STRAMIN: Strategic Mineral Resources
Tukes malminetsintäinfo 20.5.2026

Jaakko Avellan (ent. Georgi)

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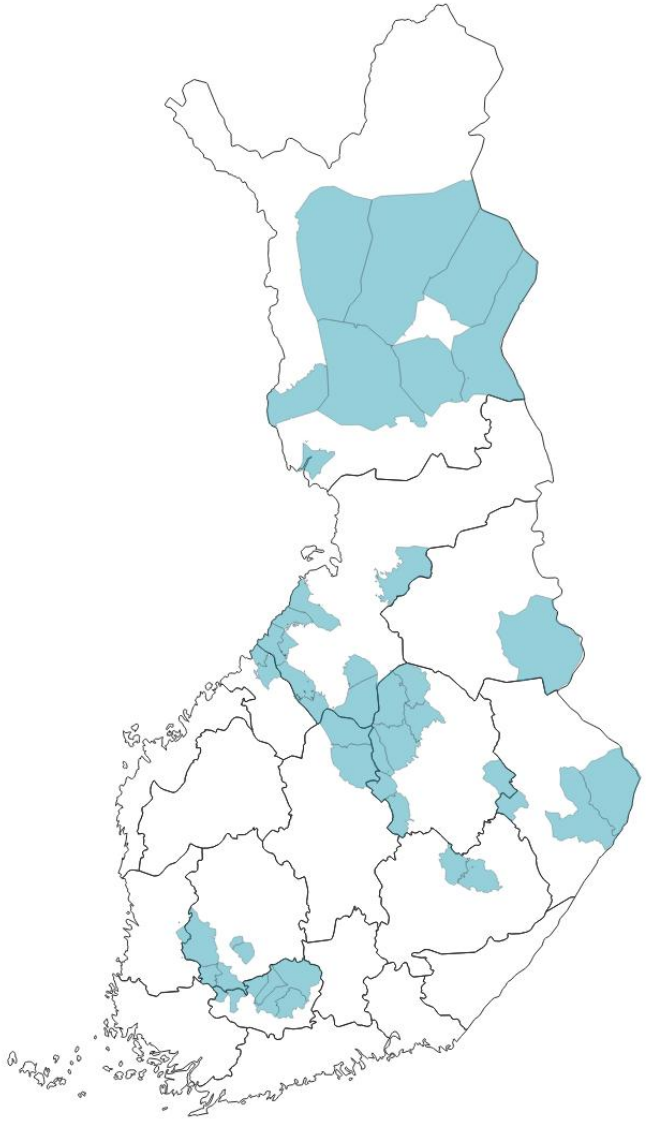


OBJECTIVES OF WORK PACKAGES

WP1 – REE
Leader: Panu Lintinen

- To investigate the REE potential, extent of magmatism and tectonic setting of 1.86 Ga alkali affinity intrusions
- Publish extensive material previously collected at GTK

WP2 – VMS
Leader: Janne Hokka

- Produces regional research material on the development of arc volcanism and the geodynamic environment.
- To study the differences between mineralized and non-mineralized units
- Compare new research data with known VMS areas (Skelleftea, Flin Flon)

WP3 – Lithium
Leader: Henrik Nygård

- To make a broad overview of Finland's lithium potential based on existing material
- Compare the petrophysical material of GTK's Li pegmatites with the European database
- Produces a co-financed project application to study the availability of critical raw materials

WP4 – Publications

- Publish peer-reviewed publications related to Finland's ore zones. Publications were not published in previous projects, e.g. due to delays in laboratory results
- Supplementing and updating GTK's database of museum specimens and making the material available for research

RESOURCES AND SCHEDULE

Resources

- Total operating expenditure budget €270,000
- The project manager is Jaakko Avellan. Core teams of 3-5 people doing project work (the leader of the work package is bolded)
    - WP1: **Panu Lintinen**, Akseli Torppa, Tapio Halkoaho, Soile Aatos, Perttu Mikkola
    - WP2: **Janne Hokka**, Ville Järvinen, Paula Salminen
    - WP3: **Henrik Nygård**, Janne Kuusela, Jaro Kuikka
- The work of the core teams is supported by an expert network of another 20 people
- In WP4, 15 people write publications, GTK's laboratory staff do the majority of the analyses

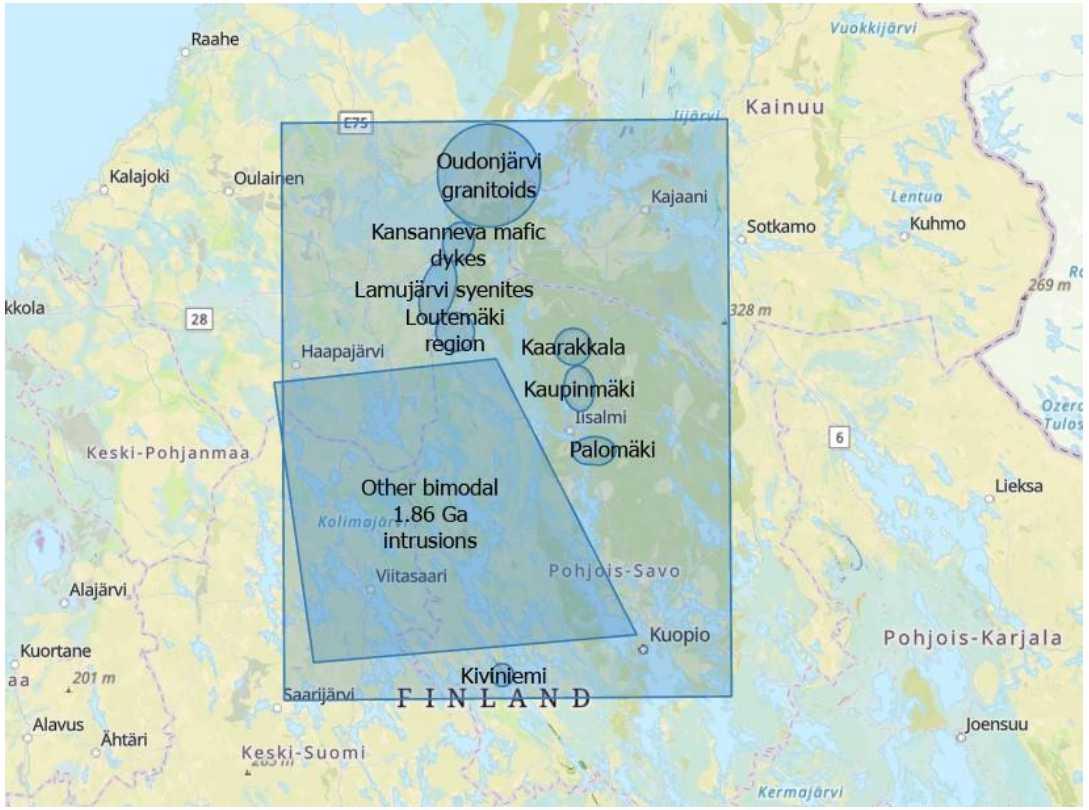
Schedule and publishing results

- Total duration three years (2024-2026)
- The results of the project are published in Hakku as research reports. The A1 publications produced are published in international journals
- The results of WP3 have been published in 2025
- All results will be published at the end of 2026.
- A final seminar is planned to be held during the next Tukes Mineral Exploration Info in Rovaniemi in May 2027

WP1 – REE

Key research questions

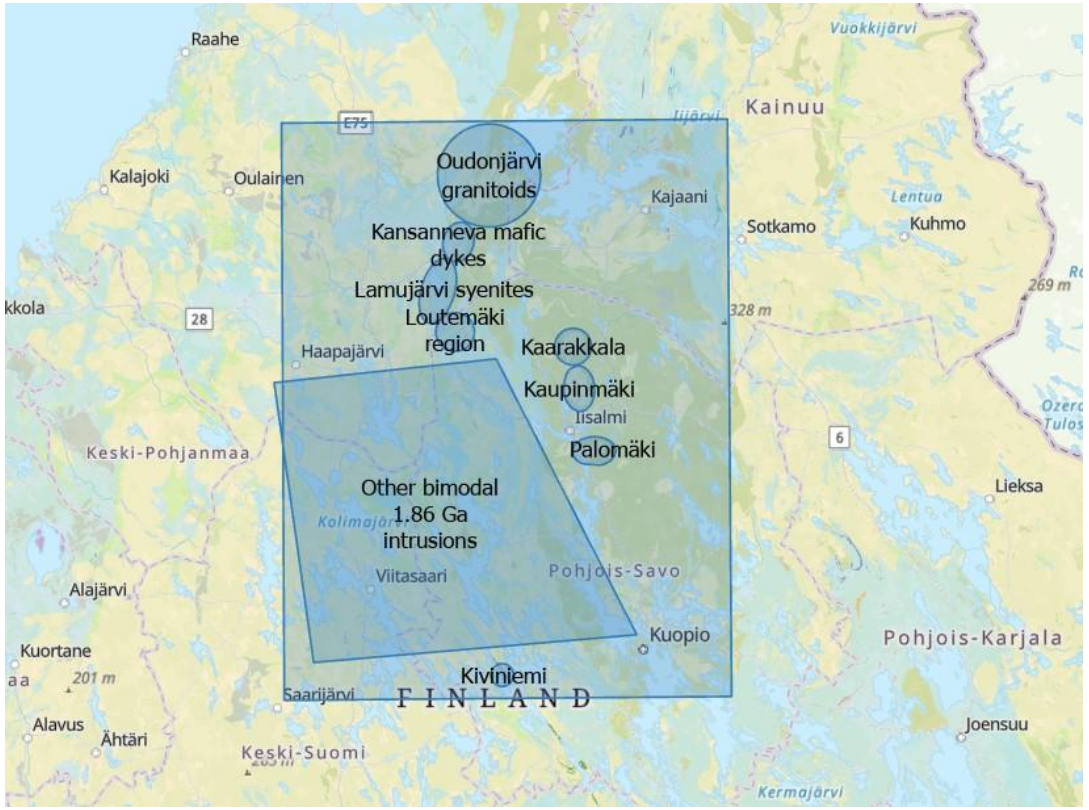
- What is the extent, source, tectonic setting and ore potential of the 1.86 Ga magmatism and associated mineral systems in the Raahe-Laatokka zone, especially for REE elements?
- What are the common features of the REE-enriched intrusions, and how do the intrusions compare to the corresponding unmineralized intrusions?
- What are the key regional materials and parameters in terms of REE potential, and how can they be used in multivariate analyzes such as prospective modeling?



WP1 – REE

Results and products

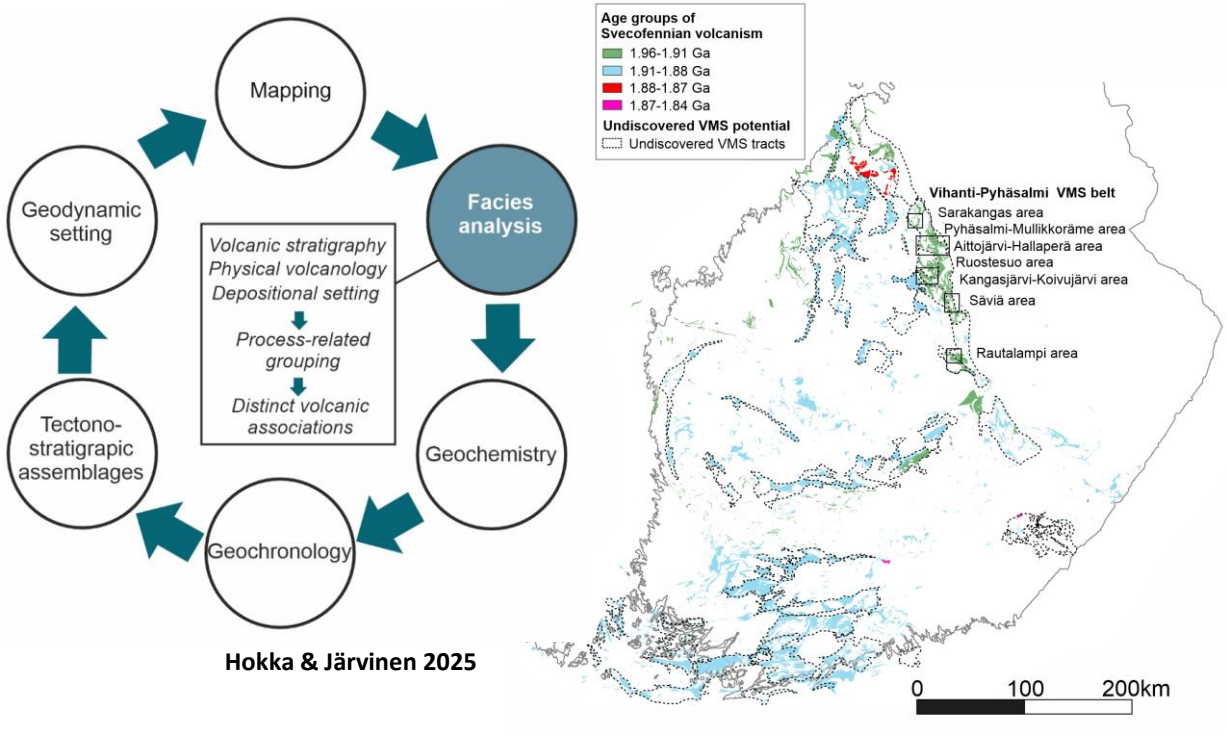
- Summary of the potential to find REE elements in the study area
- Comprehensive research information on the most potential intrusions and their relationship to the regional 1.86 Ga magmatism
- Mineral system models from the research area, based on multivariate data analysis
- The growth of GTK's knowledge capital and expertise from the researcher of REE potential sites
- 2 peer-reviewed scientific publications



WP2 – VMS

Key research questions

- Are there several different types of volcanic environments in the central parts of the Raahe-Laatokka zone, and how are they distinguished by the research methods and materials used?
- Do some identified environments have a connection with known ore deposits (e.g. Pyhäsalmi, Säviä, Kangasjärvi, Ruostesuo, Mullikkoräme)?
- What are the ore-critical features of the mineralized volcanic sequences and how do they compare to similar VMS-critical arc assemblages found in Sweden (Skellefte) and Canada (Flin Flon)?



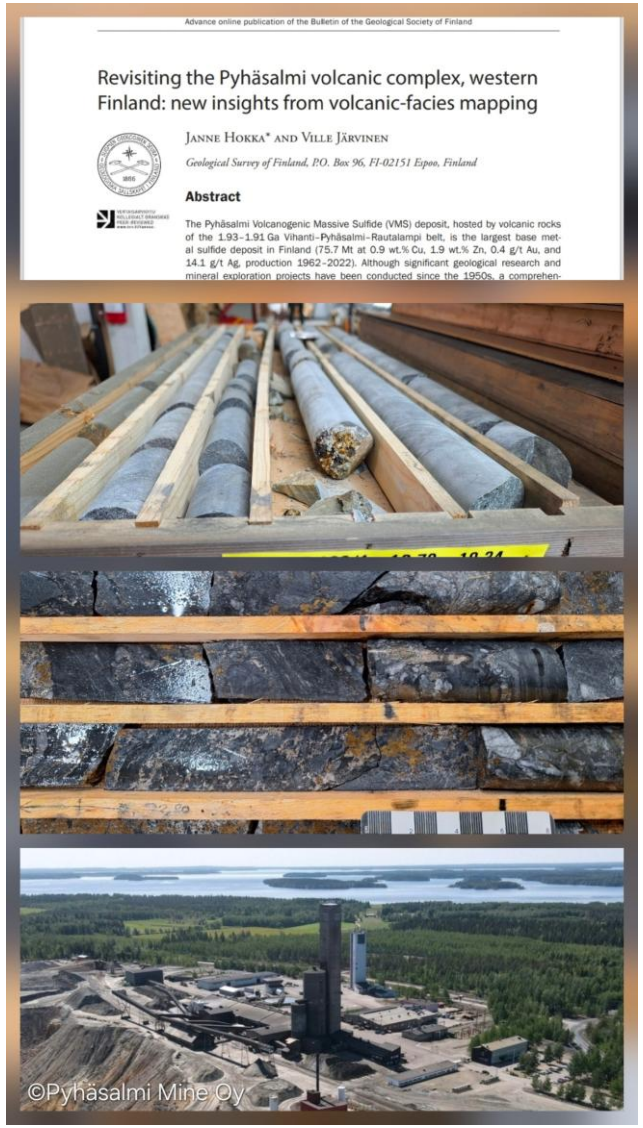
Hokka & Järvinen 2025

Workflow for comprehensive belt-scale mineral system analysis in greenstone belts. Modifed after Syme (2007).

WP2 – VMS

Results and products

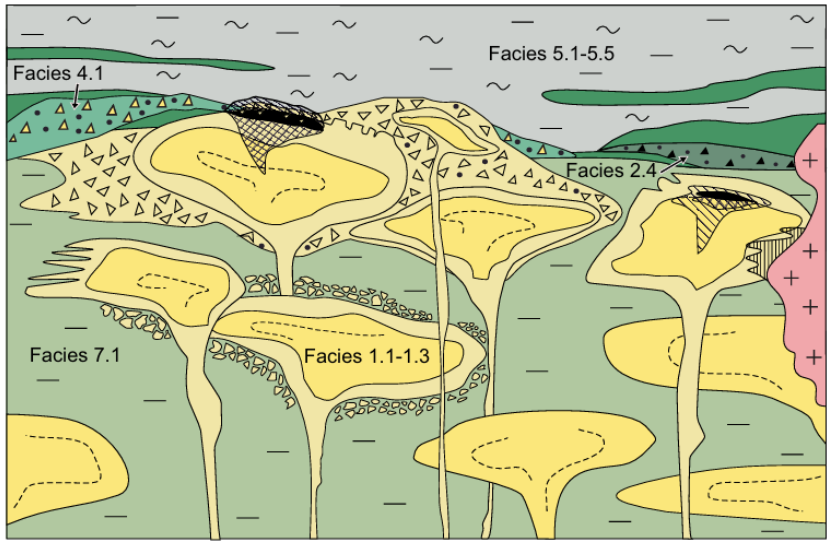
- Two peer-reviewed scientific publications, 1st published in Nov 2025 titled "*Revisiting the Pyhäsalmi volcanic complex in western Finland: New insights from volcanic-facies mapping*"
- A potentiality index, which delimits the most prospective units in the study area, and which is published online as a public GIS product
- Growth of GTK's knowledge capital and expertise regarding VMS mineral systems and regional geology in the Raahe-Laatokka zone



WP2 – VMS

Results and products – publication

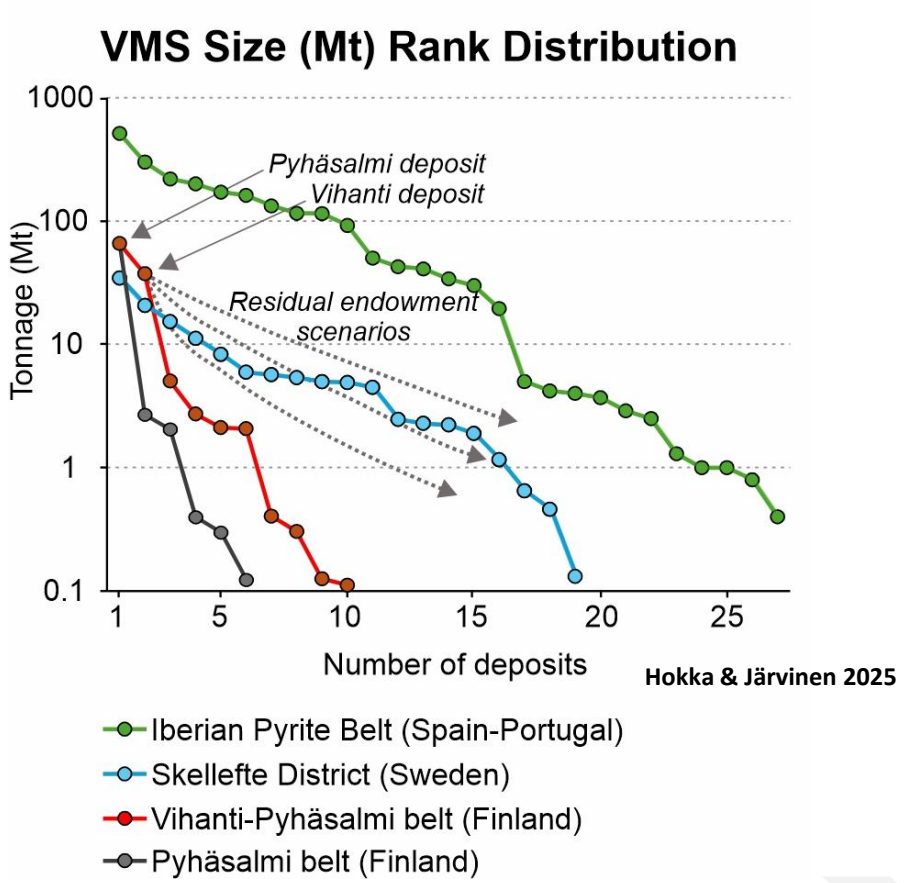
- "*Revisiting the Pyhäsalmi volcanic complex in western Finland: New insights from volcanic-facies mapping*"
- Return to meticulous physical drill core logging, focusing on textures, structures, lith unit relationships
- Logged 53 DDH's and 51 outcrops → Identified 18 distinct lithofacies.
- Observed huge volumes of coherent rhyolite lava and hyaloclastite with associated sediments suggest a submarine dome complex paleoenvironment setting. This model is in stark contradiction with the generally approved model of highly explosive pyroclastic environment. Why does this matter? Hyaloclastite is essential in creating highly permeable unit = trap site.
- Observed peperite suggests coeval deposition of seds and volcs. Seds act as impermeable blanket over subvolcanic rhyolite domes = seal



WP2 – VMS

Results and products – publication

- "*Revisiting the Pyhäsalmi volcanic complex in western Finland: New insights from volcanic-facies mapping*"
- Pyhäsalmi and Mullikkoräme have been placed in different strat units traditionally, but this paper suggests they formed at the same time, just in different paleovolcanic environments. Mullikkoräme missing (sediment) seal unlike Pyhäsalmi
- Traditionally explorers have targeted thick, volcanic sequences but ignored contact zones with sediments. The contact zone of rhyolite domes and overlying sediments is where hydrothermal fluids will focus
- Comparative size and rank distribution analysis. Skellefteå and Iberian Pyrite belt have log linear normal trends. Vihanti-Pyhäsalmi belt missing many mid-size (5-20Mt) deposits



Size-rank distribution of the Vihanti–Pyhäsalmi belt (Rasilainen et al. 2014 and references therein) compared to the mature Skellefte district (Allen et al. 1996; FODD 2012) and the Iberian Pyrite Belt (IPB) (Tornos 2016 and references therein).

WP2 – VMS

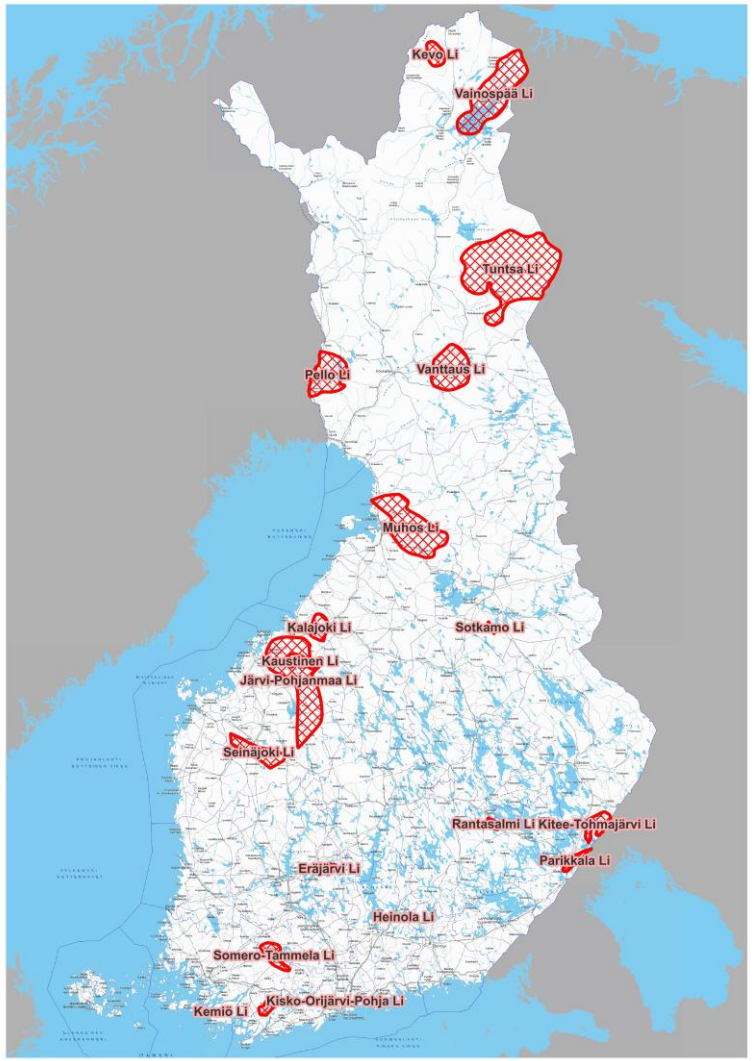
Results and products

- Drilling program, focused on gathering information about the volcano-sedimentary setting, structural framework and stratigraphy of the Pyhäsalmi-Mullikkoräme area
- 600 000€ budget approx. 3500-meter program
- A ground geophysical survey will cover the area
- Reservation notification submitted in Dec 2025, valid until Nov 2026. Drilling will be conduced with landowner consent – an exploration license will not be applied for
- Tendering for drilling contractor ongoing

WP3 – Litium

Key research questions

- Based on the existing data, can indications of lithium deposits be found in previously unknown areas?
- How can new areas with potential be characterized and which materials and methods are most useful here

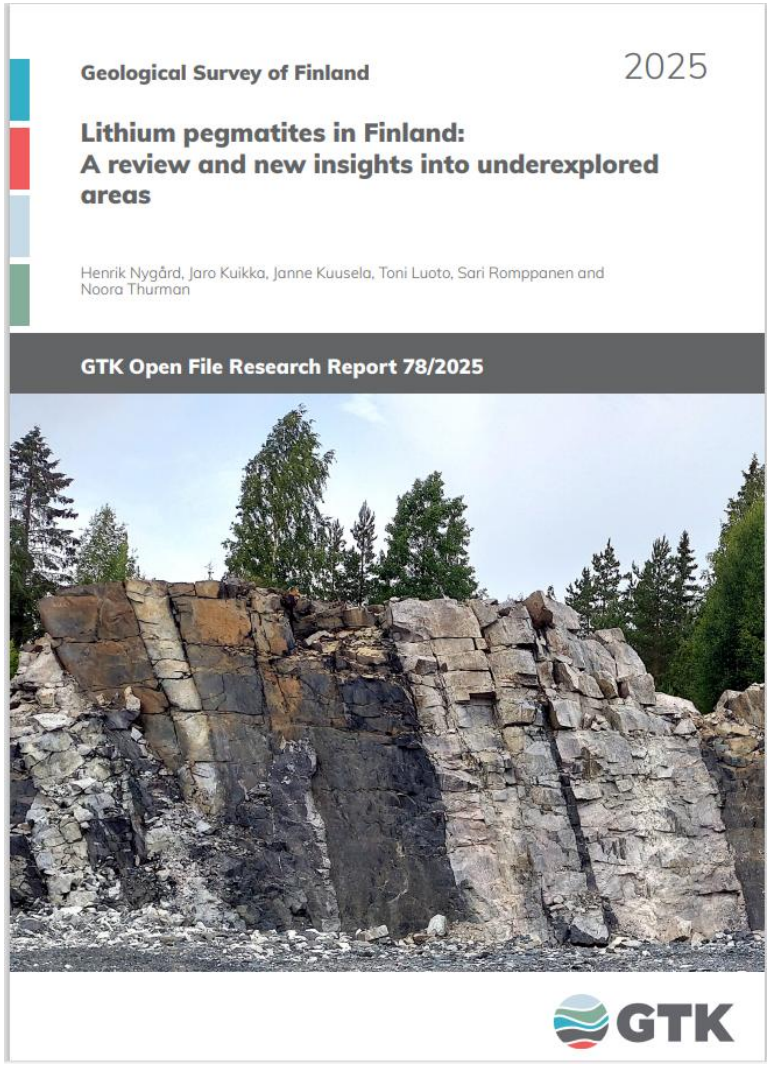


Ennestään tunnetut Li-potentiaaliset alueet

WP3 – Litium

Results and products

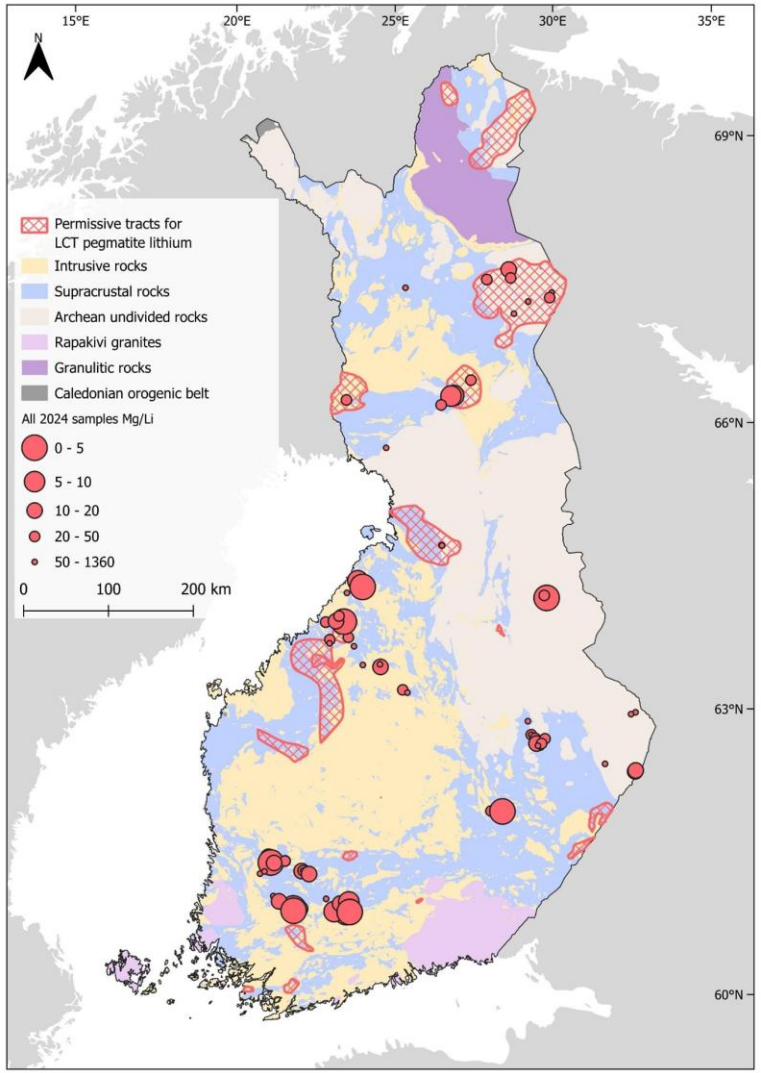
- A work report describing the main results and methodology and a summary of research and analysis data on evolved pegmatites in new areas. Report published 4th Dec 2025
- Main focus on reprocessing till geochemistry and newly collected whole rock geochemistry data
- Funding application for a co-financed project called “Hydrogen potential in Lapland”



WP3 – Litium

Results and products – main take aways

- Many regional samples analyzed with aqua regia: incomplete breaking down of silicates. Li was normalized to Fe and V to tackle this
- Li/Mg was observed to be a good indicator of fractionation. Very low values = evolved rock. Multiple samples collected outside known Li permissive areas showed elevated Li/Mg values.
- Layman sample database also interrogated. Lepidolite rich boulder in Alavieska with 4610 ppm Li found
- Report includes Best Practices for Locating LCT Pegmatites in Finland



WP4 – Publications

Authors	Title	Publication journal
Hokka J. and Lahtinen R.	Facies architecture, ore genesis and structural evolution of Paleoproterozoic Zn-Pb-Cu potential Aijala-Metsämonttu area, SW Finland	Ore Geology reviews
Karinen, T. et al.	Chilled margin and marginal reversal formation in the Koillismaa Deep Intrusion: Implications for parental magma compositions in the 2.44 Ga Tornio-Näränkävaara Belt	Contributions to Mineralogy and Petrology
Hokka, J., & Järvinen, V.	The Pyhäsalmi volcanic complex Revisited: New Insights from volcanic facies mapping	Bulletin of the Geological Society of Finland
S. Romppanen, N. Eyles N. Putkinen, H. Nygård	Fate of lithium and strategic metals under Pleistocene ice streams	Quaternary Science Reviews
Kara, J., Manninen, J., Skytta, P, Vaisanen, M., O'Brien, H., Cutts, K., Nikkola, P.	Age and structural evolution of the orogenic gold deposits in Kullaa, SW Finland: implications for fluid activity and gold precipitation during evolving orogeny.	Precambrian Research
Edward P. Lynch, Krisztián Szenpéteri, Joel B.H. Andersson, Janne Kuusela, Martiya Sadeghi, Tobias E. Bauer	Lithium Cesium Tantalum (LCT) pegmatite mineralisation in the Paleoproteozoic central Fennoscancian Shield: A review of geological characteristics and assessment of mineral system commonalities	Ore Geology Reviews

- 20 more publications in the pipeline