

Incentivizing investment in base metal mining

– A Swedish/Nordic perspective

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2023-04-26

Joint Seminar, Lisbon
ICSG, ICSG, ILZSG

Disposition

Briefly about SGU

Mining in Sweden

- History
- Today

Survey activities

- Mapping program
- Mining waste program
- Services; data and publications
- Promoting

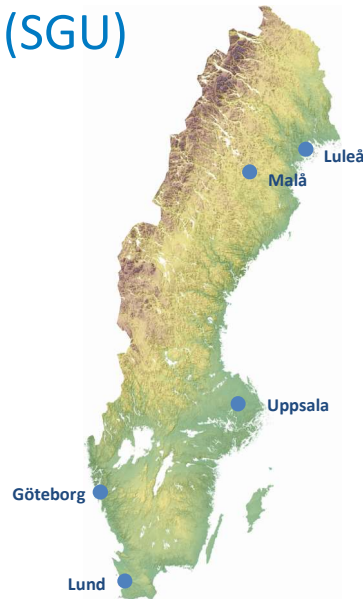
Collaboration

Bedrock map of Sweden



Geological Survey of Sweden (SGU)

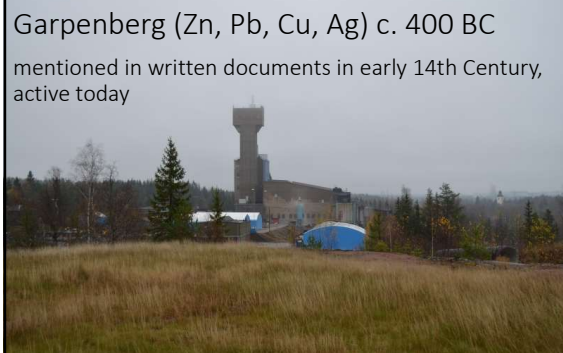
- Founded in 1858
- Government authority for issues relating to bedrock, soil, groundwater and mineral resources management.
- Nearly 300 people work at SGU.
- SGU has offices in five locations in Sweden. Our Head Office is in Uppsala, 70 km north of Stockholm.
- Mining Inspectorate of Sweden in Luleå
 - responsible for issuing permits for exploration (exploration permits) and mining (exploitation concessions) according to the Minerals Act.
 - a separate decision-making body within SGU headed by the Chief Mining Inspector.



Mining in Sweden >2 000 years



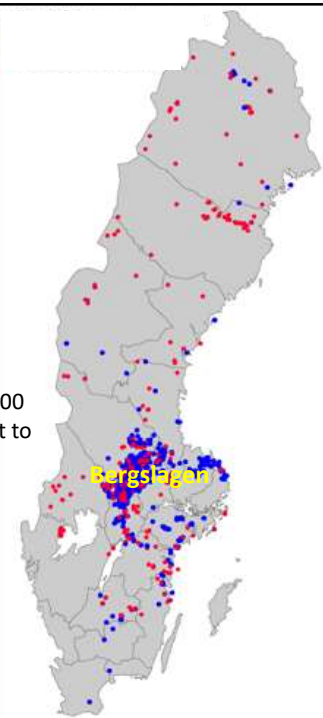
Falu mine (Cu), c. 800 – 1992
today a World Heritage



Garpenberg (Zn, Pb, Cu, Ag) c. 400 BC
mentioned in written documents in early 14th Century,
active today

There has been around 3 000 mines in Sweden (see chart to the right). Mainly in the Bergslagen district.

- Blue dots are iron ore mines
- Red dots are other mines.



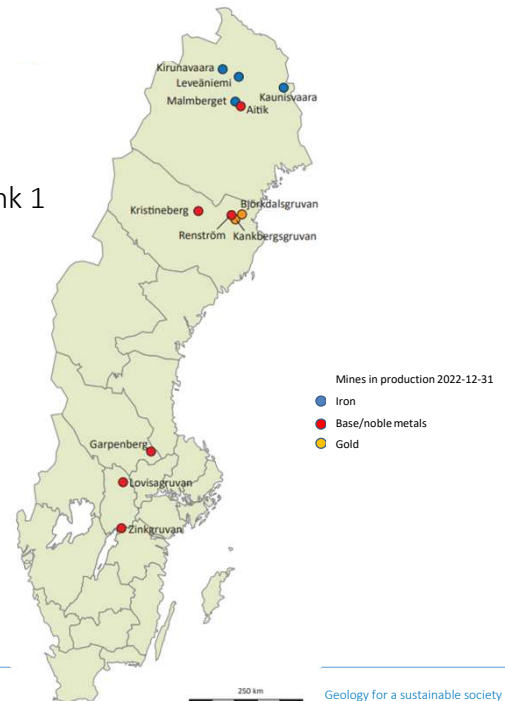
Mining in Sweden today

12 metal mines in production

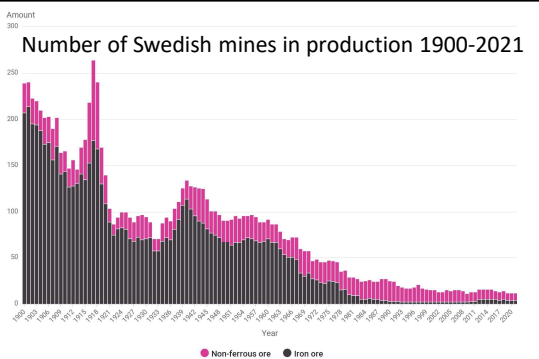
- Fe-production, c. 93% share of EU-production. Rank 1
- Pb-production, c. 32% share. Rank 1
- Zn-production, c. 31% share. Rank 1
- Cu-production, c. 11% share. Rank 4
- Au-production, c. 17% share. Rank 3
- Ag-production, c. 19% share. Rank 2

Also world leading mining equipment manufactures such as Sandvik, Epiroc and ABB.

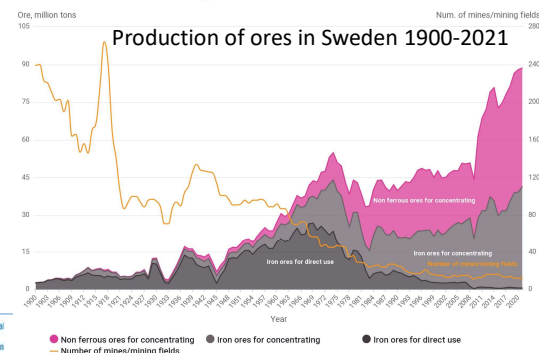
Sandvik and Epiroc together have around 70% of the global market of underground mining equipment



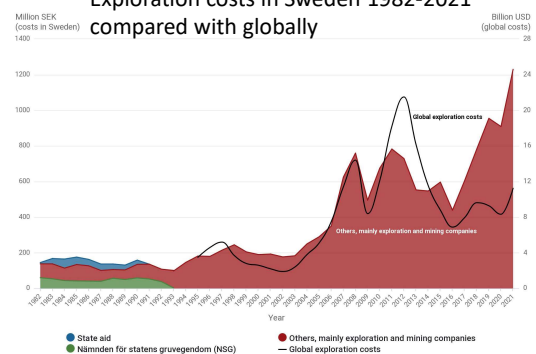
Number of Swedish mines in production 1900-2021



Production of ores in Sweden 1900-2021



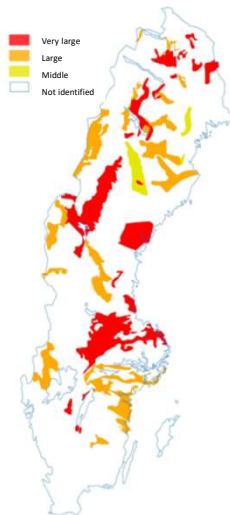
Exploration costs in Sweden 1982-2021 compared with globally



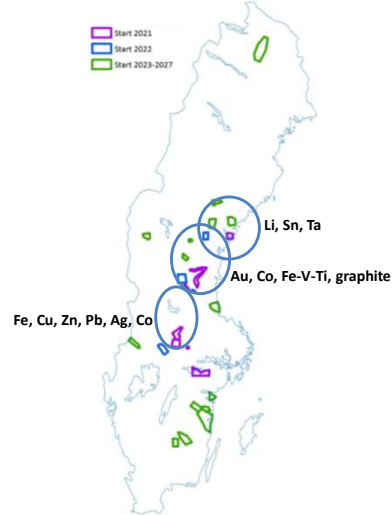
Mapping activities 2021-2027

Bedrock

Identified areas, need for mapping



Plan for mapping and ongoing projects



Inventory of mineral resources



Mapping program 2021-2027

Till geochemistry

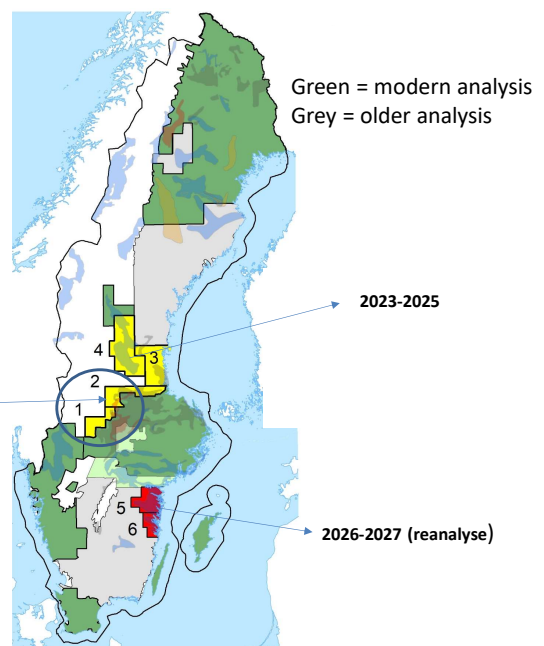
Bergslagen: sampling 2021- 2022

Hälsingland- Gästrikland: sampling 2023-2025

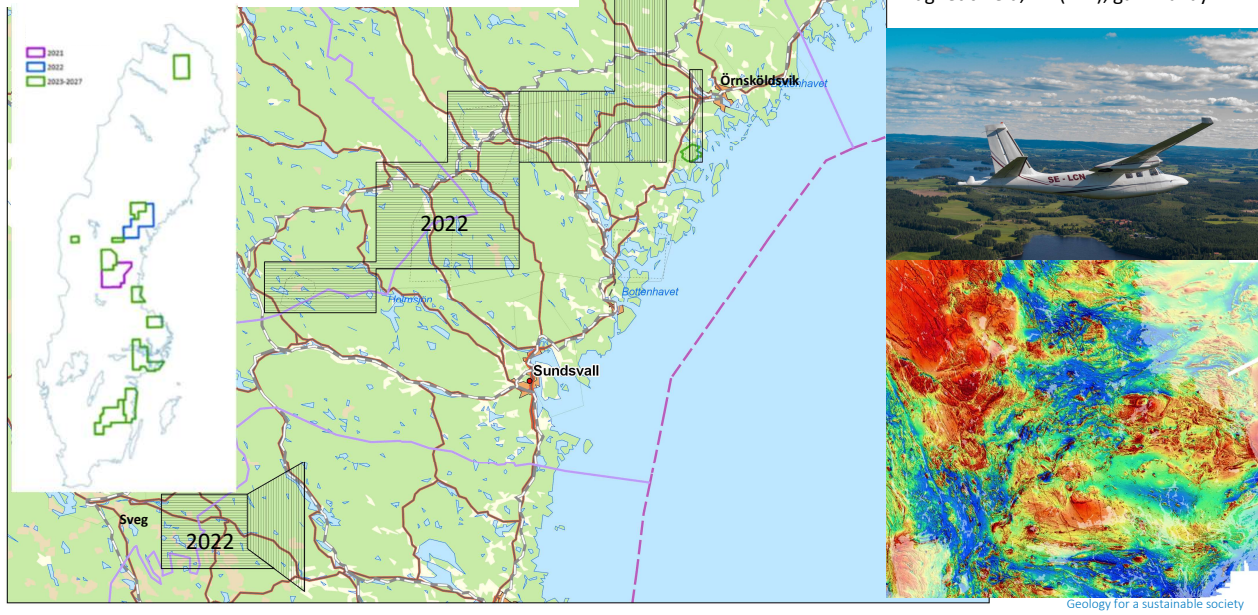
Småland: 2025-2027



Samples from c-horizon
Undisturbed by plant activity
Usually 0.5–1 m below surface



Mapping program 2021-2027: Airborne geophysics



Mining waste program in Sweden, an assignment from the Swedish Government

Overall mission:

SGU, together with the Swedish Environmental Protection Agency investigate the possibilities for sustainable extraction of minerals and metals from secondary resources.



Mapping mining waste:

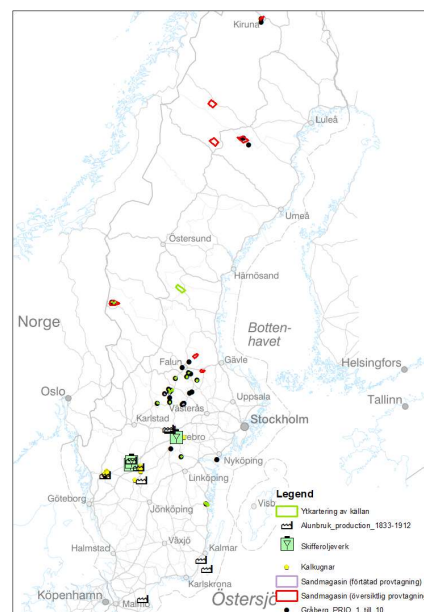
The assignment includes surveying, sampling and characterizing existing mining waste which, based on already known information, is assessed to have potential and can be used as secondary resources for minerals and metals

SGU shall develop a classification method for secondary resources in accordance with the UN-accepted system for resource classification of raw materials (United Nations Framework Classification for Resources, UNFC) and establish a database in accordance with this.

Identify practical and legal obstacles against exploration and extraction of mining waste

Survey activities:

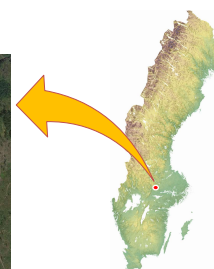
1. Sampling of tailings
2. Geophysical surveys, detailed sampling and drilling where previous investigation had shown anomalous levels of CRM
3. Systematic sampling of waste rock
4. Sampling Shale ash (burnt alum shale)
5. Lithochemical multi-element and mineralogical analyses



Geology for a sustainable society

Sampling and analysis of tailings in Bergslagen

Riddarhyttan- Bäcke-gruvan



High contents of Cobalt and other critical metals, especially in the old tailings

	Fe (%)	Cu (%)	Co (%)	Mo (%)	REE (%)	Au (ppm)	Bi (ppm)	Ga (ppm)	In (ppm)
Ore	37,10	0,44	-	-	-	-	-	-	-
Old Tailings	15,3-23,2	0,11-0,32	0,01-0,11	0,01	0,13-0,18	0,17-0,35	126-223	12-14	3,59-4,75
New tailings	9,9-18,5	0,09-0,14	0,01-0,02	0,00	0,03-0,11	0,01-0,04	9-19	8-10	2,56-4,62

Summary:

- The field work completed in June 2022
- Results – very promising
- The data will be stored in SGU's database and a UNFC-classification model
- Legal and practical obstacles will be identified (hearings with different organisations, both private and governmental completed)
- **The final report to the Swedish Ministry of Climate and Enterprise on 15 February 2023**

Sustainable extraction of metals and minerals from secondary resources

Rapportering av regeringsuppdrag

Hållbar utvinning och återvinning av metaller och mineral från sekundära resurser

februari 2023

SGU:s diarie-nr: 311-781/2021
Naturvårdsverkets diarie-nr: NV-03617-21
Näringsdepartementets diarie-nr: N2021/01038
SGU RR 2023:01



SGU Sveriges geologiska undersökning

NATURVÅRDSVERKET

SGU Geological Survey of Sweden

Geology for a sustainable society

Services:

Geolagret = "The Geo Store" = searchable on-line archive <https://apps.sgu.se/geolagret/>
- Recent och historical geological and exploration reports, geological maps, old mining maps etc.

TRANSLATION OF GOVERNMENT ASSIGNMENT

Mapping of innovation-critical metals and minerals

Anders Hallberg & Helge Reginiussen

SGU report 2019:20



SGU Geological Survey of Sweden

Critical Raw Materials in ores, waste rock and tailings in Bergslagen

Anders Hallberg & Helge Reginiussen

SGU-rapport 2020:38

Bergslagen etapp 1

Geophysical and geochemical characterisation of graphite-bearing rocks in the Giltjärn-Skrammelfall area northwest of Norberg

Peter Hedin & Torbjörn Bergman

september 2020

SGU-rapport 2020:26



Exploration Newsletter

September 2022

Exploration news

What's up in Sweden

Exploration news

What's up in Sweden

Exploration news

What's up in Sweden

Exploration news

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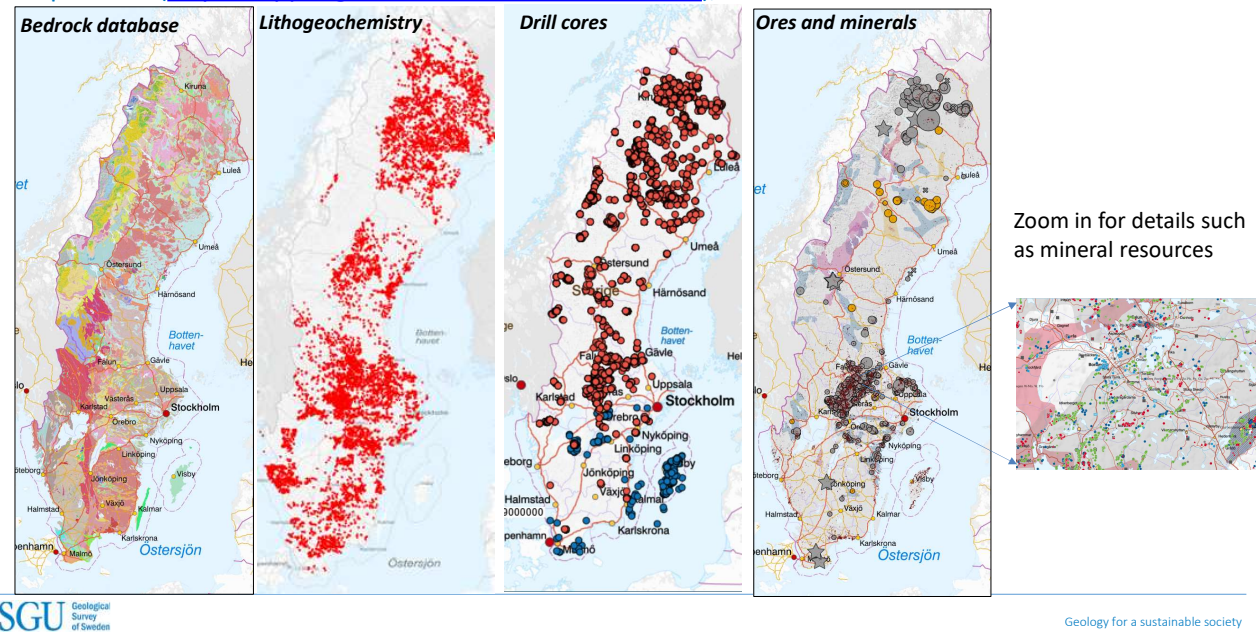
What's up in Sweden

Exploration news

Geology for a sustainable society

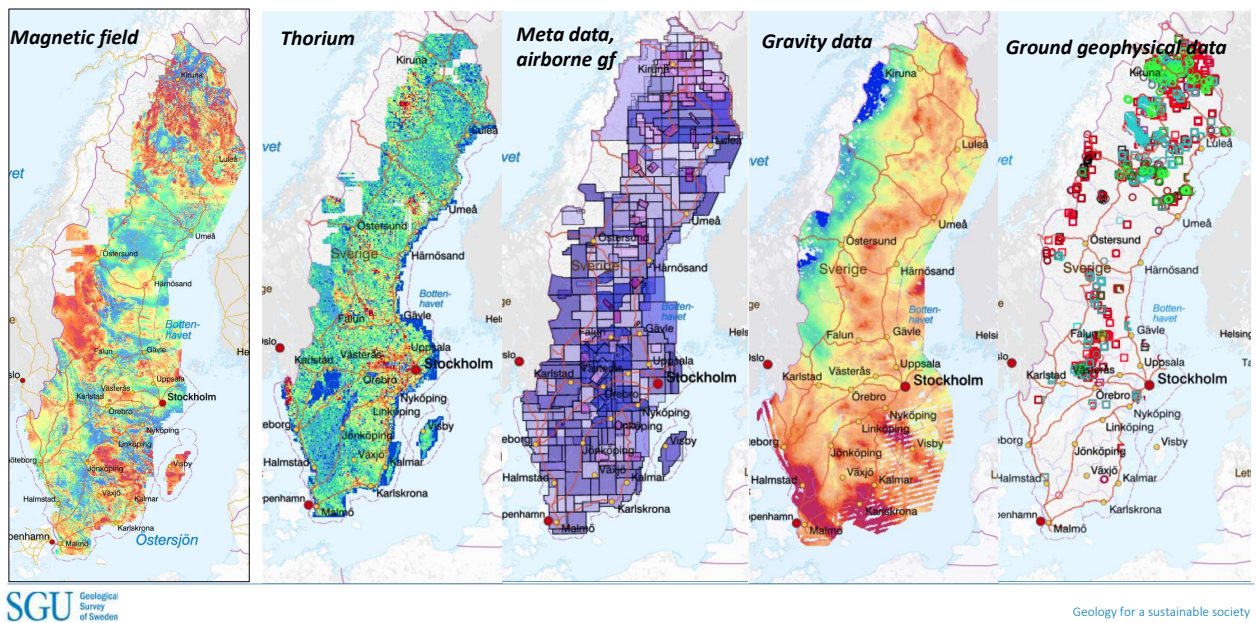
Services:

Map viewer (<https://apps.sgu.se/kartvisare/index-en.html>), bedrock and mineral related information



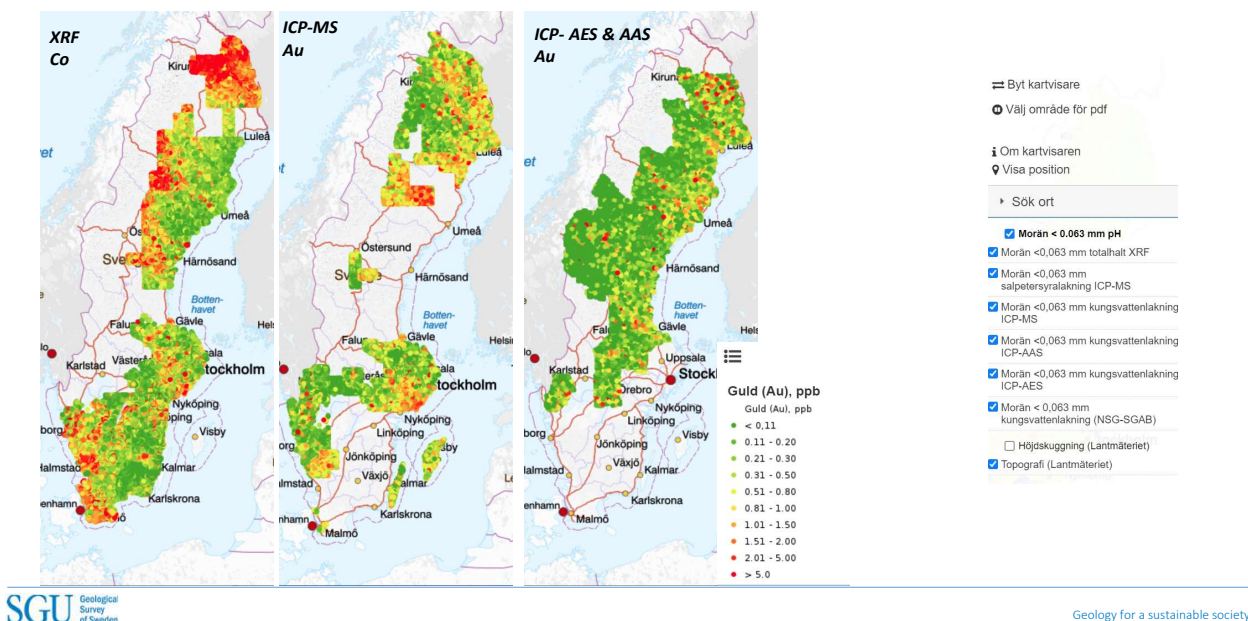
Services:

Map viewer (<https://apps.sgu.se/kartvisare/>), geophysical information



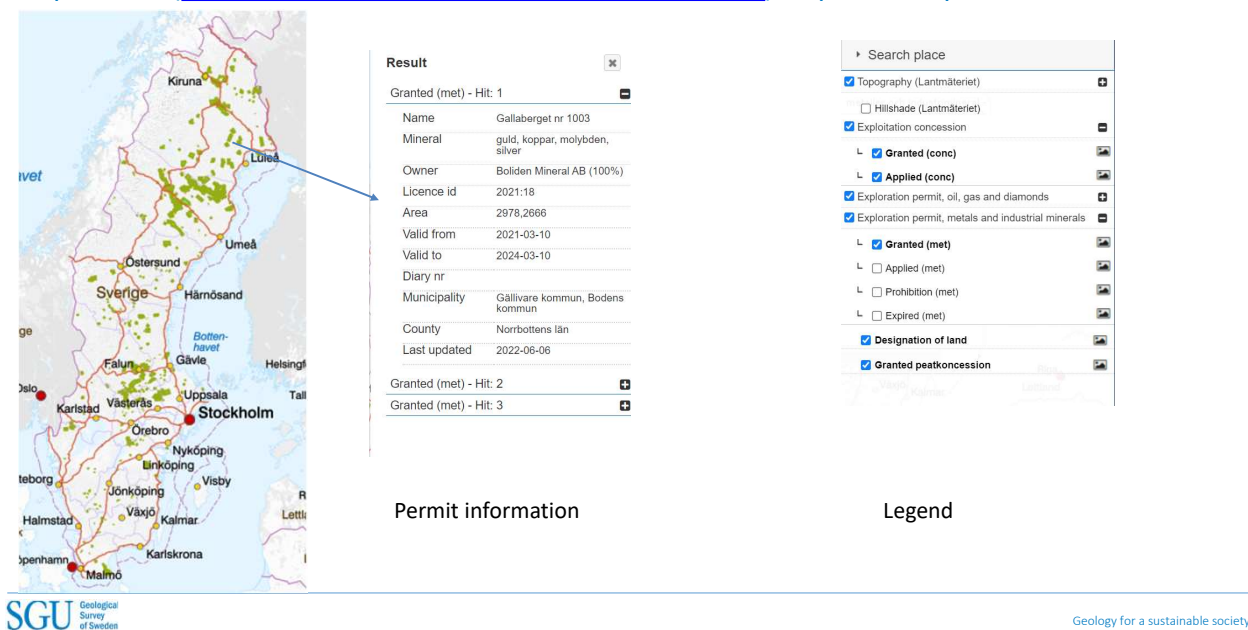
Services:

Map viewer (<https://apps.sgu.se/kartvisare/index-en.html>), till geochemistry



Services:

Map viewer (<https://apps.sgu.se/kartvisare/index-en.html>), exploration permits



Services: Mineral Resources Information Office in Malå



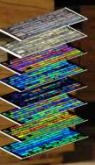
Mineral resources information office

The Mineral Resources Information Office is located in Malå, Västerbotten, and is a branch of SGU. The Office is responsible for archiving and assisting with material for exploration.

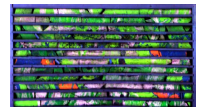


- First stop for exploration companies, personal service
- Archiving and assisting historical and recent exploration information in Sweden
- Maintains the National Drill Core Collection
 - > 3 Million meters of public drill cores
 - > 1 Million meters of confidential drill cores
 - Additional cores every year
- Comprise many maps, exploration reports, field notes, historical documents and more
- Giving service to mining/exploration companies, universities and others
- Established in 1993

Hyperspectral Infrared Drillcore Scanning at SGU



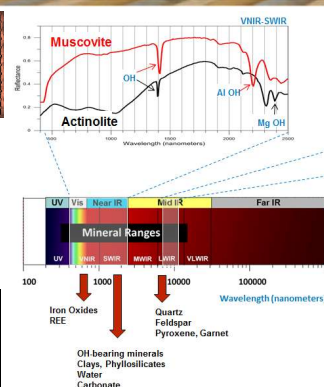
Hi-res RGB image



LWIR FCC Image

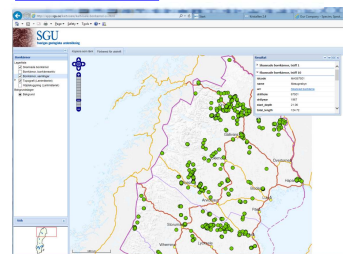


Mineral Map



- Open data – 233 000 meters
- Visible–Near Infrared (VNIR)
- Short Wave Infrared (SWIR)
- Long Wave Infrared (LWIR)
- High resolution optical RGB image

Map viewer at
<https://apps.sgu.se/kartvisare/index-en.html>



Promoting Sweden

Euro Mine Expo, Skellefteå, Sweden <https://www.euromineexpo.com/>

- International Trade Fair and Conference for the Mining Industry
- Held every second year since 2008
- Almost 2 000 participants from >30 countries, 14-16 June 2023 in Skellefteå

FEM (Fennoscandian Exploration and Mining Conference), Levi, Finland <https://femconference.fi/>

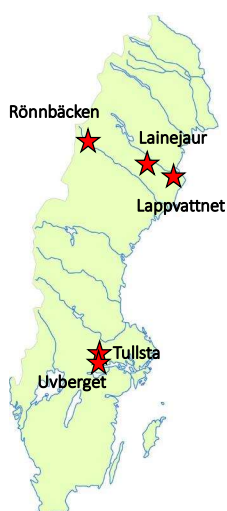
- One of the most significant and largest mining industry events in Europe
- FEM 2021 Online event had almost 1 800 participants.
- Held every second year, the 14th Conference will take place 31 October – 2 November 2023

PDAC (Prospectors & Developers Association of Canada), Toronto, Canada <https://www.pdac.ca/>

- The world's premier mineral exploration and mining convention
- Almost 24 000 attendees at PDAC 2023
- Nordic Mining Day together with the Finnish Geological Survey (GTK) and the Geological Survey of Norway (NGU)

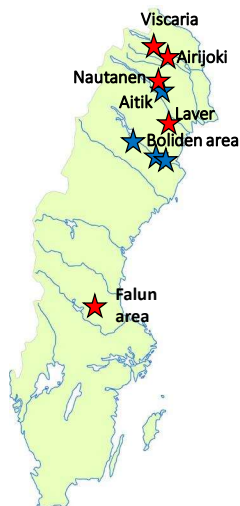


Current Ni-projects



Project	Highlights	Company
Rönnbäcken Ni	600 Mt @ 0.18% Ni, 0.003% Co, 5.7% Fe (measured+ indic.) Resource updated 2022. Exploitation concessions granted.	Bluelake Mineral
Lainejaur Ni-Cu-Co-PGM-Au	0.46 Mt @ 2.2% Ni, 0.7% Cu, 0.15% Co, 0.68 g/t Pd, 0.2 g/t Pt, 0.65 g/t Au (infer.). Considerable tonnage of low-grade Ni and Cu not included. Open down dip.	Bayrock Resources
Lappvattnet Ni-Cu-Co	0.78 Mt @ 1.35% Ni, 0.25% Cu, 0.025 Co. Resource estimate 2020. Drilling in progress.	Gungnir Resources
Tullsta Ni-Cu-Co Granmuren	Greenfield, drilling in progress. Gabbroic intrusion with disseminated –massive sulphides. High grade material is occasionally encountered such as 4.5m @ 0.81% nickel and 0.70% copper	Ragnar Metals
Uvbergs Ni-Cu-Co	Greenfield, drilling in progress. Drill intercepts include 6.7 m @ 0.32% Ni, 0.14% Cu, 0.12% Co & 0.16 g/t 3PGE, incl. 0.9 m @ 1.6% Ni, 0.17% Cu, 0.85% Co & 1.1 g/t 3PGE	Rolling Road Resources

Current Cu-projects

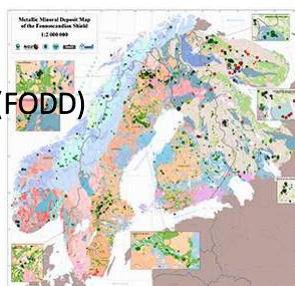


Mine/Project	Highlights	Company
Aitik	Active mine: In 2021 40,1 Mt ore was extracted and 80Kt Cu produced. Total Resource: 2278Mt @ 0.2% Cu, 0.12 g/t Au, 1.01 g/t Ag.	Boliden
Boliden Area	Active mines: Renström, Kristineberg, Kankberg. In 2021 1.9Mt ore including 280Kt slag was extracted and 47Kt Zn, 4Kt Cu and 2.6t Au.	Boliden
Laver	Exploration; 734 Mt at 0.24% Cu, 0.14 ppm Au, 4 ppm, 37 ppm Mo (Indic.) and 227 Mt at 0.21% Cu, 0.10 ppm Au, 33 ppm Mo (Infer).	Boliden
Viscaria	Exploration; 4 zones of 93Mt @ 0.21% to 1.32% Cu and 23.6% to 25.5% Fe _{Mag} in 2 zones	Copperstone Resources
Nautanen	Exploration; 12.7Mt @ 1.5% Cu, 0.9 g/t Au, 6 g/t Ag, 100 g/t Mo (Indic.) and 8.7Mt @ 1.4% Cu, 6 g/t Ag, 0.6 g/t Au, 98 g/t Mo (Infer.)	Boliden
Airijoki	Exploration; 44.3Mt @ 0.4% V ₂ O ₅ , containing 5.9Mt of magnetite at 1.7% V ₂ O ₅ . Resource from 2019. Cu soil anomaly with good continuity extends c 7km.	Kendrick Resources
Falun area <i>Skyttgruvan-Naverberg</i>	Exploration: Drill intercept 6.8m @ 114g/t Ag, 0.5% Cu, 5.5% Zn, 1.0% Pb and 0.13g/t Au. Key target 3.5km along the limestone sequence (containing zinc-silver-lead mineralisation) host to the historic Falun mine.	Alicanto

Collaboration

Fennoscandian ore deposit database (FODD)

<https://www.gtk.fi/en/fennoscandian-mineral-deposits-application-ore-deposits-database-and-maps/>



The Nordic Supply Potential of Critical Metals and Minerals for a Green Energy Transition

Collaboration between the geological surveys of Sweden (SGU), Finland (GTK), Norway (NGU), Denmark and Greenland (GEUS), the Greenland Ministry of Mineral Resources, the Norwegian Mining Authority, the Iceland Energy Authority and Reykjavik University, and was led by the GTK. The Nordic Council of Ministers' organization Nordic Innovation has funded the work

<https://norden.diva-portal.org/smash/get/diva2:1593571/FULLTEXT02>

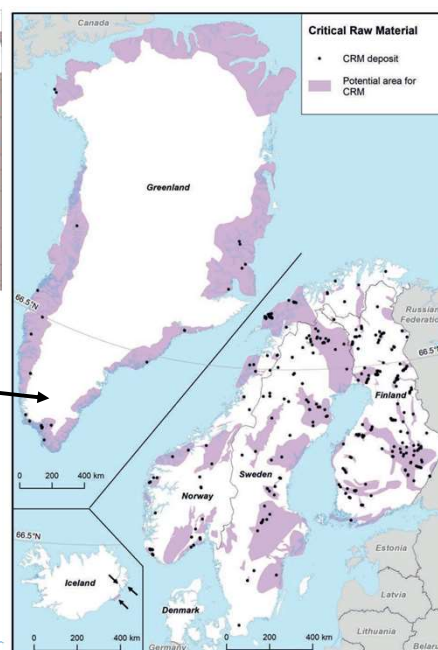


Figure 8. Locations of deposits with known critical raw material resources and areas with known or assumed potential for additional CRM resources in the Nordic countries.

Thank you for your attention!

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