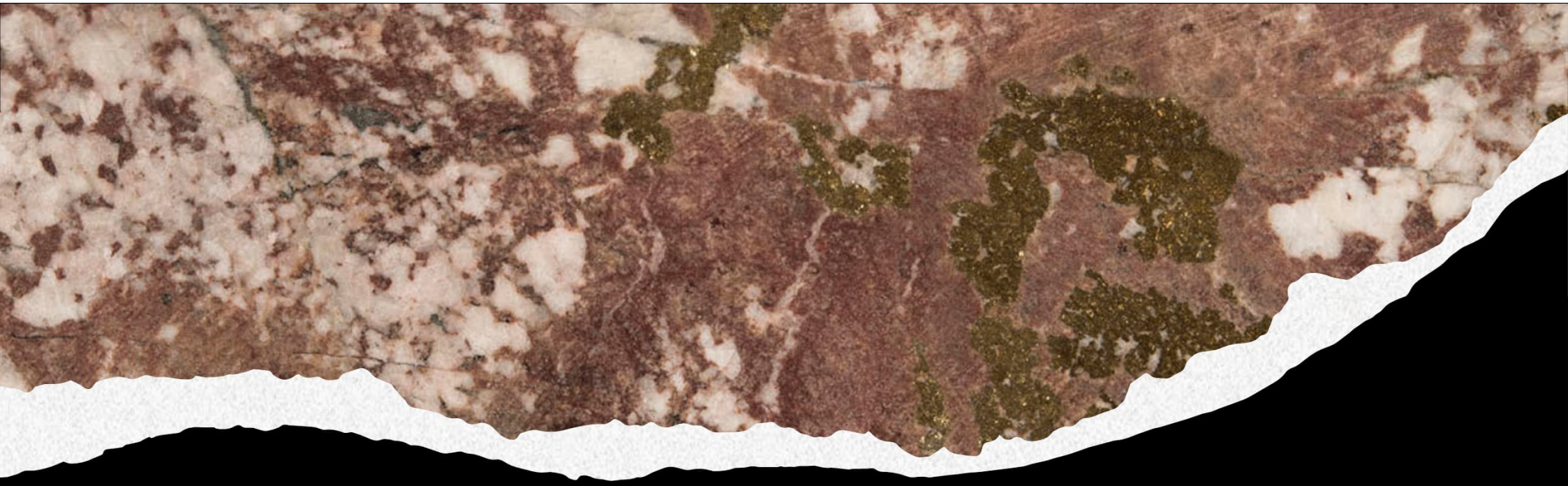


# Rare Earth Elements in the Nordic Countries

**Nordic Mining Day 2024**

**Nolwenn Coint (NGU), Tero Niiranen (GTK) and Martiya Sadeghi (SGU),**

# Highlight

The Nordic countries contain the most important REE resources in Europe

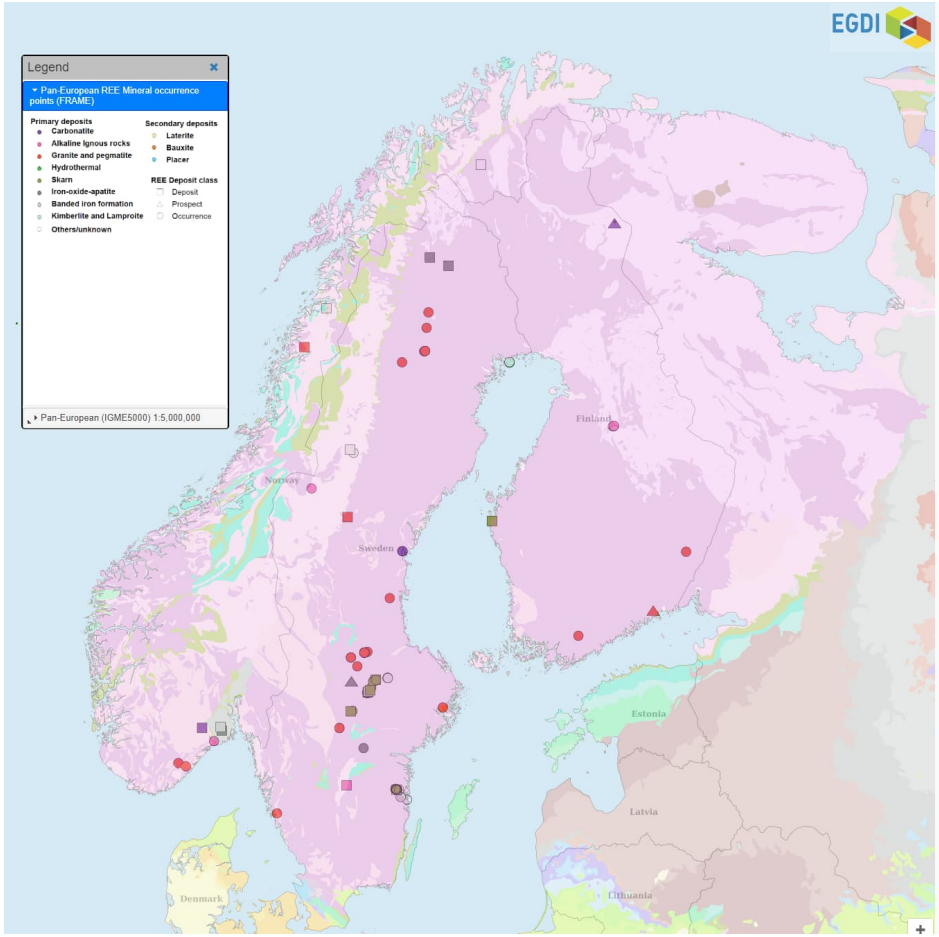
Diversity of deposits covering both LREE and HREE needs:

- Finland and Norway: carbonatite (LREE-P-Nb)
- Sweden, Finland: alkaline complex (HREE-Zr-Nb)
- Sweden, Norway: Fe-P-REE deposit (REE)

FRAME project (EGDI – European Geological Data Infrastructure (europe-geology.eu)

Based on Fennoscandian mineral deposit map

Fennoscandian Mineral Deposits (gtk.fi)

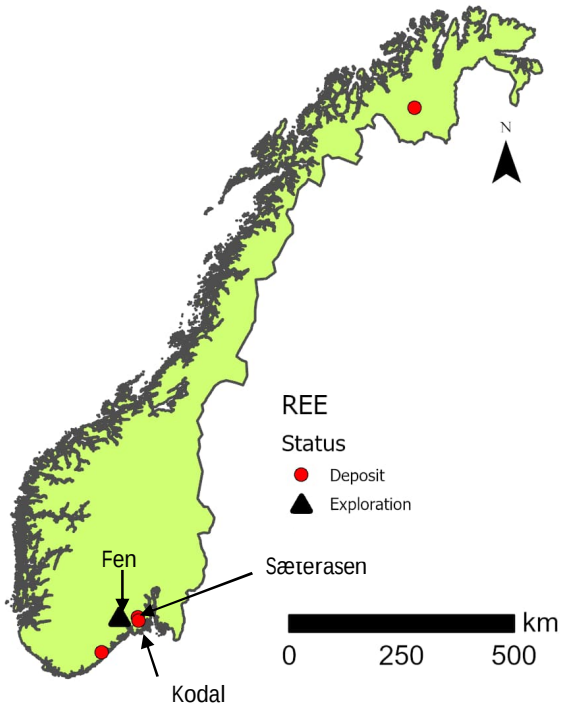



GEOLOGICAL SURVEY OF NORWAY - NGU -

SGU Geological Survey of Sweden

GTK

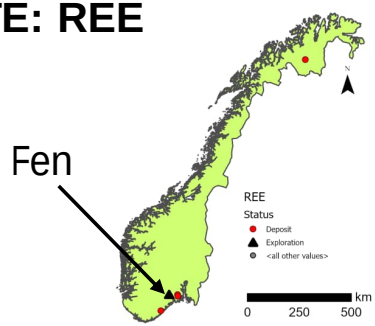
# Norway

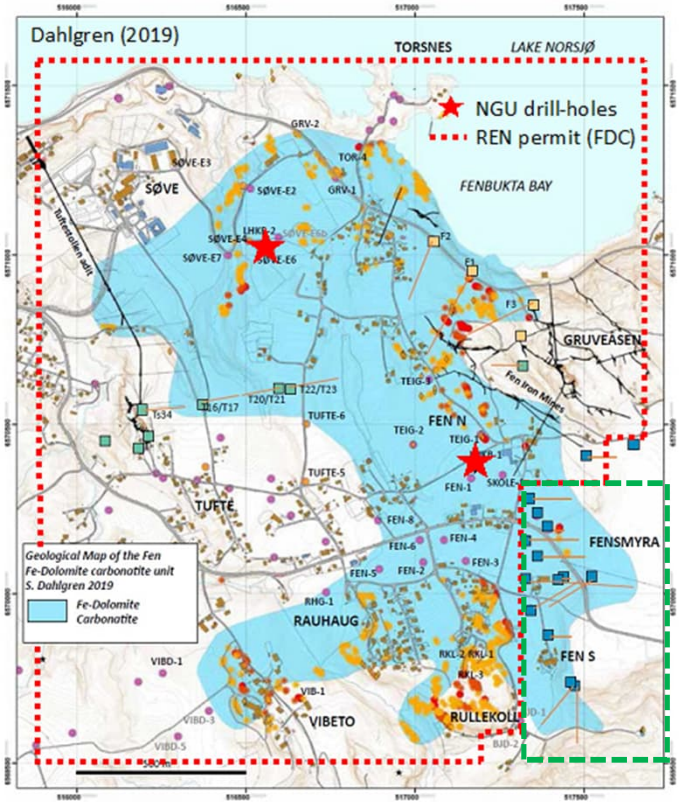



| Project | Highlights | Company |
|---|---|---|
| Fen REE | Carbonatite: potential for very large resource.<br>Pre-feasibility stage project:<br>2011-2022: CIM Inferred 95 Mt @1.28 % TREO<br>Scoping-stage project: Exploration drilling ongoing, 16 km of core assayed<br>JORC-compliant- Exploration target: 1.4-3.3 Gt @ 0.4-2% TREO* official resource estimate to come in 2024 | REE Minerals<br>Rare Earths Norway |
| Sæteråsen REE-Nb-Ta-Zr | Trachyte lava flows Oslo rift<br>Crude resource estimate based on 4 cores: 8 Mt @ 0.245 % Nb, 0.18% Ce, 0.11 % La, 0.075% Y, 0.069 Nd and 0.049 Th* | REE mining AS |
| Kodal Fe-P-REE | Fe-Ti-P-(REE) deposit in monzonite, Oslo Rift<br>Exploration project 1970's and 2013-2016<br>JORC compliant inferred resource of 34.3 Mt @ 4.59 % P2O5 and 20.38 % Fe, assuming 1930 ppm TREO in apatite -> 0.158 Mt TREO * Decrée *et al*., 2022<br>https://doi.org/10.6084/m9.figshare.c.5913009 | Fritzøe Skoger AS |

*Non-compliant resource estimation

# THE FEN CARBONATITE: REE

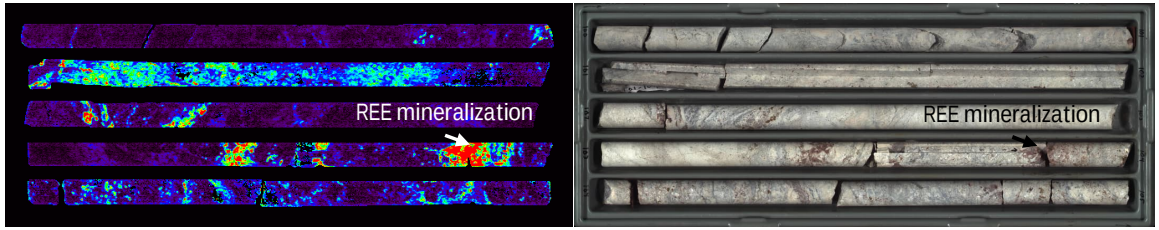



REE mineral AS permit

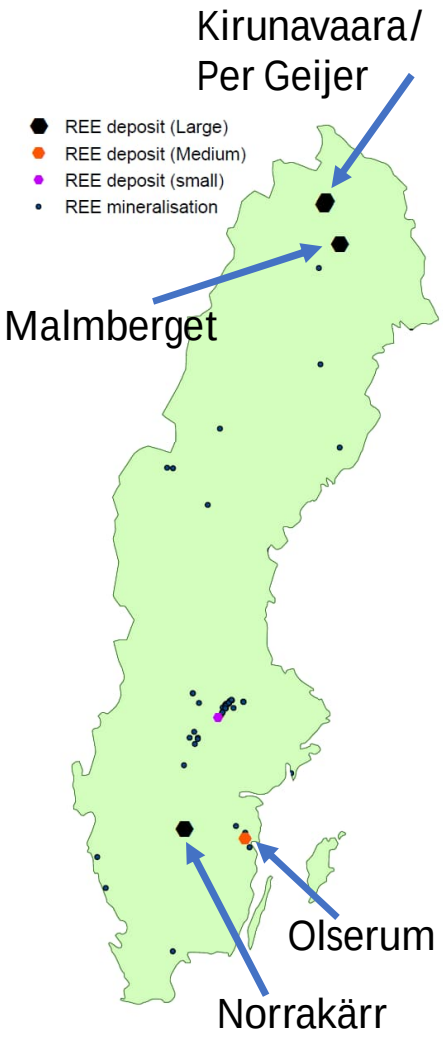
- 580 Ma carbonatite in South Norway
- A major European REE resource
- A mineralized volume documented to at least 1 km depth
- REE hosted in REE-F carbonates (bastnäsite, parisite-synchysite) and phosphates (monazite)
- Additional potential for niobium and phosphate resources.

Hyperspectral imaging –innovative methods to highlight the presence of REE



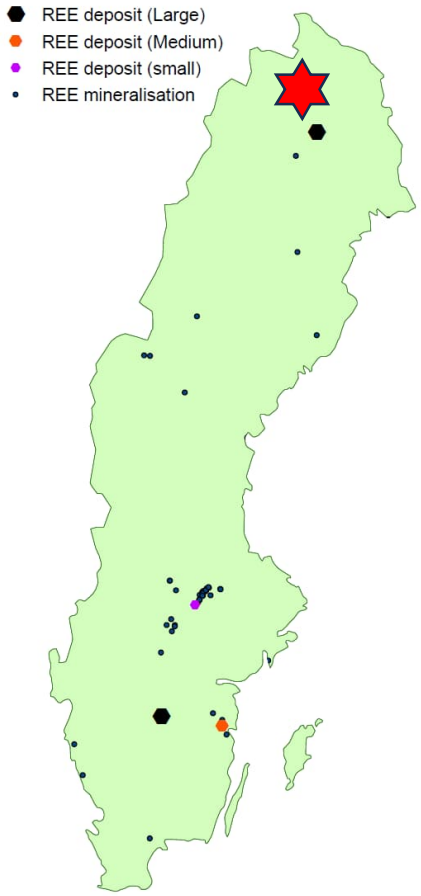

https://www.ngu.no/upload/Publikasjoner/Rapporter/2019/2019_008.pdf

# Sweden




| Mine/Project | Highlights | Company |
|---|---|---|
| Norra Kärr | Norra Kärr PEA- 2021:<br>Orthomagmatic peralkaline/syenitic deposit type with 110 Mt resource @0.5% TREO | LEADING EDGE MATERIALS |
| Per Geijer | Apatite-iron oxide deposit type with 734 Mt inferred resource [magnetite 557 Mt@0.17 TREO (in-situ)%; Mixed 122 Mt@0.20 TREO (in-situ)%; Hematite 48 Mt@ 0.20 TREO (in-situ)%] and approximately total tonnage 1.1 Mt REE | LKAB |
| Malmberget | LKAB_annual_2022 Official Statistics of Sweden, Metal and Mining industries www.lkab.com<br>Apatite-iron oxide deposit type with 1371 Mt resource @ 0.0227 % TREO resource | LKAB |
| Kirunavaara | LKAB_annual_2022 Official Statistics of Sweden, Metal and Mining industries www.lkab.com<br>Apatite-iron oxide deposit type with 1373 Mt resource @ 0.0163 % TREO | LKAB |
| Olserum | https://europeangreenmetals.com/<br>Hydrothermal, granite-associated type and according historic 43-101 : indicated resource 4.5 Mt grading 0.6 % TREO, and inferred resource of 3.3 Mt grading 0.63% TREO using a 0.4% cut-off dated 2013. | European green metals |

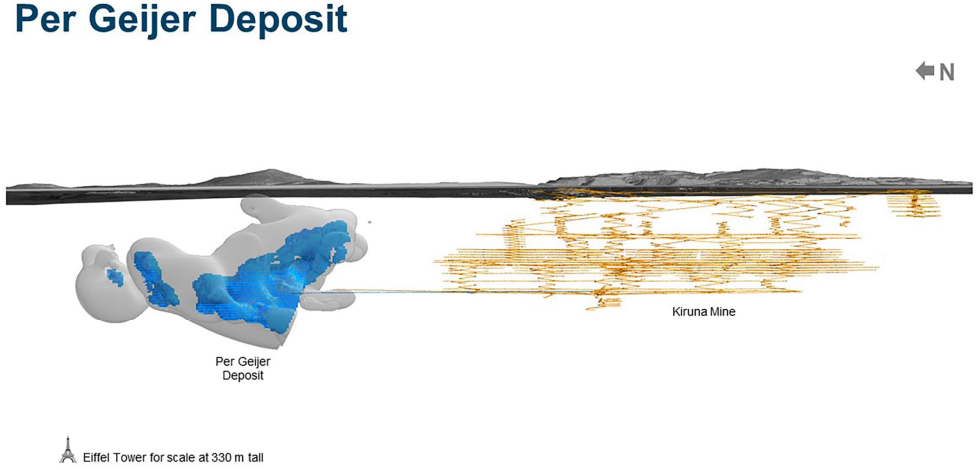
# Kiruna- Per Geijer




Per Geijer – potential to become Europe's most important mine for critical raw materials

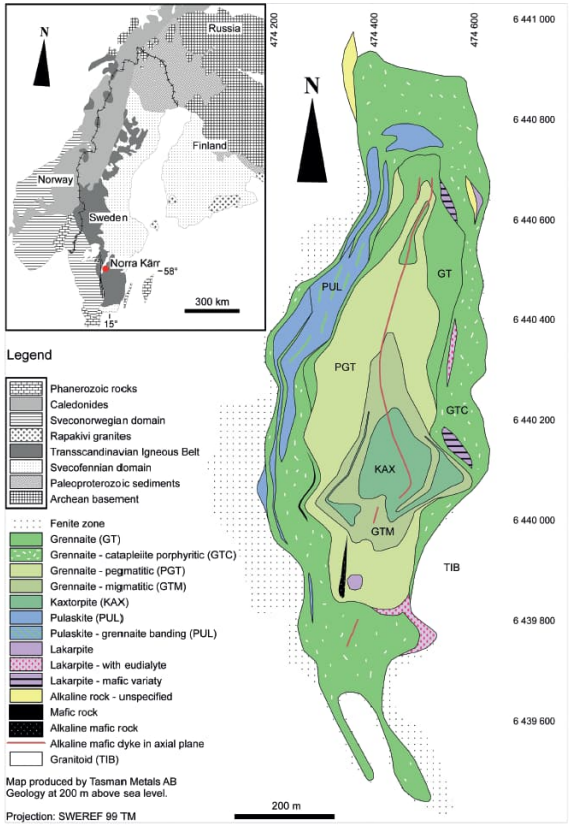
- Magnetite, hematite, apatite (REE)
- Testwork production; apatite concentrate with a P2O5 grade >34% and an associated TREO grade of 0.84%-0.85%.
- Inferred 734 Mt@0.18% TREO (in-situ)
- Close proximity to existing operations in Kiruna

- Submitted application for exploitation concession in 2023
- Prepare a drift from the Kiruna mine, 700 m depth, Km's long




LKAB ökar mineraltillgångarna – och redovisar sällsynta jordartsmetaller - LKAB

# NorraKärr




*Saxon et al., 2015*



**Table ES 1: Norra Kärr Mineral Resource Statement (SRK, 18 August 2021)***

| Mineral Resource Classification | Tonnes (Mt) | TREO (%) | $ZrO_2$ (%) | $Nb_2O_5$ (%) | Nepheline Syenite (%) |
|---|---|---|---|---|---|
| Inferred | 110 | 0.5 | 1.7 | 0.05 | 65 |

*Notes:*

1. *Effective date 18 August 2021.*
2. *Qualified Person Mr Martin Pittuck MSc C.Eng*
3. *Mineral Resources are not Mineral Reserves until they have Indicated, or Measured confidence and they have modifying factors applied and they have demonstrated economic viability based on a Feasibility Study or Prefeasibility Study.*
4. *There is no guarantee that Inferred Mineral Resources will convert to a higher confidence category after future work is conducted.*
5. *The Mineral Resources reported have been constrained using an open pit shell assuming the deposit will be mined using open pit bulk mining methods and above a cut-off grade of USD150/t., including a 30% premium on projected commodity prices and unconstrained by commodity production rates and the 260m highway buffer zone.*
6. *The Mineral Resources reported represent estimated contained metal in the ground and has not been adjusted for metallurgical recovery.*
7. *Total Rare Earth Oxides (TREO) includes: $La_2O_3$, $Ce_2O_3$, $Pr_2O_3$, $Nd_2O_3$, $Sm_2O_3$, $Eu_2O_3$, $Gd_2O_3$, $Tb_2O_3$, $Dy_2O_3$, $Ho_2O_3$, $Er_2O_3$, $Tm_2O_3$, $Yb_2O_3$, $Lu_2O_3$, $Y_2O_3$.*
8. *Heavy Rare Earth Oxides (HREO) include: Eu2O3, Gd2O3, Tb2O3, Dy2O3, Ho2O3, Er2O3, Tm2O3, Yb2O3, Lu2O3, Y2O3*
9. *HREO is 52% of TREO*

**Table ES 2: Norra Kärr Rare Earth Element Distribution**

| Light REO proportion of Total REO | | | | | Heavy REO proportion of Total REO | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $La_2O_3$ | $Ce_2O_3$ | $Pr_2O_3$ | $Nd_2O_3$ | $Sm_2O_3$ | $Eu_2O_3$ | $Gd_2O_3$ | $Tb_2O_3$ | $Dy_2O_3$ | $Ho_2O_3$ | $Er2O_3$ | $Tm_2O_3$ | $Yb_2O_3$ | $Lu_2O_3$ | $Y_2O_3$ |
| 0.100 | 0.210 | 0.030 | 0.110 | 0.030 | 0.004 | 0.030 | 0.007 | 0.050 | 0.010 | 0.034 | 0.005 | 0.033 | 0.005 | 0.340 |
| 0.48 | | | | | 0.52 | | | | | | | | | |

*Source: NorraKärr PEA*

## Peralkaline nepheline syenite:

- 350 x 1200 m large intrusion
- 50% of TREO are HREE
- Mineralization in Zr and Nb
- Low content of radioactive elements, well serviced by local infrastructures

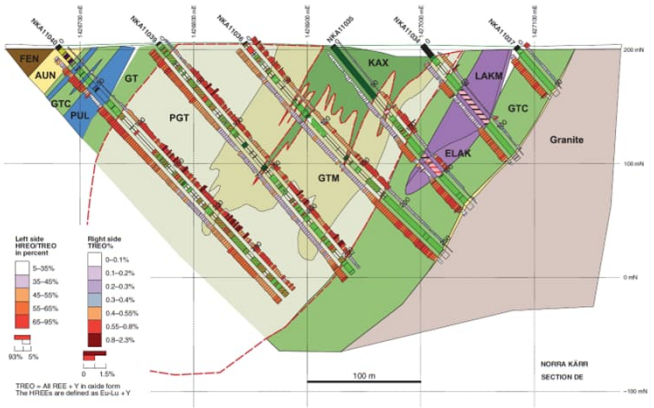
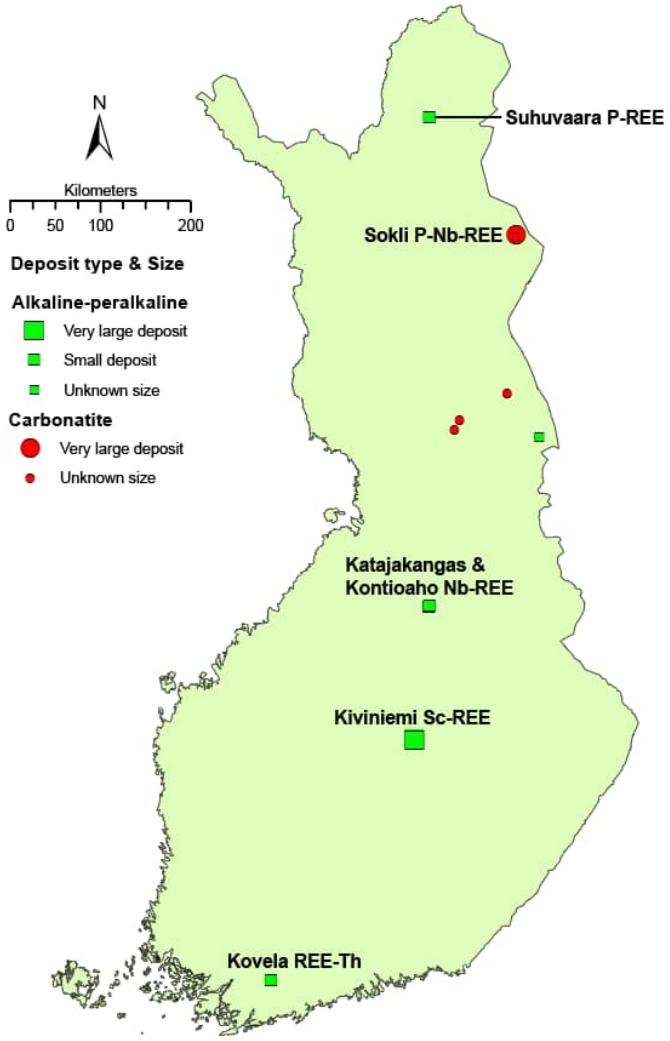



Figure 12. Section (DE) through the Norra Kärr complex, based on recent drilling. Six drillholes lie in the section, with HREO/TREO and TREO% shown alongside. Legend to rock units as in Figure 11. Courtesy of Tasman Metals.

*https://leadingedgematerials.com/leading-edge-materials-announces-positive-preliminary-economic-assessment-results-for-its-norra-karr-ree-project-with-us1026m-pre-tax-npv10-and-30-8-pre-tax-irr/*

# FINLAND




## REE Projects and deposits

| Project | Highlights | Company |
|---|---|---|
| Sokli P-Nb-REE | Mine development project: Carbonatite complex. Potentially very large resources. Mining concession, Scoping study completed 2023. Exploration drilling ongoing | Suomen Malminjalostus Oy |
| Kiviniemi Sc-REE | Exploration project: Alkaline gabbro. Discovery 2008 by GTK, 13.4 Mt @ 162.7 ppm Sc, 1726.2 ppm Zr, 81 ppm Y, 0.8% P2O5* | Scandium International |
| Katajakangas Nb-REE | Exploration project: Peralkaline intrusion. 0.46 Mt @ 0.76% Nb2O5, 1.13% ZrO2, 2.402% TREO , 0.307% Y2O3* | Otanmäki Mine Oy |
| Kontioaho Nb-REE | Exploration project: Peralkaline intrusion.7.69 Mt @ 0.122% Nb2O5, 0.135% Y2O3, 0.454% TREO, 2.59% ZrO2* | Otanmäki Mine Oy |
| Kovela REE-Th | Exploration project: Granite. 99 kt @ 1.362 % TREO* | elementX Finland Oy |

*Non-compliant resource estimation

# Sokli P-Nb project - Suomen Malminjalostus Oy

- Carbonatite hosted phosphorous deposit
  - Other commodities: Nb, Ta, Zr, REE, U, Th, Hf, Sr, Mn
- Discovered in 1967
- Very large resources:
  - 244.5 Mt @ P2O5 13.346 % (regolith)
  - 12 000 Mt @ P2O5 3.5 % (hard rock, down to 200 m depth)
  - 77.1 Mt @ Nb 0.147 % (Nb-ore)
  - All ore types with economically interesting REE grades, not included in published resource estimates
- Mining concession, EIA completed, Scoping Study completed 2023, Environmental permit pending
- Previous feasibility study currently evaluated and updated
- Exploration drilling ongoing

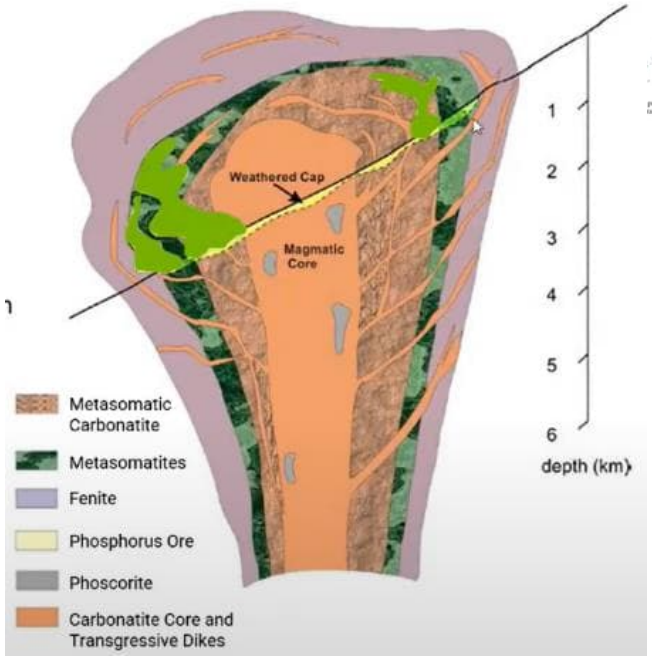



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Photo: Nolwenn Coint, NGU