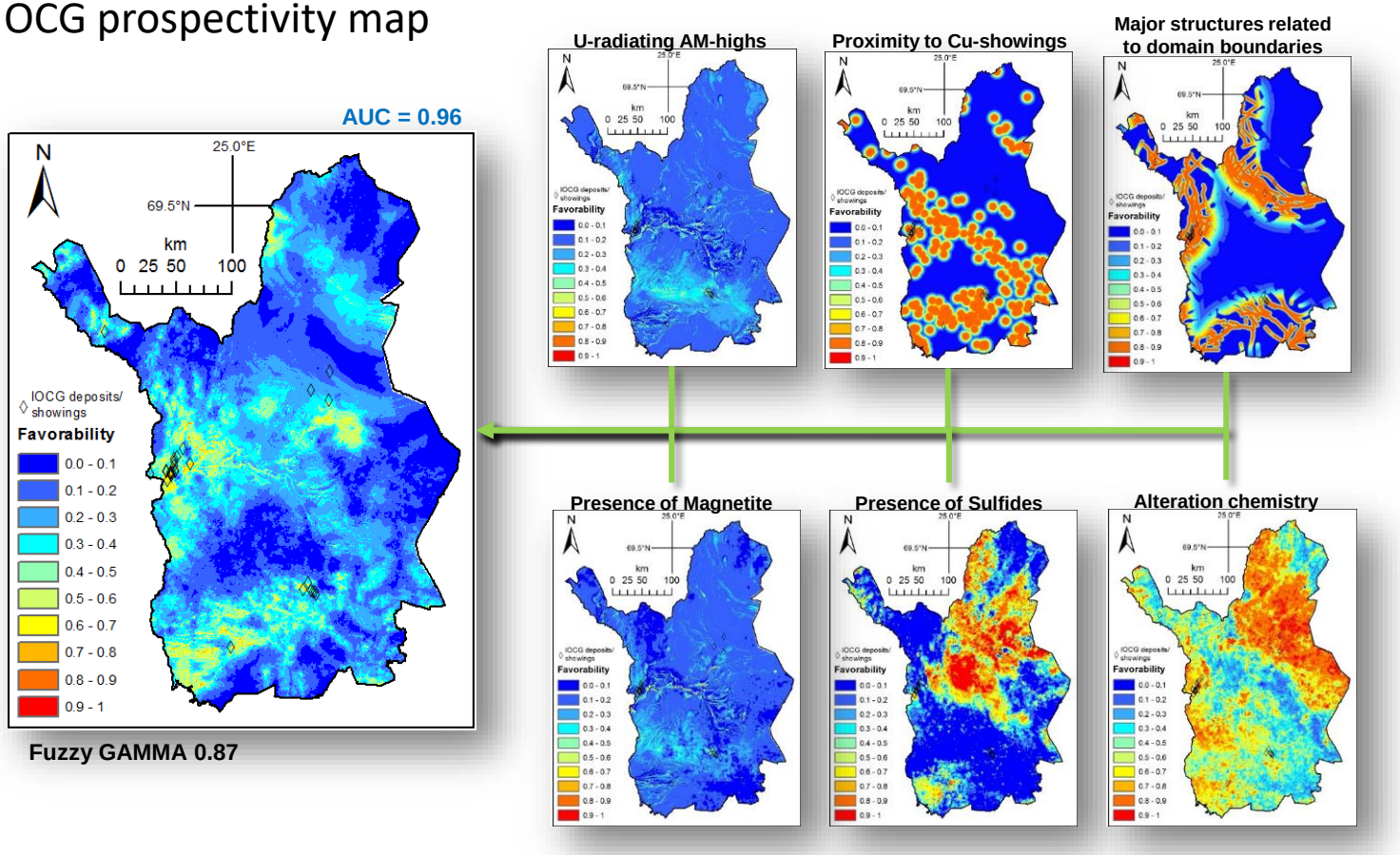
AUC = 0.86



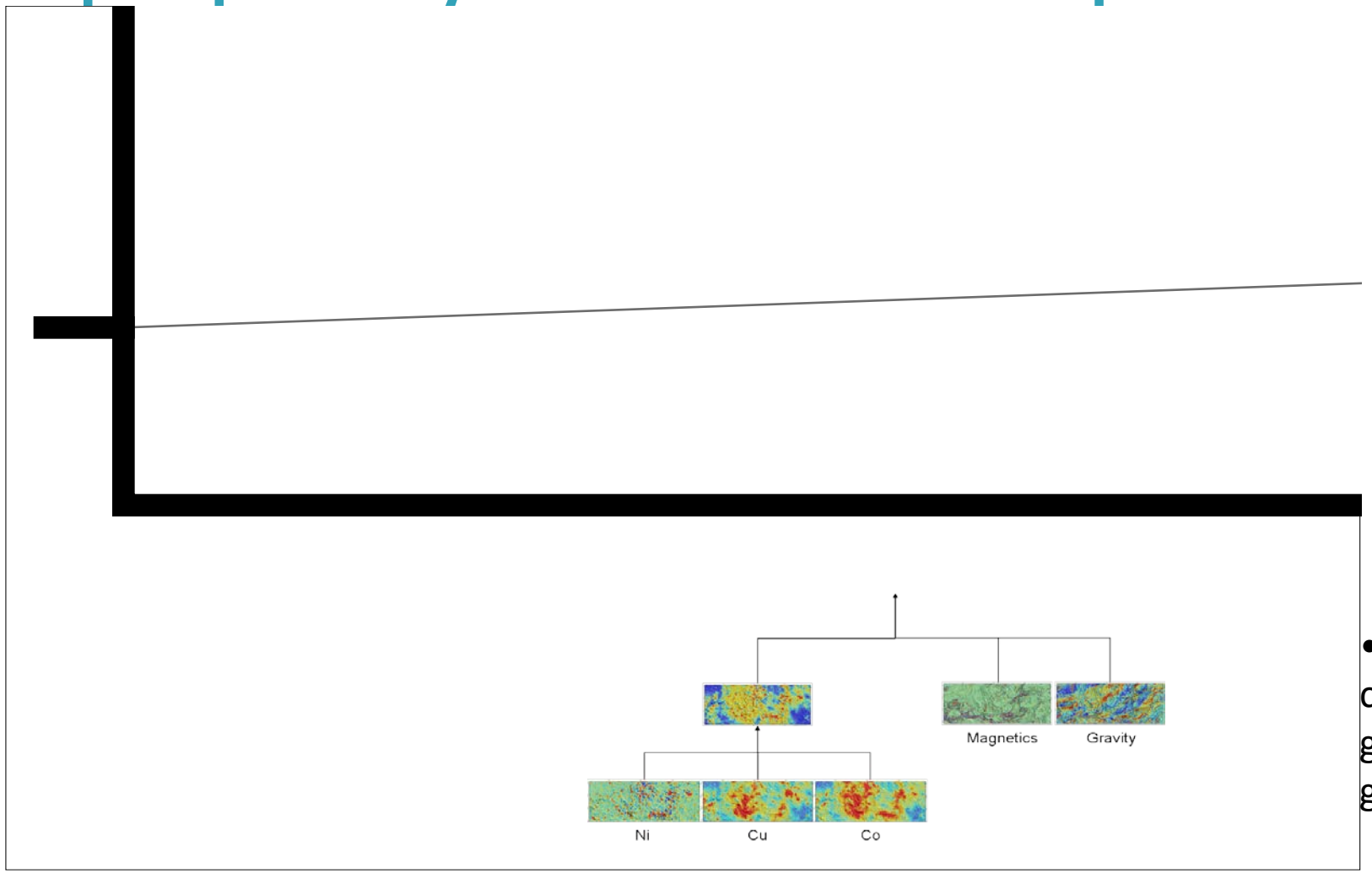
Till geochem. Te, Cu, Co, Fe

Knowledge-driven (fuzzy logic) prospectivity model for iron oxide-Cu-Au (IOCG) deposits in Northern Finland

- IOCG prospectivity map



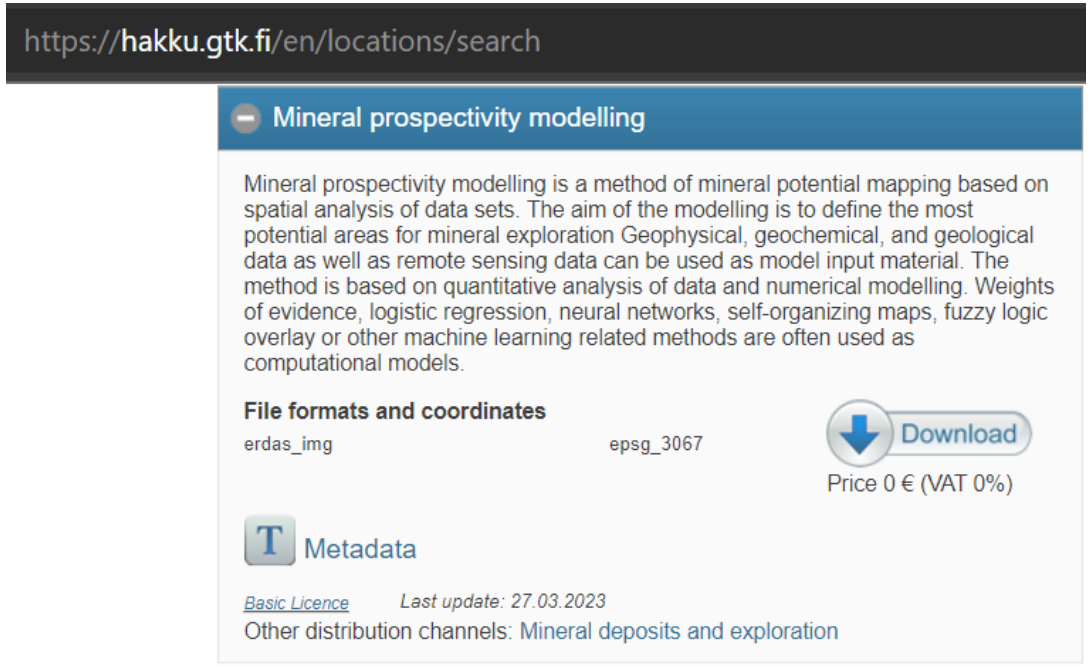
Knowledge-driven (fuzzy logic) magmatic nickel-copper prospectivity model for Central Lapland area

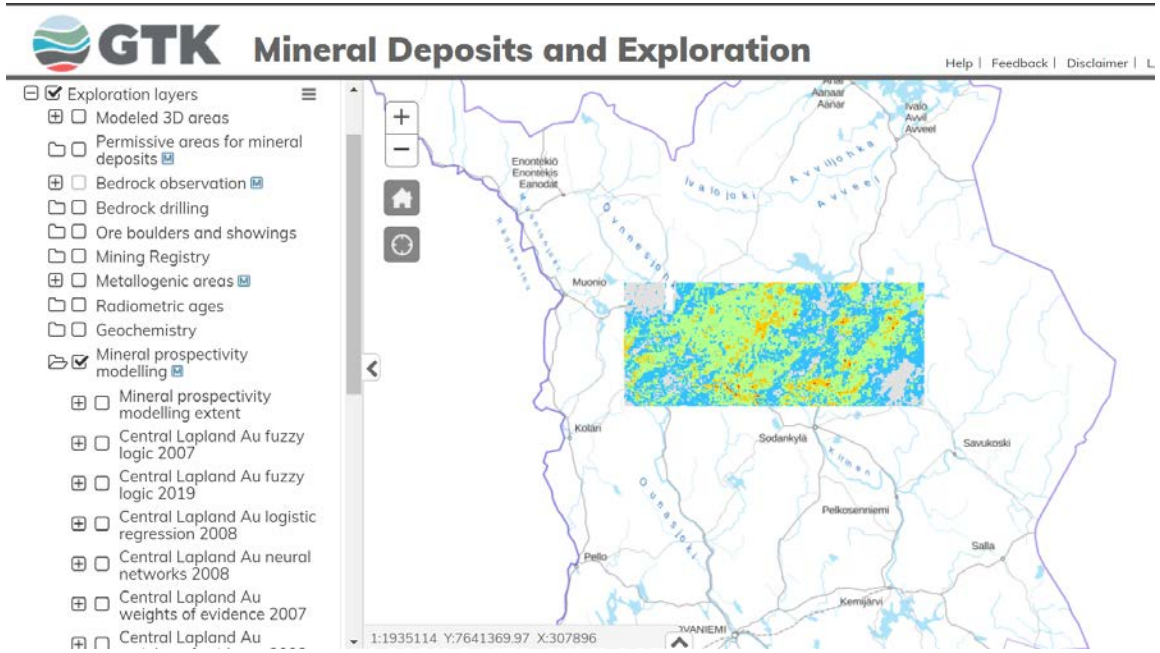


- Prospectivity map combining AM, gravity and till geochemistry

Existing models are available:

- For downloading in Hakku service https://hakku.gtk.fi/en/locations/search?location_id=214
- For viewing in Mineral deposits and exploration (gtk.fi)
- The data set is under update





Hyperspectral drill core image data

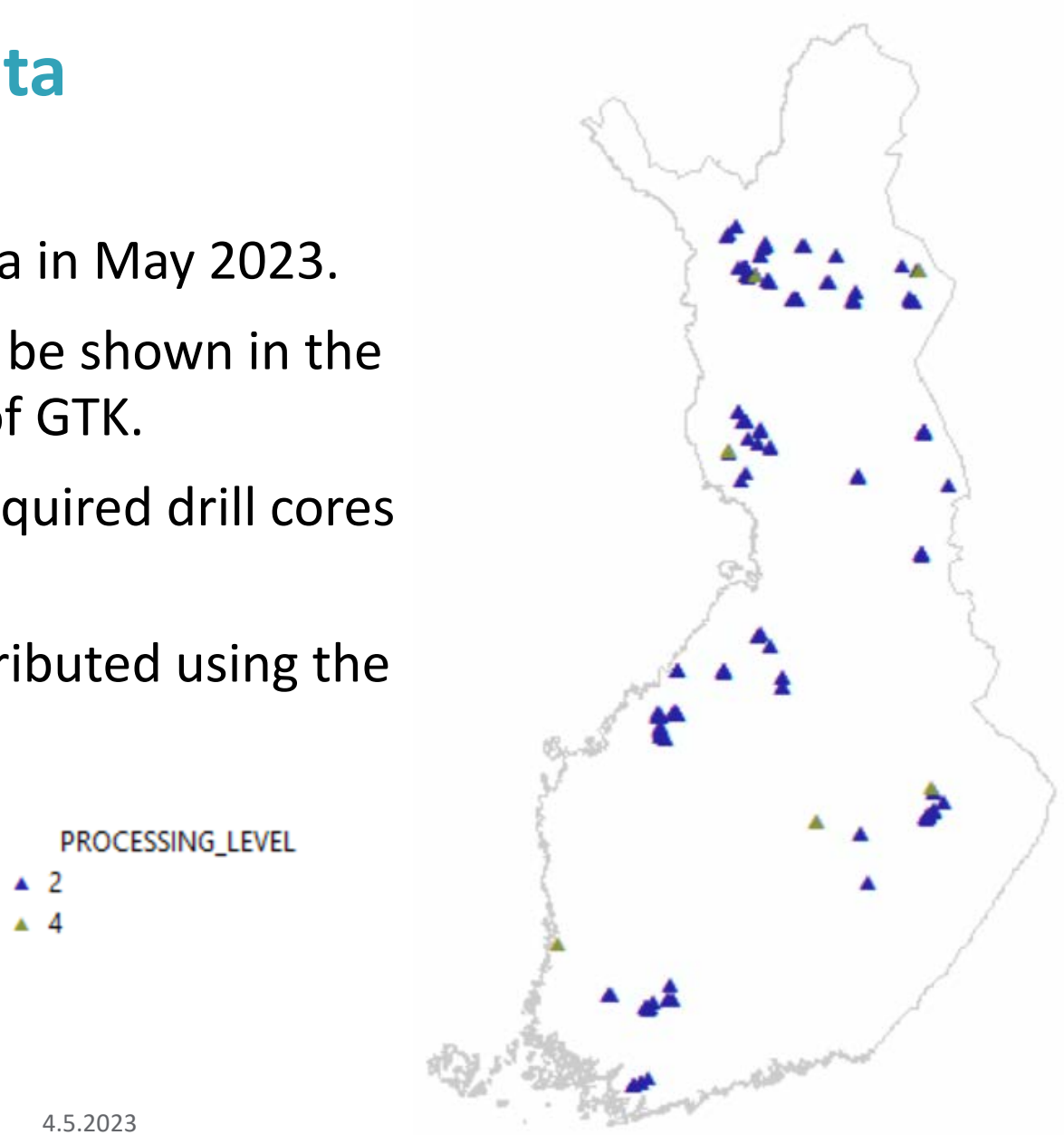
- GTK has been collecting hyperspectral drill core image data since 2018 and work continues.
- The data has been acquired in different wavelength regions:
  - *visible-near infrared-short-wave infrared (VNIR-SWIR 400-2,500 nm; näkyvät, lähi-infrapuna- ja lyhytaaltoinfrapuna-aallonpituusalueet) and*
  - *long-wave infrared (LWIR 7,500-12,000 nm; pitkäaaltoinfrapuna-aallonpituusalueet).*
- At best, hyperspectral drill core data can be acquired at a rate of ~900 m per day.

Hyperspectral drill core image data

- Hyperspectral sensing offers a fast, non-invasive and non-destructive method for mineral exploration. Mineral maps can be produced from hyperspectral image data. Scales vary from field/laboratory to UAVs, manned airborne and satellite.
- The alteration zones of different deposit types, e.g. volcanogenic massive sulphide deposits and orogenic gold deposits, can sometimes be modeled using hyperspectral data, providing vectors toward mineralized zones.
- For precise results, prior geological knowledge and laboratory analytical data (e.g. X-Ray Diffraction data) are often needed to complement hyperspectral results.

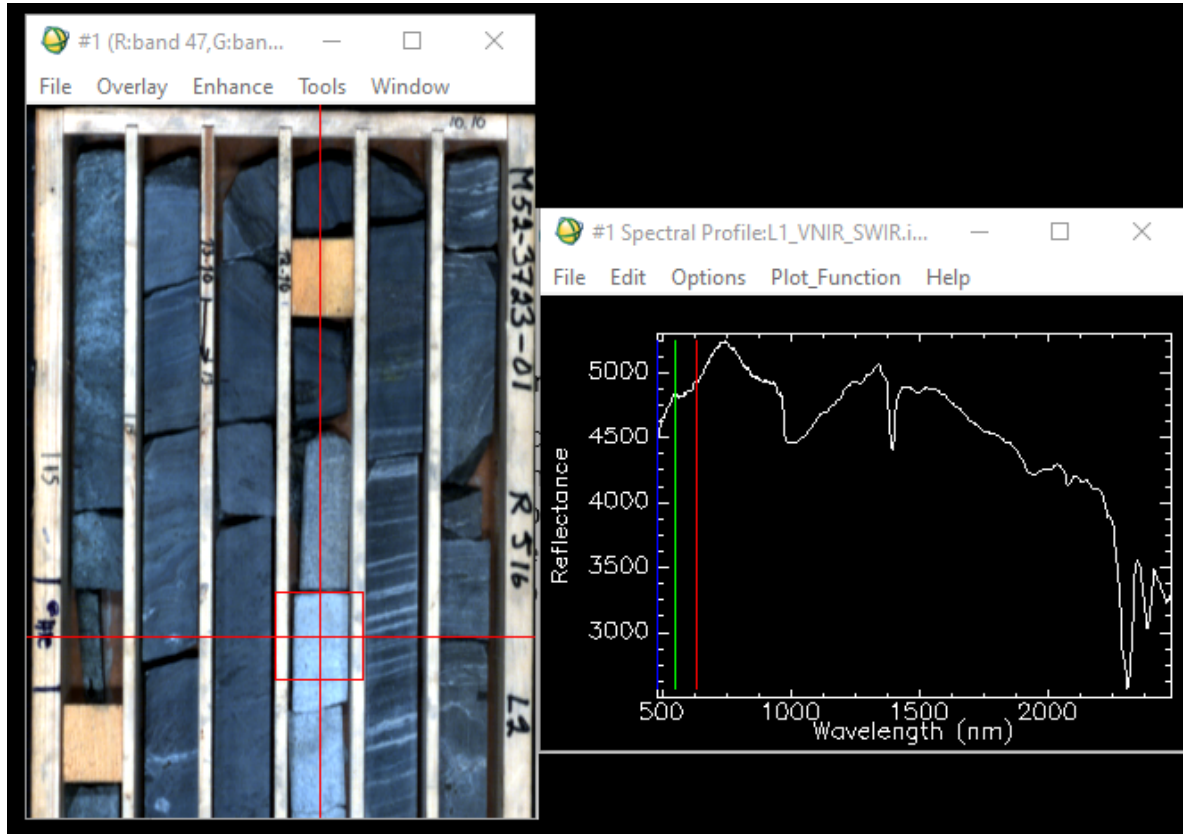
Hyperspectral drill core image data

- GTK is preparing for the distribution of data in May 2023.
- The drill holes with hyperspectral data will be shown in the Mineral Deposits and Exploration service of GTK.
- The data can be requested by listing the required drill cores by email at geodata@gtk.fi.
- The data are commercial and they are distributed using the basic license of GTK.
  - *For the package L1+L2 2€/m*
  - *For the package L3+L4 3,5 €/m*
  - *All available data 4 €/m*



The hyperspectral data are delivered in four levels:

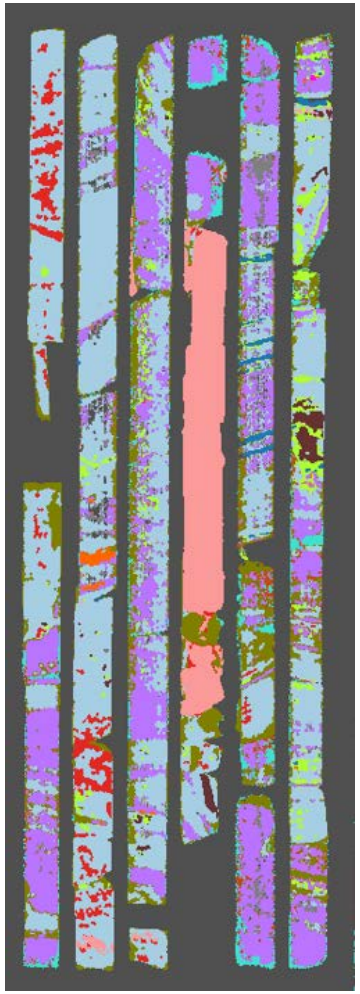
- **Level 1) Reflectance data**
- Level 1 reflectance data are provided as BIL images. The data enables the making of own interpretations, but require spectral geological expertise. The data can be opened e.g. with the ENVI software package, or using free Python libraries. Level 1 data are available for all drill cores.



Examples are from Kirakka-Aapa orogenic gold depost. Data is available on levels 1-4.

The hyperspectral data are delivered in four levels:

- **Level 2) L2 mineral classification results**
- Level 2 mineral classification results were automatically created using machine learning methods (self-organizing maps). The results have not been checked by a geologist and can thus be imprecise. Level 2 data are available for all drill cores.



VNIR-SWIR

LWIR

VNIR-SWIR

Mineral Legend

Unmasked Auto Dominant Mineral (VN-SWIR)

- Alunite
- Amphibole
- Biotite
- Bitumen
- Buddingtonite
- Carbonate
- Chlorite
- Chloritoid
- Dickite
- Epidote
- Gibbsite
- Gypsum
- Illite
- Jarosite
- Kaolinite
- Montmorillonite
- Muscovite
- NH4 Illite
- Nontronite
- Prehnite
- Pyrophyllite
- Saponite
- Serpentine
- Talc
- Topaz
- Tourmaline
- Tray
- Unclassified
- Water
- Zeolite
- Zunyite

LWIR

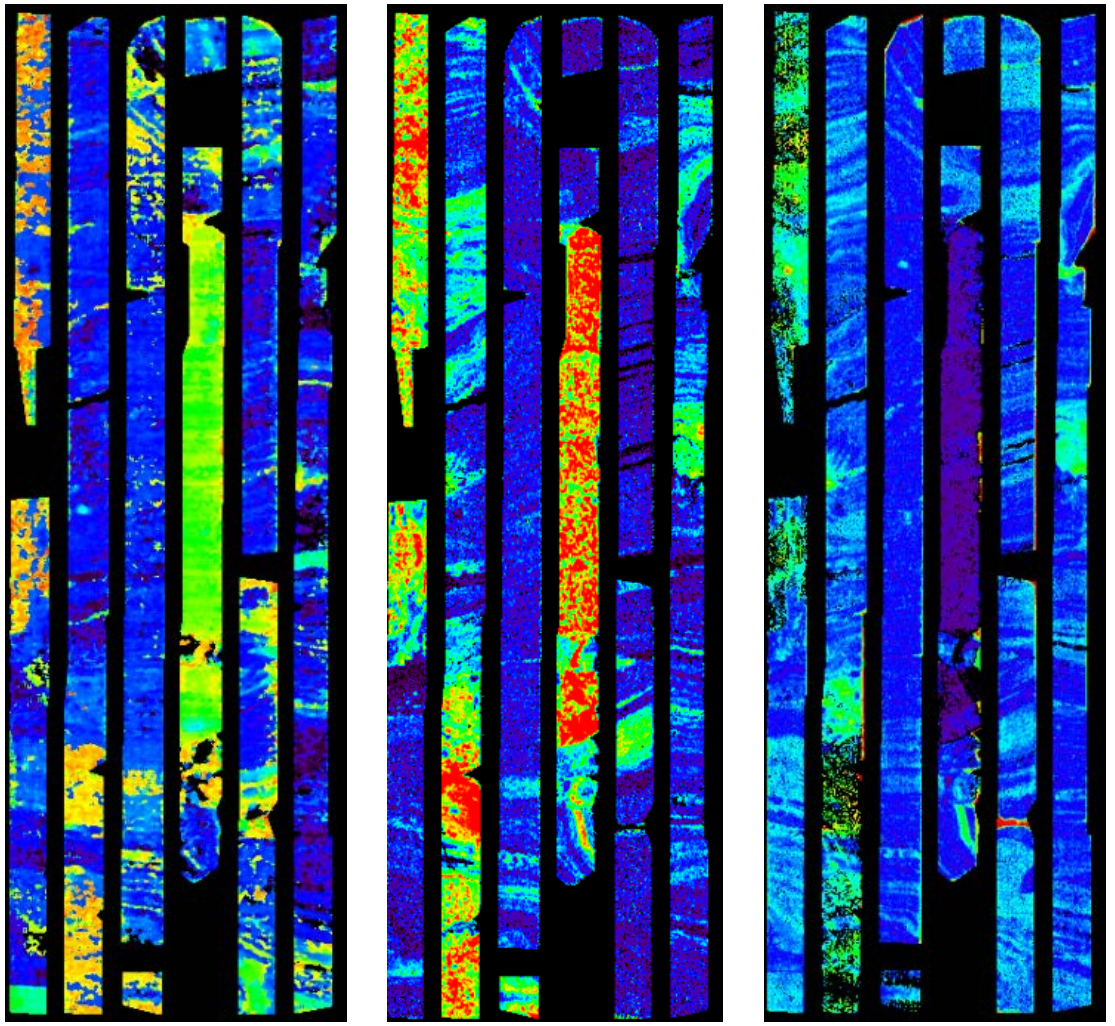
Mineral Legend

Unmasked Auto Dominant Mineral (LWIR (OWL))

- Albite
- Almandine
- Alunite
- Amphibole
- Andradite
- Anorthite
- Apatite
- Barite
- Biotite
- Carbonate
- Chlorite
- Chrysotile
- Clinopyroxene
- Epidote
- Gypsum
- Illite
- Kaolinite
- Microcline
- Montmorillonite
- Muscovite
- Natrolite
- Olivine
- Orthoclase
- Orthopyroxene
- Quartz
- Serpentine
- Unclassified

The hyperspectral data are delivered in four levels:

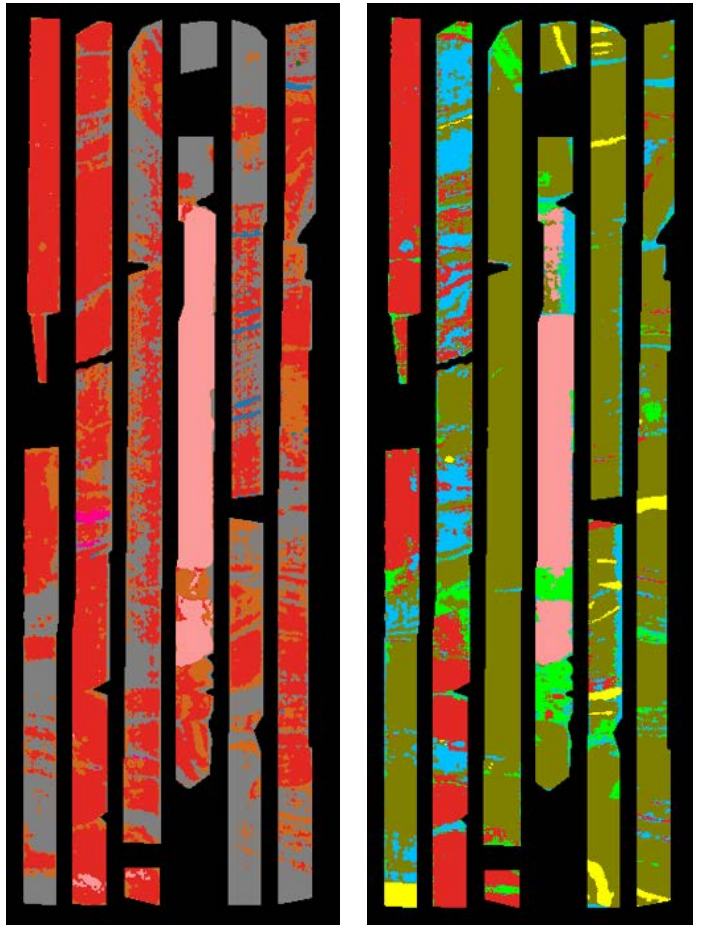
- **Level 3) L3 Scalar results**
- Scalar results are based on mineral spectral features and can be used to derive information about, for instance, the **chemical composition of minerals**. Scalar information is not available for all drill cores.



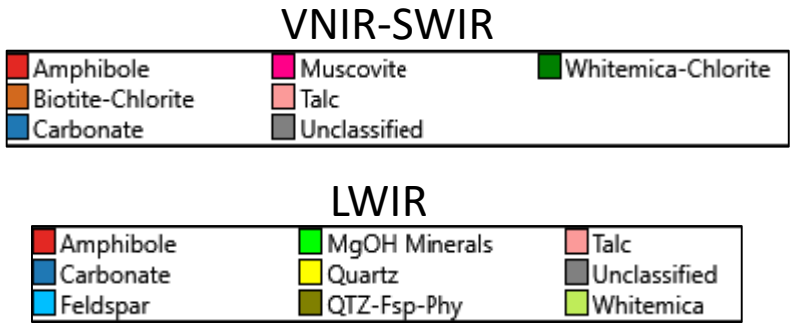
PW9200, D2390, D2250

The hyperspectral data are delivered in four levels:

- **Level 4) L4 mineral classification results**
- Level 4 mineral classification results have been checked by a spectral geologist, and are thus, by default, more accurate than level 2 mineral classification results. Level 4 mineral classification results are not available for all drill cores.



VNIR-SWIR LWIR



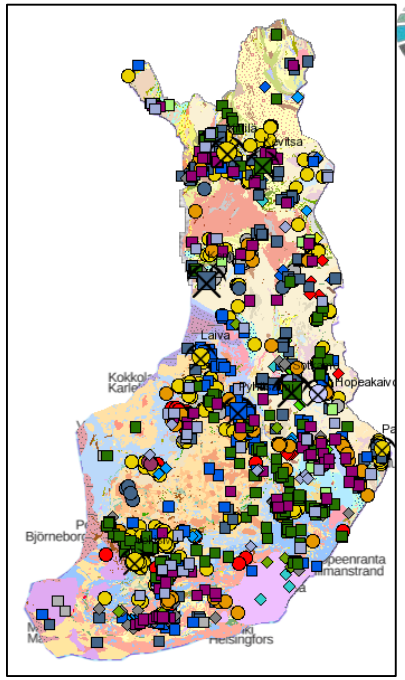
The hyperspectral data are delivered in four levels:

- **RGB (red, green, blue) images** and **false color composites** are always delivered together with data of any of the previously described levels (1-4).

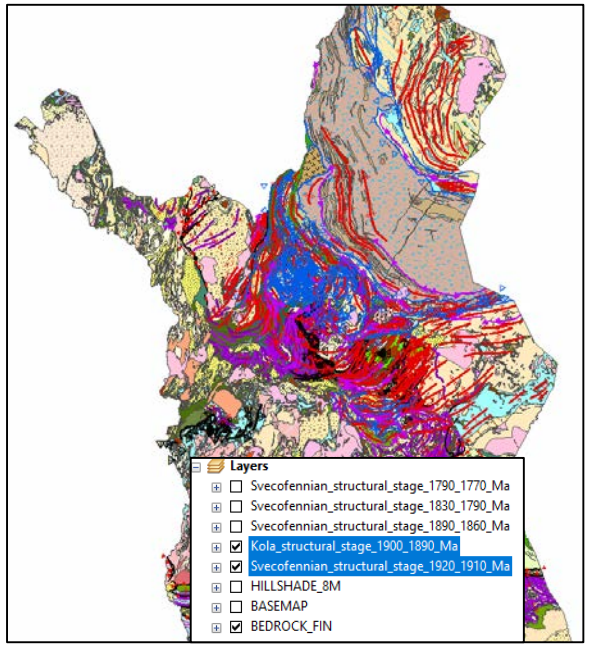
RGB image

A false color composite

Regional geological data and 3D

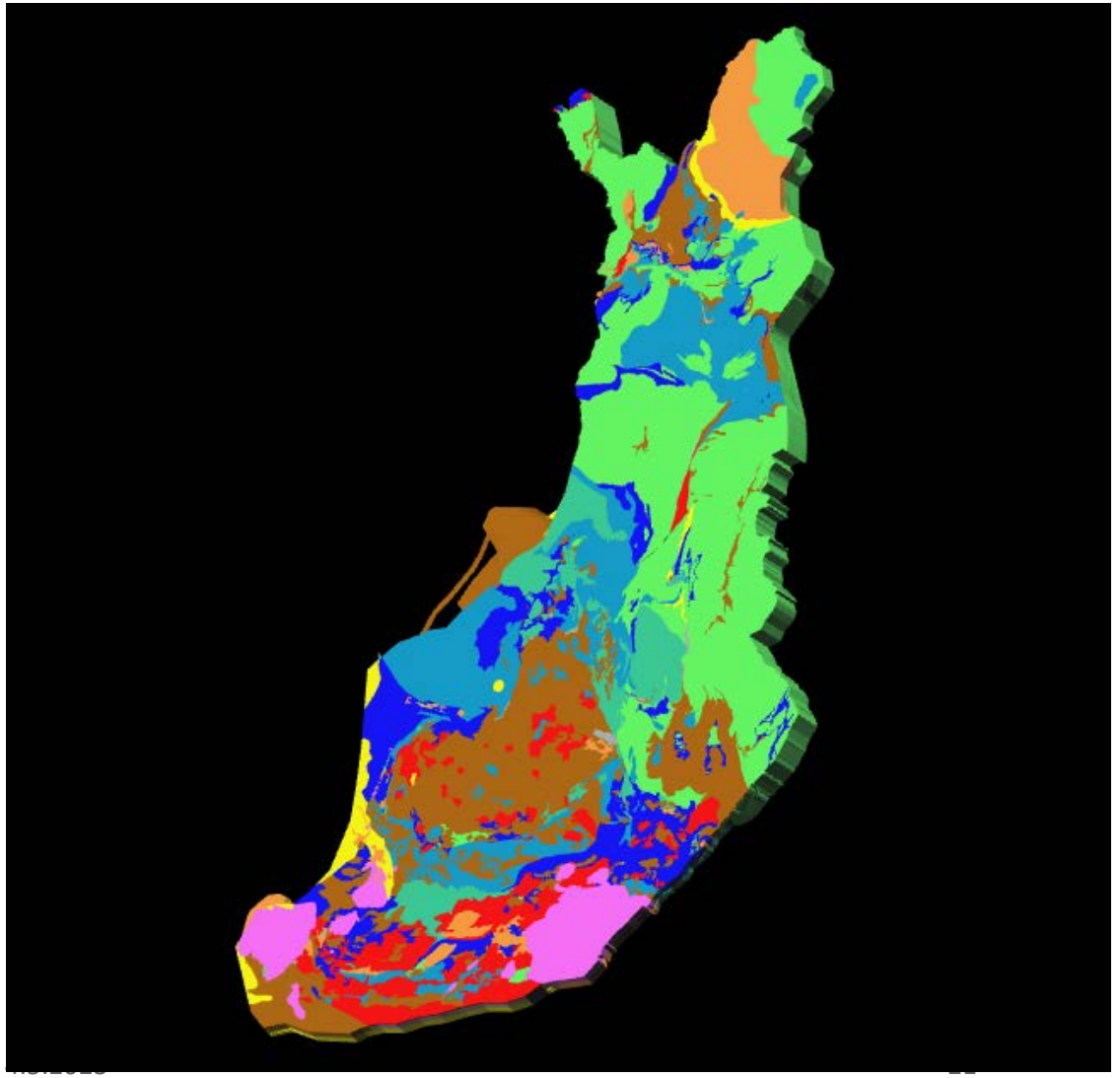


- GTK provides comprehensive knowledge regarding regional geology, tectonic evolution and stratigraphy of the bedrock (belt scale) and superficial deposits
  - *Understanding on mineral systems and metallogenic areas*
  - *Expertise regarding geodata management and distribution of data, including international standards, data models and vocabularies*
  - *Up-to-date map databases (2D) provide harmonized interpretation*
  - *Development of 3D/4D –modelling and data management provide new information*



3D model for the upper crust of Finland

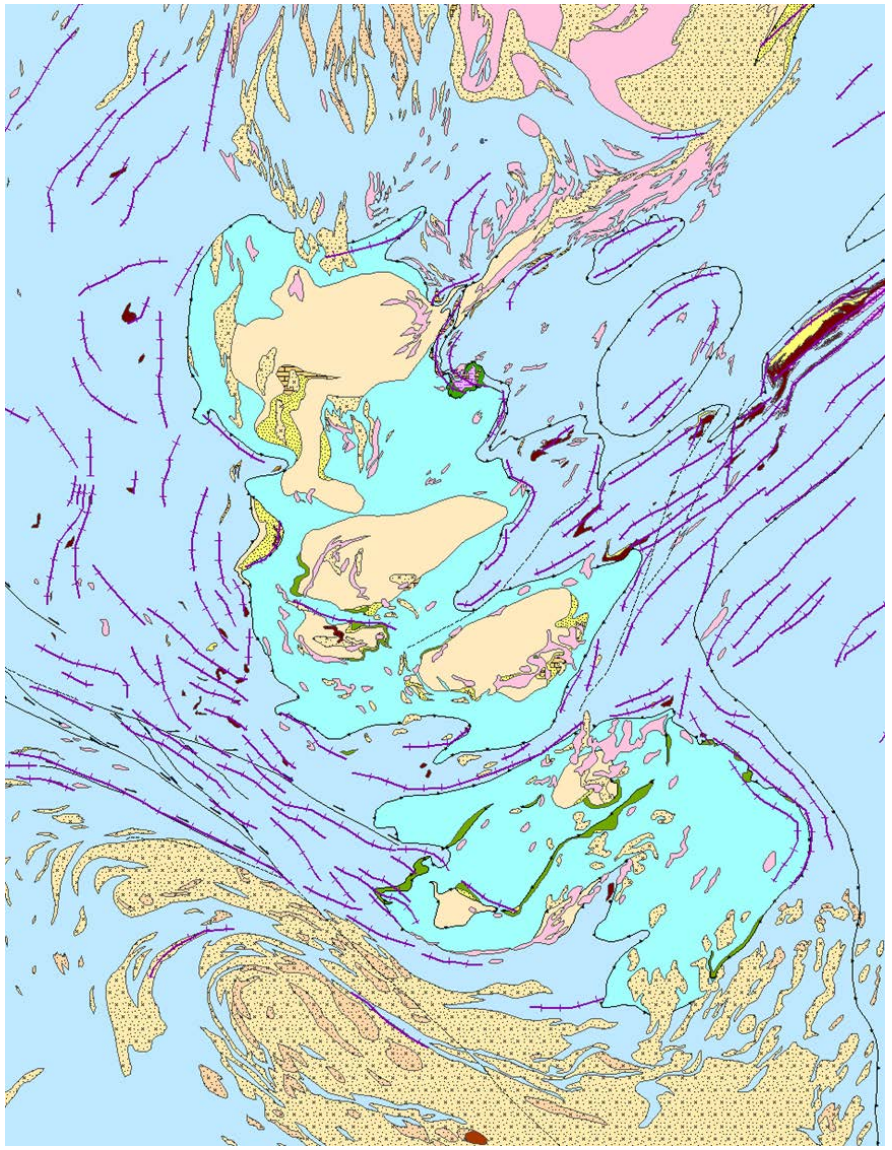
- The first version of the 3D model for the upper crust of Finland was published in the end of 2022.
- It is available as a 3D PDF file in Hakku service (https://tupa.gtk.fi/raportti/aineistotallenne/10_2023_liite.zip).
- Also a working report, which describes the principles of modelling work, is available in Hakku (https://tupa.gtk.fi/raportti/arkisto/10_2023.pdf).



Point of contact:

- Data Sets and Online Services – geo.fi | GTK
- Customer services geodata@gtk.fi
- Head of Unit, Information Solutions

  Katja Lalli, katja.lalli@gtk.fi
- Thank you!



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

@GTK.FI @GTK @geologicalsurvey_fi

@GTK_FI Youtube.com/c/GeologiantutkimuskeskusGTK

.