

The logo for the Arctic Economic Council (AEC) is centered on a background of overlapping geometric shapes in various shades of blue. The acronym 'AEC' is rendered in a large, bold, white sans-serif font. A thin horizontal line, colored in a light orange or yellow, runs beneath the 'AEC' text. Below this line, the full name 'ARCTIC ECONOMIC COUNCIL' is written in a smaller, white, all-caps sans-serif font.

**AEC**  
ARCTIC ECONOMIC COUNCIL

# ARCTIC MINING REPORT 2024

- September 2024

# CONTENTS

<b>FOREWORD.....</b>	<b>4</b>
• Address from the AEC Executive Director.....	5
• How to start up CRM in the Arctic.....	6
<b>MINING AND CRITICAL RAW MATERIALS IN THE ARCTIC.....</b>	<b>9</b>
• Introduction.....	11
• Five countries dominating CRM production.....	14
• A region of mining opportunities.....	15
• A brief history of the Arctic mining.....	16
• Time is an issue.....	18
• Raw materials needed in renewables.....	20
<b>UNDERSTANDING CRM.....</b>	<b>25</b>
• Why are critical raw materials needed?.....	26
• Countries accounting for the largest share of CRM supply.....	27
• Concepts and practical use.....	28
• 31 out of 34 CRM are in the Arctic.....	30
• CRM potential in the Arctic States.....	31
• Global clean energy investment.....	33
• Commodity price index.....	34
• Changes in base metals prices.....	35
• Price indexes for selected minerals.....	36
<b>INDIGENOUS PERSPECTIVES.....</b>	<b>37</b>
• ICC Declaration on Responsible Resource Development.....	39
• CAFF: Mainstreaming Biodiversity in Arctic Mining.....	40

<b>CIRCULARITY AND RECYCLING.....</b>	<b>41</b>
• Various initiatives.....	44
• European Critical Raw Materials Act.....	45
• European Raw Materials Alliance.....	46
• Rankings.....	45
• Chinese investments going into the Arctic states.....	47
<b>NATIONAL CRM POLICIES OF THE ARCTIC STATES</b>	
• Canada.....	50
• Greenland (Kingdom of Denmark).....	58
• Finland.....	64
• Iceland.....	71
• Norway.....	76
• Russia.....	84
• Sweden.....	90
• Alaska (USA).....	96
<b>RECOMMENDATIONS.....</b>	<b>103</b>
• Importance of infrastructure and energy.....	105
• Innovation and investments.....	106
• Skills and competences.....	107
• Regulation and governance.....	108
• How to start up CRM in the Arctic.....	109
<b>SOURCES.....</b>	<b>112</b>

”

*We need mining to transition to a low-carbon future. In the Arctic we have the critical raw materials that will make it possible to reach our climate goals.*

*For centuries, mining together with fisheries and energy, has been the backbone of Arctic communities and economies.*

*Today the mining sector in the Arctic operates responsibly and to some of the highest standards in the world with fewer greenhouse gas emissions than anywhere else.*

*Critical Raw Materials are important because of the link to industry, because of modern technology's reliance on them and due to the impact they will have on the environment and climate.*

*We have developed a set of recommendations of how to kick-start the CRM development in the Arctic. We need to look at skills, speed, showcasing opportunities and much more.*

*Mads Qvist Frederiksen  
Executive Director  
Arctic Economic Council*

---



# MINING AND CRITICAL RAW MATERIALS IN THE ARCTIC

---

# INTRODUCTION

The purpose of this report is to provide a comprehensive analysis of the state of critical raw materials mining in the Arctic.

Throughout this report, we will bring some light into the status of critical raw materials extraction within the Arctic states' mining industry and its potential to supply critical minerals to the region and the world. This report aims to explore current mining activities, future projects and potential in critical raw materials production in the Arctic, and its relevance and significance for the global critical raw materials needs.

Governments around the world are racing to develop strategies to ensure a just energy transition and critical raw materials will play a key role here.

For the Arctic this mean massive opportunities to develop remote communities with new infrastructure and create local jobs. The region is already home to some of the world's leading mining companies.

The Arctic region has stable and robust environmental and ethical regulations. There is a history of indigenous participation in the mining industry with local variations throughout the region. Furthermore, many of the Arctic states are frontrunners in circularity and recycling.

In the future, the Arctic could be at the forefront of new ways of mining. In Northern Sweden, the steel industry is converting to fossil-free production and mining is becoming a part of a battery production cluster.

In Arctic Canada and Alaska, models of Indigenous co-ownership and collaboration in mines have been in the spotlight for many years.

Exploration and extraction projects are already underway, with the ambition to mine new types of minerals, like the first rare earth elements deposit in Europe in Kiruna, Sweden.

Critical raw materials projects are also promoted and facilitated by blooming critical raw materials strategies, focusing on better and faster opening of new mines.

The Arctic region has historically seen the exploitation of mines on its territory, with local companies established for sometimes centuries, providing minerals for the region and the entire world.

Northern territories are endowed with a rich subsoil with plentiful mineral resources, including significant quantities of raw materials that are deemed critical in most of the Arctic and observer countries.

The structure of the report is first an introduction to critical raw materials overall followed by brief introduction to each Arctic state's work on mining. In the end recommendations are stated based on the challenges at hand.



*According to IEA To reach net zero emissions by 2050 (NZE) global EV sales are set to grow fivefold to 70 million by 2030.*

*The demand for critical minerals will nearly triple by 2030 and grow to over 3.5 times the current levels by 2050.*

*In a NZE Scenario, demand for copper rises by 50% by 2040, while demand for nickel, cobalt and rare earth elements doubles, and graphite demand increases by four times over the same period, propelled by the substantial increase in battery deployment for EVs and grid storage.*

*Of all the minerals, lithium stands out in this scenario with eightfold growth by 2040, highlighting its crucial role in batteries.*

*The combined market value of key energy transition minerals more than doubles by 2040 in climate-driven scenarios, reaching USD 770 billion in the NZE Scenario.*

*The current investments and expected volumes of several critical minerals are far from guaranteed and meeting the requirements for an NZE Scenario.*

*International Energy Agency  
Global Critical Minerals outlook 2024*

---



# A REGION OF MINING OPPORTUNITIES



## Largest gold deposit in Europe

Suurikuusikko at Kittilä mine is the largest gold deposit located in central Finnish Lapland



## Largest nickel and cobalt deposits

Greenland contains one of the largest sources of nickel and cobalt.



## Largest zinc mine in the world

One of the world's largest zinc mines in the world is in Alaska.

In 1982, Red Dog Operations was established through a unique operating agreement between the operator Teck and NANA, a Regional Alaska Native corporation owned by the Iñupiat people of northwest Alaska

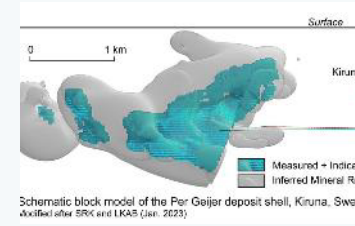


## Largest iron mine Europe/ North America

The largest iron mine in Europe is located in the Arctic.

The Kiruna mine opened in 1898.

One of world's richest reserves of high-grade iron are located in Nunavut



## Largest REE deposits in Europe

Norway and Sweden are home to some of the largest Rare Earth Element deposits in the world.



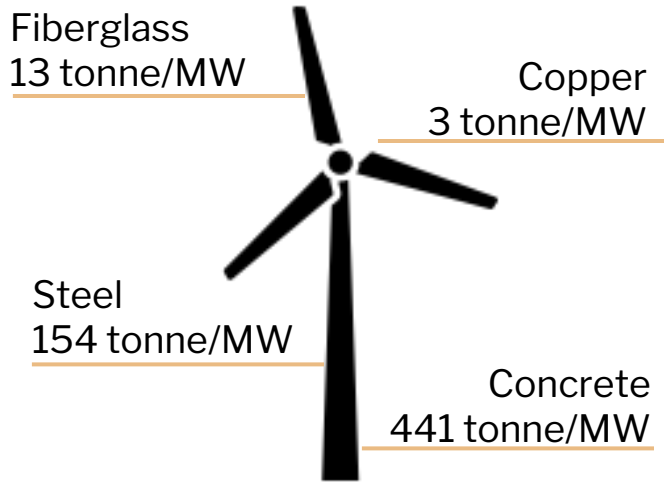
## Largest producer of palladium

Nornickel is the largest palladium producer. The Norilsk-Talnakh area in the North of Siberia.

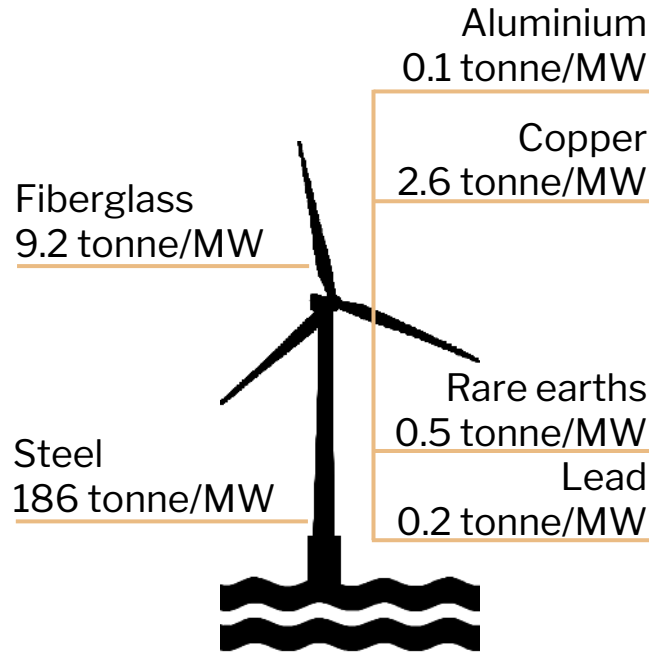


TEMPERATURES RISE **4X AS FAST** IN THE ARCTIC

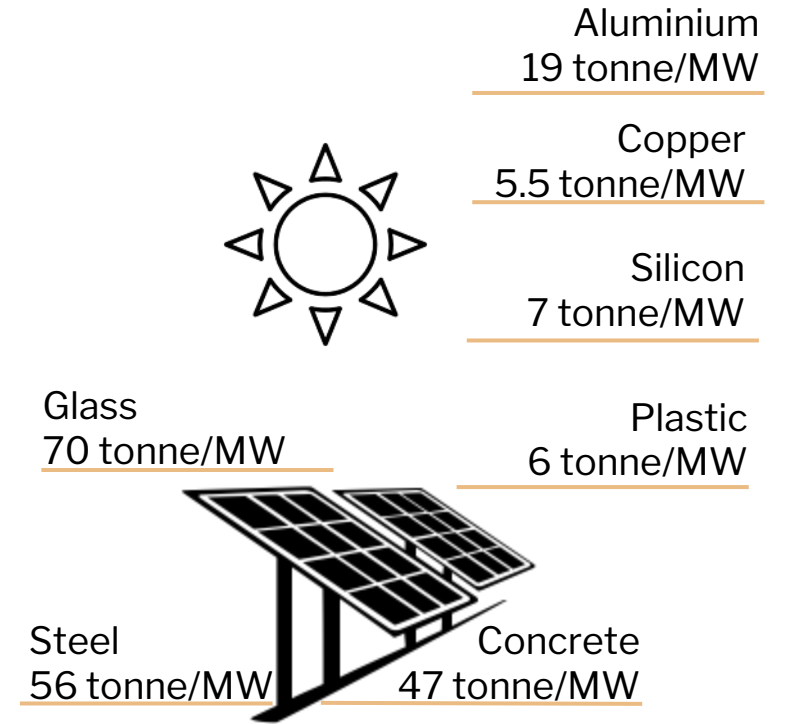
# RAW MATERIALS NEEDED IN RENEWABLES



**Onshore wind**



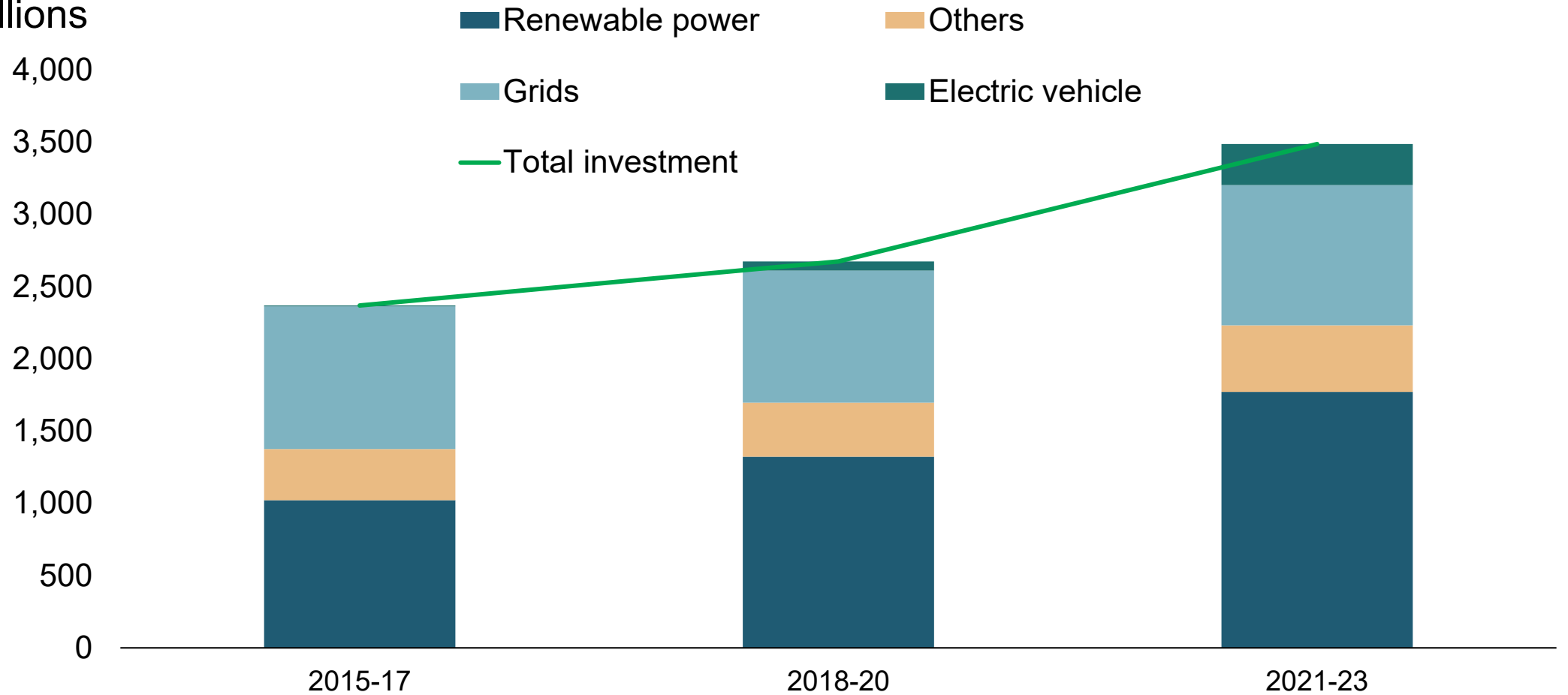
**Offshore wind**



**Solar**

# GLOBAL CLEAN ENERGY INVESTMENT

US\$, billions



# INDIGENOUS PERSPECTIVES

---



*In 2019 a working group of the Arctic Council on Conservation of the Arctic Flora and Fauna CAFF prepared a report on how to integrate biodiversity considerations into mining operations in the Arctic. A report that strongly focused on Indigenous peoples perspectives mining operations.*

*One of the main challenges of mining in the Arctic is associated with balancing resource extraction and environmental protection, the main position of Indigenous peoples on mining, emphasizes the need for meaningful engagement and respect for traditional knowledge.*

*Indigenous communities recognize the potential economic benefits from mining but express concerns about its impacts on biodiversity, food security, and traditional ways of life. They advocate for early involvement in the decision-making process, co-management of resources, and long-term agreements that ensure their cultural practices and the environment are protected.*

*The importance of trust-building, partnerships, and agreements, such as **Impact and Benefit Agreements (IBAs)**, is highlighted to ensure that Indigenous communities have a voice in mining projects. This includes the need for transparent communication, recognition of Indigenous rights, and integration of their knowledge systems alongside scientific methods.*

# Mainstreaming BIODIVERSITY in Arctic Mining Challenges and Proposed Solutions





# CANADA

---

# CANADA'S CRITICAL RAW MATERIALS

**Periodic Table of the Elements**

1 IA 1A <b>H</b> Hydrogen 1.008	2 IIA 2A <b>He</b> Helium 4.003																
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012											5 <b>B</b> Boron 10.811	6 <b>C</b> Carbon 12.011	7 <b>N</b> Nitrogen 14.007	8 <b>O</b> Oxygen 15.999	9 <b>F</b> Fluorine 18.998	10 <b>Ne</b> Neon 20.180
11 <b>Na</b> Sodium 22.990	12 <b>Mg</b> Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 9	10 VIII 10	11 IB 1B	12 IIB 2B	13 <b>Al</b> Aluminum 26.982	14 <b>Si</b> Silicon 28.086	15 <b>P</b> Phosphorus 30.974	16 <b>S</b> Sulfur 32.065	17 <b>Cl</b> Chlorine 35.453	18 <b>Ar</b> Argon 39.948
19 <b>K</b> Potassium 39.098	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.956	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.942	24 <b>Cr</b> Chromium 51.996	25 <b>Mn</b> Manganese 54.938	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933	28 <b>Ni</b> Nickel 58.693	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.631	33 <b>As</b> Arsenic 74.922	34 <b>Se</b> Selenium 78.971	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 83.798
37 <b>Rb</b> Rubidium 85.468	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.906	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.906	42 <b>Mo</b> Molybdenum 95.95	43 <b>Tc</b> Technetium 98.907	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.906	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.868	48 <b>Cd</b> Cadmium 112.414	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.711	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.905	54 <b>Xe</b> Xenon 131.294
55 <b>Cs</b> Cesium 132.905	56 <b>Ba</b> Barium 137.328	57-71 Lanthanide Series	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.948	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.25	77 <b>Ir</b> Iridium 192.222	78 <b>Pt</b> Platinum 195.085	79 <b>Au</b> Gold 196.967	80 <b>Hg</b> Mercury 200.592	81 <b>Tl</b> Thallium 204.383	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.980	84 <b>Po</b> Polonium [209]	85 <b>At</b> Astatine [210]	86 <b>Rn</b> Radon [222]
87 <b>Fr</b> Francium [223]	88 <b>Ra</b> Radium [226]	89-103 Actinide Series	104 <b>Rf</b> Rutherfordium [261]	105 <b>Db</b> Dubnium [262]	106 <b>Sg</b> Seaborgium [266]	107 <b>Bh</b> Bohrium [264]	108 <b>Hs</b> Hassium [265]	109 <b>Mt</b> Meitnerium [268]	110 <b>Ds</b> Darmstadtium [281]	111 <b>Rg</b> Roentgenium [280]	112 <b>Cn</b> Copernicium [285]	113 <b>Nh</b> Nihonium [284]	114 <b>Fl</b> Flerovium [289]	115 <b>Mc</b> Moscovium [289]	116 <b>Lv</b> Livermorium [293]	117 <b>Ts</b> Tennessine [294]	118 <b>Og</b> Oganesson [294]
		57 <b>La</b> Lanthanum 138.905	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.242	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.055	71 <b>Lu</b> Lutetium 174.967	
		89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [252]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]	

© 2017 The McGraw-Hill Companies

Baryte	Bauxite	Borate	Coking Coal	Diamonds	Electrical Steel
Feldspar	Fluorspar	Groundwater	Natural gas	Oil	Phosphate Rock
Potash	Pure quartz raw materials	Rare earth elements (heavy)	Rare earth elements (light)	Silicon Carbide	

**Legend:**

- most significant CRM for Canada's economic growth
- Canada's CRM

# CANADIAN MINING GROUPS INVOLVING INUIT COMMUNITIES

Agnico Eagle Mines Limited (Agnico Eagle) is a Canadian based and led senior gold mining company and the third largest gold producer in the world, producing precious metals from operations in Canada, Australia, Finland and Mexico with close to 16,000 employees globally.

Agnico Eagle is deeply committed to and active in Canada's North with two mines in Nunavut – Meadowbank Complex and Meliadine mine in the Kivalliq region – and the Hope Bay project in the Kitikmeot region. They believe in the long-term potential of Nunavut, as have **invested over \$9.9 billion since 2007** to build their Nunavut platform.

Agnico Eagle has developed an ESG strategy that encompasses both environmental sustainability goals, and indigenous and community participation and benefit sharing initiatives.

Following their ESG objectives, they have developed a Climate Change Strategy which is still an interim goal only, but they have completed a Climate change report for the first time in their history. The company is **seeking to achieve carbon neutrality by 2050**.

Regarding indigenous involvement and collaboration, they've "continued to adapt (their) processes based on feedback from Indigenous groups and governments".

It is important to note that Agnico Eagle signed an **Inuit Impact and Benefit Agreement for the Meadowbank mine with the local Kivalliq Inuit Association**, meaning that they need to ensure that work and education opportunities are available to the local Inuit population.

Today the employee base includes **over 400 Inuit employees and millions of dollars per year is invested in training**.

They've also committed to community development by implementing further internal training and "a scholarship development program targeted to advance women into leadership roles".

**Agnico Eagle's two active mines account for 22% of Nunavut GDP** and the company employs over 3500 people and is the Territory's largest private sector partner. Since 2007, Agnico Eagle has spent over \$5.2B with Inuit owned business.

# GREENLAND (KINGDOM OF DENMARK)

---

# GREENLAND'S CRITICAL RAW MATERIALS (EU LIST)

**Periodic Table of the Elements**

The periodic table shows the following color-coding for elements:

- Blue (CRM that are also strategic):** B, C, Al, Si, P, S, Cl, Ar, Ga, Ge, As, Se, Br, Kr, In, Sn, Sb, Te, I, Xe, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Rn, Rf, Db, Sg, Bh, Hs, Mt, Ds, Rg, Cn, Nh, Fl, Mc, Lv, Ts, Og.
- Orange (EU CRM):** Li, Be, Na, Mg, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr, In, Sn, Sb, Te, I, Xe, Cs, Ba, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, Fr, Ra, Rb, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe.
- Dark Blue (Materials that are only strategic):** Ni, Cu, Pt, Au, Pd, Rh, Ru, Ir, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr, In, Sn, Sb, Te, I, Xe.

**Lanthanide Series:** La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu.

**Actinide Series:** Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr.

© 2017 Royal Holstenline  
www.holstenline.org

**Legend:**

- CRM that are also strategic
- EU CRM
- Materials that are only strategic

Baryte	Bauxite	Borate	Coking Coal	Diamonds	Electrical Steel
Feldspar	Fluorspar	Groundwater	Natural gas	Oil	Phosphate Rock
Potash	Pure quartz raw materials	Rare earth elements (heavy)	Rare earth elements (light)	Silicon Carbide	



# CUTTING-EDGE TECHNOLOGY AND MILLIONAIRES IN GREENLAND

The Disko/Nuussuaq project is an exploration project on the Southwest coast of Greenland, which covers an area of 2,776 km<sup>2</sup> - equivalent to the size of Luxembourg.

It hosts deposits of nickel, copper, platinum group metals and cobalt, all of which are generally considered to be critical raw materials.

Its potential has been confirmed by over 30 years long explorations by Cominco and Falconbridge. The area shows similarities with the Norilsk-Talnakh mine in Siberia, which is the world's largest nickel-copper sulphide mine.

This project was initiated by the London-officed Bluejay Mining company, which focuses on projects in Greenland and Finland.

For the Disko-Nuussuaq project, their exploration process is funded by KoBold Metals, a mineral exploration company whose some of its biggest investors include the climate and technology fund Breakthrough Energy Ventures, with billionaire contributors Bill Gates, Micheal Bloomberg and Jeff Bezos backing it.

In 2021, KoBold was acknowledged as a Technology Pioneer by the World Economic Forum and was listed by CB Insights as one of the 100 most promising private artificial intelligence companies globally—the only one from the mining industry.

This company is a pioneer in using AI and machine learning in raw materials exploration and invested USD15 million in the exploration of the Disko project.



# FINLAND

---

# FINLAND'S CRITICAL RAW MATERIALS (EU LIST)

- CRM that are also strategic
- EU CRM
- Materials that are only strategic

Periodic Table of the Elements

The periodic table shows the following color-coding for elements:

- Light Blue (CRM that are also strategic):** B, Si, Al, Ga, In, Tl, Sn, Pb, Bi, Po, At, Rn, Fr, Ra, Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr.
- Orange (EU CRM):** Li, Be, Na, Mg, Ca, Sr, Ba, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, Hg, Pt, Au, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hf, Ta, W, Re, Os, Ir, Pt, Au.
- Dark Blue (Materials that are only strategic):** Fe, Co, Ni, Cu, Zn, Mn, Cr, V, Ti, Sc, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, Hg, Pt, Au, Hf, Ta, W, Re, Os, Ir, Pt, Au.

Baryte	Bauxite	Borate	Coking Coal	Diamonds	Electrical Steel
Feldspar	Fluorspar	Groundwater	Natural gas	Oil	Phosphate Rock
Potash	Pure quartz raw materials	Rare earth elements (heavy)	Rare earth elements (light)	Silicon Carbide	

# SHIFTING TO CRITICAL MINING: REVITALISATION AS AN OPTION

The Hautalampi project is a nickel-cobalt-copper underground mine in Finland.

The new project is located in the Outokumpu mining camp area, on historic Keretti mining grounds that has been developed during 1980s. The municipality has evolved from a mining town into a prominent industrial machinery and manufacturing center and has a lot of available infrastructure in place. There is a strong local support for mining activities as Finland consistently ranks at the top of the of mining jurisdictions

The pre-feasibility study has demonstrated a strong economic outlook. And now the project is being developed by FinnCobalt and Eurobattery Minerals, a company from Sweden that is active in mining operations and targets critical raw materials production for electric vehicle battery manufacturing.

It is an example of the possible revitalisation of old mining sites, as the demand for minerals has shifted towards said “critical” and “strategic” minerals.

FinnCobalt’s goal is to “produce traceable and responsible copper and nickel chemicals for the battery industry”, an industry which is quickly growing in Arctic Sweden and should soon be an important industry in Finland as well (FREYR’s Giga Factory project in Vaasa, Arctic Finland).

In January 2024, FinnCobalt was preparing the environmental permit application.



Photo credit: Euro Battery Minerals



# ICELAND

---



# ICELANDIC INVESTORS IN GREENLAND

## Case study: Amaroq Minerals

Amaroq Minerals is a Greenland-focussed mining company engaged in the identification, acquisition, exploration and development of gold properties and other strategic mineral assets in Greenland. The CEO and founder is Eldur Ólafsson from Iceland.

The Company's licence portfolio covers an area of 6,072.5Km<sup>2</sup> in South Greenland. The Company's asset closest to production is the past-producing Nalunaq gold mine, which Amaroq is in the process of redeveloping.

Mr Ólafsson started to research the mineral potential in Greenland in 2012 at a time when commodity prices were falling and several companies were pulling out of Greenland. Falling commodity prices often lead to companies stopping to research for new opportunities. Instead they either keep their current mines running or close them down all together.

However, with new technologies such as satellites Mr Ólafsson believes that their work can be done more cost effective.



Source: <https://www.amaroqminerals.com/>

# NORWAY

---

# NORWAY'S CRITICAL RAW MATERIALS (EU LIST)

- CRM that are also strategic
- EU CRM
- Materials that are only strategic

Periodic Table of the Elements

The periodic table shows the following color-coding for elements:

- Light Blue (CRM that are also strategic):** B, Al, Si, Ga, Ge, As, Se, Te, Bi, Pb, Po, At, Rn, Cs, Ba, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr.
- Orange (EU CRM):** Li, Be, Na, Mg, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr, Rb, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, Cs, Ba, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, Fr, Ra, Rf, Db, Sg, Bh, Hs, Mt, Ds, Rg, Cn, Nh, Fl, Mc, Lv, Ts, Og.
- Dark Blue (Materials that are only strategic):** Ni, Cu, Zn, Ga, Ge, As, Se, Te, Bi, Pb, Po, At, Rn, Cs, Ba, Sr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr.

© 2017 Todd Helmenstein  
astheweb.com

Baryte	Bauxite	Borate	Coking Coal	Diamonds	Electrical Steel
Feldspar	Fluorspar	Groundwater	Natural gas	Oil	Phosphate Rock
Potash	Pure quartz raw materials	Rare earth elements (heavy)	Rare earth elements (light)	Silicon Carbide	

# THE WORLD'S FIRST CARBON-FREE IRON ORE MINE

## Case study: Rana Gruber

Rana Gruber has been exploiting mines North-east of Mo I Rana (Nordland, Northern Norway) for 60 continuous years, extracting iron ore in their different deposits. In 2023, Rana Gruber produced a record-high of 1.8 million metric tonnes of iron ore concentrates, all of which were exported, mainly to Europe. With numbers continuously growing, Rana Gruber employed 372 people, which are only a fraction of a dynamic **industry cluster of approximately 2500 employees.**

**In 2023, Rana Gruber's carbon emissions were equal to 7.17 kg CO2 equivalents per tonne iron ore they produced.** The company has overtime been able to become one of the world's least CO2 intensive iron ore producers. Thanks to hydropower, the processing of their iron ore is already relying on green energy.

The mines are also quickly connected to the port of Gullsmedvik and to the railway, which is an infrastructure that Rana Gruber relies on to transport their products. The mining company supports the **railway's electrification process, in their ambition to be truly carbon free.** The tracks are state-owned, but their electrification is considered by the government.

Rana Gruber's ambition is to become **the first iron ore mining company that is entirely carbon-free by 2025.** Therefore, they have started a large-scale electrification of their entire machinery and transport.

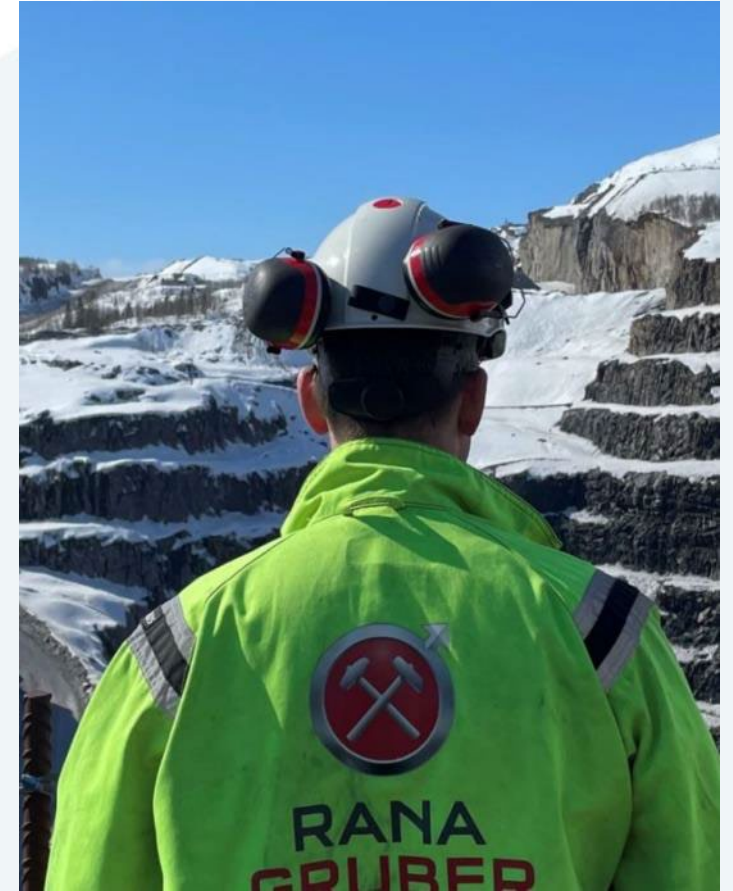


Photo credit: Rana Gruber

# RUSSIA

---

# RUSSIA'S CRITICAL RAW MATERIALS

■ Rare metals  
■ Russia's CRM

**Periodic Table of the Elements**

The periodic table shows elements color-coded as follows: Rare metals (blue) and Russia's CRM (orange). CRM elements include Potassium (K), Calcium (Ca), Scandium (Sc), Titanium (Ti), Vanadium (V), Chromium (Cr), Manganese (Mn), Iron (Fe), Cobalt (Co), Nickel (Ni), Copper (Cu), Zinc (Zn), Gallium (Ga), Germanium (Ge), Arsenic (As), Selenium (Se), Bromine (Br), Krypton (Kr), Rubidium (Rb), Strontium (Sr), Yttrium (Y), Zirconium (Zr), Niobium (Nb), Molybdenum (Mo), Ruthenium (Ru), Rhodium (Rh), Palladium (Pd), Silver (Ag), Cadmium (Cd), Indium (In), Tin (Sn), Antimony (Sb), Tellurium (Te), Iodine (I), Xenon (Xe), Cesium (Cs), Barium (Ba), Hafnium (Hf), Tantalum (Ta), Tungsten (W), Rhenium (Re), Osmium (Os), Iridium (Ir), Platinum (Pt), Gold (Au), Mercury (Hg), Thallium (Tl), Lead (Pb), Bismuth (Bi), Polonium (Po), Astatine (At), Radon (Rn), Francium (Fr), Radium (Ra), Rutherfordium (Rf), Dubnium (Db), Seaborgium (Sg), Bohrium (Bh), Hassium (Hs), Meitnerium (Mt), Darmstadtium (Ds), Roentgenium (Rg), Copernicium (Cn), Nihonium (Nh), Flerovium (Fl), Moscovium (Mc), Livermorium (Lv), Tennessine (Ts), and Oganesson (Og). Lanthanide and Actinide series are also shown at the bottom.

Baryte	Bauxite	Borate	Coking Coal	Diamonds	Electrical Steel
Feldspar	Fluorspar	Groundwater	Natural gas	Oil	Phosphate Rock
Potash	Pure quartz raw materials	Rare earth elements (heavy)	Rare earth elements (light)	Silicon Carbide	



# LAUNCHES SULFUR PROGRAM AFTER HISTORIC FINE FOR ARCTIC FUEL SPILL

Nornickel the world's leading producer of palladium and metallic nickel and a major global producer of platinum and copper. Its main operations are located in the Arctic in Norilsk, Taimyr peninsular and in Murmansk region on Kola peninsular. The company also runs a nickel refinery through its subsidiary in Harjavalta, Finland which is the one of the largest facilities of this kind in Europe.

## **Nornickel Faces Historic \$2 Billion Fine for 21,000-Ton Diesel Spill in Arctic**

In 2020 an aging fuel tank at a Nornickel subsidiary power plant collapsed near the city of Norilsk causing 21,000 tons of diesel fuel leak into the Ambarnaya and Daldykan rivers as well as surrounding waterways and soil. The state of emergency was declared in the region. Following this incident, Nornickel faced a the largest compensation for environmental damage in Russia's history. In early 2021, the company had to pay 146 billion rubles (\$2 bil)

for the environmental damage caused. Oil spill clean up and land remediation took two years.

## **Sulphur programme in Norilsk**

Norilsk is a mining city located north of the Arctic Circle on the Taymyr Peninsula, with a population of around 180,000 people. For many years, it has been among the top ten most polluted cities because of its large metal smelting complex, which annually releases roughly 1.8 million tons of sulfur dioxide (SO<sub>2</sub>).

In 2023, Nornickel launched the Sulfur Program, an initiative to capture SO<sub>2</sub> emissions at the Nadezhda Smelter facilities in Norilsk. This project utilizes a technological process that converts sulfur dioxide into sulfuric acid. The acid is then neutralized using limestone to produce gypsum waste, which is safely managed within a designated storage facility.

In 2023 Nornickel has reconfigured its metallurgical processes, established an advanced facility for SO<sub>2</sub> utilization, and constructed essential infrastructure, trained and hired approximately 500 new personnel.

By 2025, it is expected that the smelter will reduce O<sub>2</sub> emissions by 45% compared to 2015 levels.

Originally the Sulphur programme began on the Kola Peninsula. In 2021, the optimization of smelting operations along the Russia-Norway border and shutdown of the obsolete smelting shop in Nickel led to a 90% reduction in SO<sub>2</sub> emissions compared to 2015.

Nornickel's total investment in the full implementation of the Sulfur Program will amount to RUB 180 billion (\$2 billion).

# SWEDEN

---

# SWEDEN'S CRITICAL RAW MATERIALS (EU LIST)

- CRM that are also strategic
- EU CRM
- Materials that are only strategic

**Periodic Table of the Elements**

1 1A 1A <b>H</b> Hydrogen 1.008	2 2A 2A <b>He</b> Helium 4.003																
3 <b>Li</b> Lithium 6.941	4 2A 2A <b>Be</b> Beryllium 9.012											5 3A 3A <b>B</b> Boron 10.811	6 4A 4A <b>C</b> Carbon 12.011	7 5A 5A <b>N</b> Nitrogen 14.007	8 6A 6A <b>O</b> Oxygen 15.999	9 7A 7A <b>F</b> Fluorine 18.998	10 8A 8A <b>Ne</b> Neon 20.180
11 <b>Na</b> Sodium 22.990	12 2A 2A <b>Mg</b> Magnesium 24.305	3 3B 3B <b>Sc</b> Scandium 44.956	4 4B 4B <b>Ti</b> Titanium 47.867	5 5B 5B <b>V</b> Vanadium 50.942	6 6B 6B <b>Cr</b> Chromium 51.996	7 7B 7B <b>Mn</b> Manganese 54.938	8 8 8 <b>Fe</b> Iron 55.845	9 8 8 <b>Co</b> Cobalt 58.933	10 8 8 <b>Ni</b> Nickel 58.693	11 9B 9B <b>Cu</b> Copper 63.546	12 10B 10B <b>Zn</b> Zinc 65.38	13 3A 3A <b>Al</b> Aluminum 26.982	14 4A 4A <b>Si</b> Silicon 28.086	15 5A 5A <b>P</b> Phosphorus 30.974	16 6A 6A <b>S</b> Sulfur 32.066	17 7A 7A <b>Cl</b> Chlorine 35.453	18 8A 8A <b>Ar</b> Argon 39.948
19 <b>K</b> Potassium 39.098	20 2A 2A <b>Ca</b> Calcium 40.078	21 3B 3B <b>Sc</b> Scandium 44.956	22 4B 4B <b>Ti</b> Titanium 47.867	23 5B 5B <b>V</b> Vanadium 50.942	24 6B 6B <b>Cr</b> Chromium 51.996	25 7B 7B <b>Mn</b> Manganese 54.938	26 8 8 <b>Fe</b> Iron 55.845	27 8 8 <b>Co</b> Cobalt 58.933	28 9 9 <b>Ni</b> Nickel 58.693	29 9B 9B <b>Cu</b> Copper 63.546	30 10B 10B <b>Zn</b> Zinc 65.38	31 3A 3A <b>Ga</b> Gallium 69.723	32 4A 4A <b>Ge</b> Germanium 72.631	33 5A 5A <b>As</b> Arsenic 74.922	34 6A 6A <b>Se</b> Selenium 78.971	35 7A 7A <b>Br</b> Bromine 79.904	36 8A 8A <b>Kr</b> Krypton 83.798
37 <b>Rb</b> Rubidium 85.468	38 2A 2A <b>Sr</b> Strontium 87.62	39 3B 3B <b>Y</b> Yttrium 88.906	40 4B 4B <b>Zr</b> Zirconium 91.224	41 5B 5B <b>Nb</b> Niobium 92.906	42 6B 6B <b>Mo</b> Molybdenum 95.95	43 7B 7B <b>Tc</b> Technetium 98.907	44 8 8 <b>Ru</b> Ruthenium 101.07	45 9 9 <b>Rh</b> Rhodium 102.906	46 10 10 <b>Pd</b> Palladium 106.42	47 9B 9B <b>Ag</b> Silver 107.868	48 10B 10B <b>Cd</b> Cadmium 112.414	49 3A 3A <b>In</b> Indium 114.818	50 4A 4A <b>Sn</b> Tin 118.710	51 5A 5A <b>Sb</b> Antimony 121.760	52 6A 6A <b>Te</b> Tellurium 127.6	53 7A 7A <b>I</b> Iodine 126.904	54 8A 8A <b>Xe</b> Xenon 131.294
55 <b>Cs</b> Cesium 132.905	56 2A 2A <b>Ba</b> Barium 137.328	57-71 Lanthanide Series	72 4B 4B <b>Hf</b> Hafnium 178.49	73 5B 5B <b>Ta</b> Tantalum 180.948	74 6B 6B <b>W</b> Tungsten 183.84	75 7B 7B <b>Re</b> Rhenium 186.207	76 8 8 <b>Os</b> Osmium 190.23	77 9 9 <b>Ir</b> Iridium 192.217	78 10 10 <b>Pt</b> Platinum 195.085	79 9B 9B <b>Au</b> Gold 196.967	80 10B 10B <b>Hg</b> Mercury 200.592	81 3A 3A <b>Tl</b> Thallium 204.383	82 4A 4A <b>Pb</b> Lead 207.2	83 5A 5A <b>Bi</b> Bismuth 208.980	84 6A 6A <b>Po</b> Polonium [209]	85 7A 7A <b>At</b> Astatine [210]	86 8A 8A <b>Rn</b> Radon [222]
87 <b>Fr</b> Francium [223]	88 2A 2A <b>Ra</b> Radium [226]	89-103 Actinide Series	104 4B 4B <b>Rf</b> Rutherfordium [261]	105 5B 5B <b>Db</b> Dubnium [262]	106 6B 6B <b>Sg</b> Seaborgium [266]	107 7B 7B <b>Bh</b> Bohrium [264]	108 8 8 <b>Hs</b> Hassium [269]	109 9 9 <b>Mt</b> Meitnerium [278]	110 10 10 <b>Ds</b> Darmstadtium [281]	111 9B 9B <b>Rg</b> Roentgenium [280]	112 10B 10B <b>Cn</b> Copernicium [285]	113 3A 3A <b>Nh</b> Nihonium [286]	114 4A 4A <b>Fl</b> Flerovium [289]	115 5A 5A <b>Mc</b> Moscovium [289]	116 6A 6A <b>Lv</b> Livermorium [293]	117 7A 7A <b>Ts</b> Tennessine [294]	118 8A 8A <b>Og</b> Oganesson [294]
57 Lanthanide Series <b>La</b> Lanthanum 138.905	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.242	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.055	71 <b>Lu</b> Lutetium 174.967			
89 Actinide Series <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.046	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]			

Baryte	Bauxite	Borate	Coking Coal	Diamonds	Electrical Steel
Feldspar	Fluorspar	Groundwater	Natural gas	Oil	Phosphate Rock
Potash	Pure quartz raw materials	Rare earth elements (heavy)	Rare earth elements (light)	Silicon Carbide	

© 2017 Udo K. Heilmann  
u.k.heilmann@swedishcouncil.org

# A FUTURE OF FOSSIL-FREE IRON ORE AND STEEL PRODUCTION?

## Case study: LKAB's HYBRIT Project

The HYBRIT project is a joint initiative led by LKAB, state-owned leading mine company in Northern Sweden, SSAB and Vattenfall and partly funded by the Swedish Energy Agency and the EU's Innovation fund. Its goal is to produce the world's first fossil-free iron ore and steel by 2026.

HYBRIT stands for Hydrogen Breakthrough Ironmaking Technology and is aiming to revolutionise steel production throughout the whole value chain, by changing the energy sources used during the production process. The production will rely on a direct reduction process using hydrogen produced with hydropower electricity instead of carbon and coke.

So far, a pilot direct reduction plant was built and is operating in Luleå since 2020. On LKAB's Malmberget site in Kiruna municipality, the world's first fossil-free iron ore pellets were produced at the end of 2020.

The last development in the project was the confirmation that the demonstration plant will be built in Vitåfors, Gällivare municipality, where hydrogen production, and the manufacturing of sponge iron using hydrogen-powered direct reduction will take place

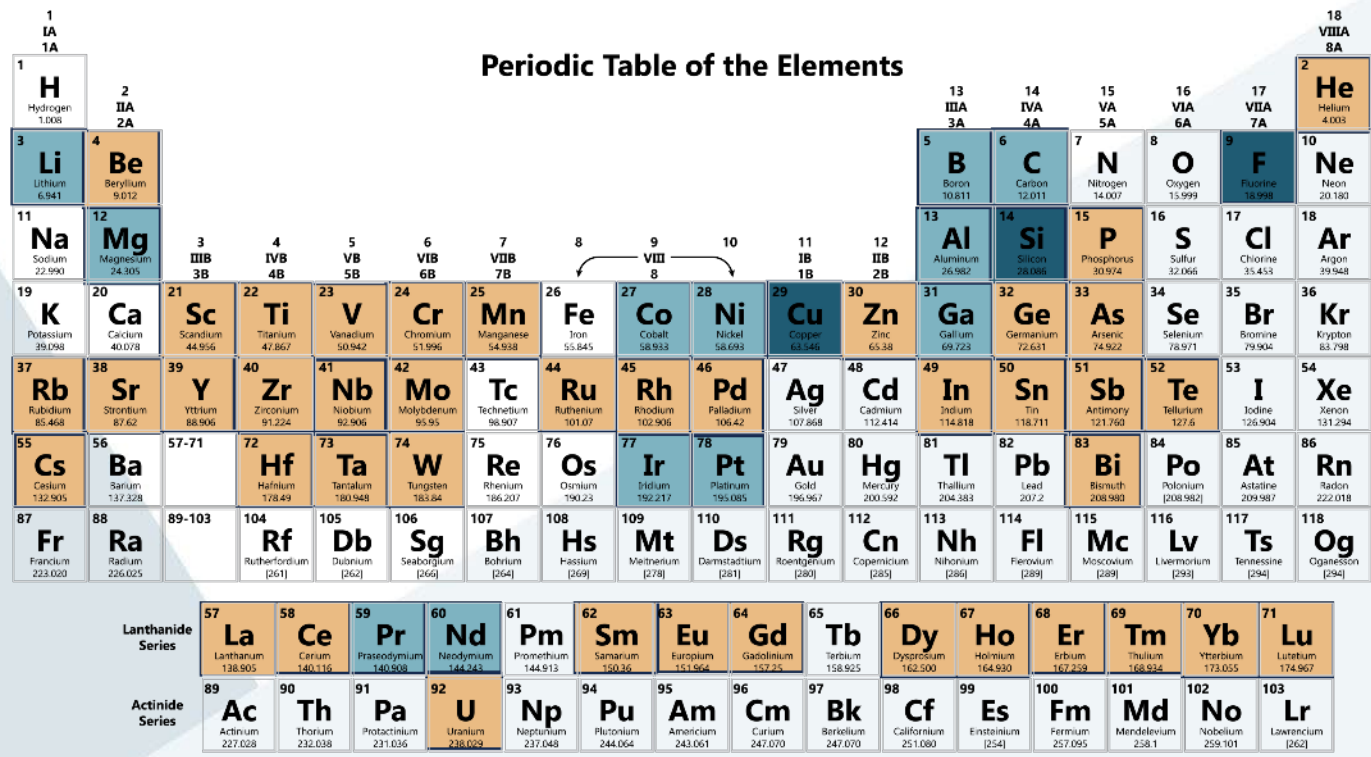


# ALASKA (USA)

---

# THE USA'S CRITICAL RAW MATERIALS

- CRM that are also critical for energy
- USA CRM
- Materials that are only critical for energy



Baryte	Bauxite	Borate	Coking Coal	Diamonds	Electrical Steel
Feldspar	Fluorspar	Groundwater	Natural gas	Oil	Phosphate Rock
Potash	Pure quartz raw materials	Rare earth elements (heavy)	Rare earth elements (light)	Silicon Carbide	

© 2017 Todd Holmes/Info. @aenormis.org



# A WORLD-RENOWNED EXAMPLE OF INDIGENOUS-INDUSTRIAL PARTNERSHIP

## Case study: Red Dog Operations

The Red Dog mine is one of the largest zinc mines in the world, located near Kotzebue, in northwest Alaska. The mine was created through an agreement between Teck Resources, a Canadian mining company, and NANA, a regional for-profit Alaska Native Corporation.

NANA is owned by Iñupiaq shareholders from 11 different communities, who live in or have ties with the region. This partnership is innovative and original in the way the indigenous communities are involved with mining, since NANA owns the mine and concentrator properties.

Teck Resources distributes its profits and gives hiring preference to NANA shareholders and their families. Additionally, NANA plays a role in overseeing the mine's operations as a partner.

Since mining started, NANA has received more than \$1.2 billion in royalties from Red Dog and, based on requirements in the Native claims settlement act, has shared another \$2 billion with other Indigenous owned corporations. The mine has contributed over quarter of the wage and in the local borough. Further more, it subsidises community stores and fuel businesses.

In 2020, 55% of employees were NANA shareholders, That same year, Red Dog also started an Accelerated Leadership Development Program, which was put into place to promote shareholder-employees to more senior roles within the company. The program was successful and therefore extended in 2022, following the organisation's goal to have a workforce of 100% local indigenous community workers.

The mine has been in operation since 1989 producing zinc, and also lead. Its exploitation is expected to last until 2031.

Putting new deposits that are about 10 miles away from the current site will allow to keep the production going for many decades. However, federal environmental permits to access the area have been delayed. A state agency's plan to build a new industrial road across remote Northwest Alaska to connect mining deposits have been rejected.

The majority of NANA shareholders support continued mining in the Red Dog area.

# RECOMMENDATIONS

# RECOMMENDATIONS INTRO

Given that most mines are polymetallic and that technology driving demand for minerals to power the energy transition is evolving rapidly, it is vital that we ensure policies designed to support the development of critical minerals in the Arctic take a broad lens and support the entire mining sector.

For a holistic strategy on critical minerals to succeed, Arctic governments will need to harness the skills and experience of its mining sector and supporting industries, which is world-renowned for its technical expertise, skilled workforce, capacity for innovation and globally recognized approach to sustainability and community relations.

Junior mining companies can play a role in the development of the critical minerals, but without the knowledge and investment of the larger established mining companies with experience in developing, operating and closing mines, there is a risk that many critical mineral projects won't get off the ground.

Global efforts have focused on enabling the construction of downstream battery facilities and retooling factories to make them ready for the future. While these are important investments, the upstream component of that supply chain – the mines that provide the minerals – also need support.

Innovative Arctic companies are creating and deploying new technologies and leading-edge expertise to mining operations around the world leading to billions in exports of mining technology and services.

# HOW TO START UP CRM IN THE ARCTIC



**SPEED**



**SKILLS**



**SCALE**



**STRENGTHEN  
DIALOGUE**



**SECURITY**



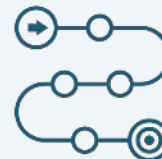
**SHOWCASE**



**SCIENCE**



**STUDY**



**STRATEGIC  
PLANING**



**SOCIAL  
LICENCE**

# HOW TO START UP CRM IN THE ARCTIC



## SPEED

Speed is of the essence and we don't have much time left if we want to achieve our climate ambitions. We must recognise that the health of the mining economy and supply chain in the Arctic, the capacity and expertise of our workforce, and well-functioning regulatory processes that offer clear and reasonable timelines are the base case for any investment in new critical mineral developments. Faster responses on decisions from the public sector is key to develop CRMs in the Arctic.

---



## SKILLS

A skilled and diverse workforce is key for the mining sector. Some mining jurisdiction puts very high demands on the need for local labour. However, that is not always possible because they compete with other sectors and because the competences might not always be there locally. In a sparsely populated region with worrying demographic trends we need to both invest in skills locally as well as attracting a workforce from outside the region. Policy makers must focus on skills development from early childhood education and onwards to further education. There should be a strong focus on vocational training and education.

---



## SCALE

Governments need to make substantial investments in building the economic backbone of roads, ports, rail, power lines and communications that will attract private investments and benefit local communities. Investments in larger infrastructure projects will make the business case stronger for mining companies.

---



## STRENGTHEN DIALOGUE

We must strengthen and ensure meaningful Indigenous and community consultation and participation to establish a comprehensive and inclusive economic, social and environmental development through the development of the critical mineral industry in the Arctic.

---



## SECURITY

Critical Raw Materials are necessary for our national security and should be seen in that prism when making decisions. For the Arctic region to remain competitive we must develop domestic level of mineral production through investments in mining and mineral processing. To make investments more secure and attractive in the Arctic, we must determine a common framework to make investments in CRM.

**Request the full version of the report via email**  
**[info@arcticeconomiccouncil.com](mailto:info@arcticeconomiccouncil.com)**





## Reach out to AEC and follow us online

