RBC
Thought
Leadership

# The New Great Game:

## How the race for critical minerals is shaping tech supremacy

# Key Findings

**Canada and the U.S. are each other's largest minerals trading partner,** amounting to C$146 billion in bilateral trade.[1]

**The U.S. is 100% import reliant** for 12 of its identified list of 50 critical minerals, and net import reliant (>50%) for 29 of those critical minerals.[2]

**China is the primary foreign source** for a quarter of the U.S.'s critical minerals.[3]

**Disruptions to the supply of critical minerals could cause material damage to the U.S. economy.** One example: a 30% supply restriction of gallium could cause a $600 billion (U.S.) decline in U.S. GDP.[4]

**Defence procurement is an underutilized source of financing** for key defence critical minerals, particularly graphite, tungsten, scandium, and gallium.

# Bedrocks of a Fourth Industrial Revolution

Minerals are the bedrock of any industrial economy. From steel to copper to aluminum, they lay the foundation of economic, civil, and defence infrastructure. And increasingly, a growing cohort of minerals underlie the critical components of the so-called Fourth Industrial Revolution — an era of disruptive technological forces driven by human-machine interaction across research, manufacturing and an ever-expanding data economy.

In this new age, the demand for that cohort of "critical minerals" will be driven by a growing use of semiconductors and data processing machines, increased adoption of battery technologies and new energy sources, and advancements in defence and aerospace technologies. For Canada, the race to develop and process these minerals is about much more than the mining sector; it underscores a new security paradigm to protect and enhance our economic and national interests in an evolving world order. Here's some of what's at stake:



## Semiconductors

The early days of generative AI are showing how much more computing power we will need. Global semiconductor sales are on pace to reach $1 trillion (U.S.) by 2030, with high-powered artificial intelligence (AI) chips likely accounting for the majority of sales.[5] To date, silicon has been the material of choice but AI is testing silicon's thermal limits. Gallium nitrade's (GaN) superior conductivity results in over 30% improvements in wafer power efficiency.[6] Palladium, arsenic, copper, and cobalt are also used in chip fabrication (plating, wiring).

## Batteries

Whether it's for EVs on the road, energy efficiency at home or long-duration storage at power generation sites, we'll need a lot more battery technology in the years ahead. An EV battery requires an average of 205 kilograms of critical minerals (or six times that of an internal combustion engine), comprised of lithium, cobalt, nickel, graphite and manganese.[7] Based on Bloomberg New Energy Finance's Economic Transition Scenario, we estimate North American battery minerals demand (transport and utility storage) is likely to increase between four to five-fold by 2040, relative to today.[8]

## Frontier energy

We're likely to see more oil and gas consumption over the next decade in North America, but we also will see much more growth in newer energy sources, including small modular nuclear reactors, geothermal, wind and solar. The rapid growth in renewable power, which is now about 15% of global power[9], is increasing the demand of a number of critical minerals. Silicon, silver and aluminum are needed for solar panels with cobalt, tellurium and rare earth elements for wind. Based on Bloomberg New Energy Finance's Economic Transition Scenario, we estimate North American renewables (solar and wind) electricity generation to at least triple on the back of increased demand for electricity by 2040, compared to 2024 levels.[10]

## Defence

The push for materially more defence and security spending across the West, including in Canada, will require a lot more heavy equipment and the materials and minerals that go into them. A typical artillery tank requires over 20 different critical minerals across navigation, communications, and combat systems,[11] while an F-35 jet relies on more than 400 kilograms of rare earth elements.[12] Batteries and semiconductors are also increasingly important to military operations, along with more traditional needs to strengthen artillery, naval and aerospace (antimony, beryllium, titanium, among others). And then there's border security; tungsten is used in automobile x-rays and germanium within thermal imaging and night vision goggles.

# A New Great Game

The battle for global tech supremacy between China and the U.S. is manifesting a critical mineral resource war, and a geopolitical great game for the 21st century that may soon rival the race for oilfields that came out of the Second World War or the competition for trade routes that shaped the 19th century.

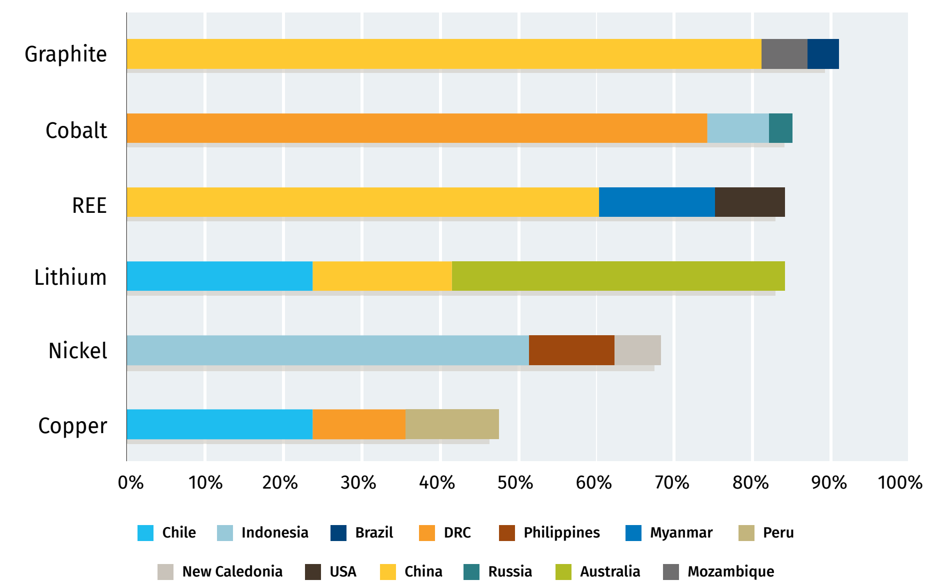
For the U.S. and its Western allies, this competition is at risk of being lost to China. In areas of EVs, renewable energy, and advanced civil and defence technologies, China is proving to be as innovative as America. Global autos rely on Chinese battery technology. Ford CEO Jim Farley views China a decade ahead on battery technology – and still innovating.[13] On defence, China can bring on new weapons systems five times as quickly as the U.S.[14]

Even more concerning is that, the U.S. has little to no presence across the critical mineral value chain. The country is 100% import reliant for almost a quarter of its identified 50 critical minerals, and over 50% import reliant on 29 minerals.[15] In many instances, that reliance is on China. The country is the primary import source for a quarter of U.S. critical minerals and is the leading global producer of 16 of the U.S.'s list of critical minerals.[16]

China has dominant positions in either the production and/or refining across the six 'core' critical minerals, i.e., lithium, graphite, cobalt, nickel, copper, and rare earth elements (REE). At the most extreme, China has 75% or more global market share of produced and refined graphite, refined rare earth elements, and refined cobalt.[17] Across the entire six minerals, China has control of, on average, two-thirds of global processing/refining output.[18]

## Critical mineral production is characterized by meaningful concentration risk

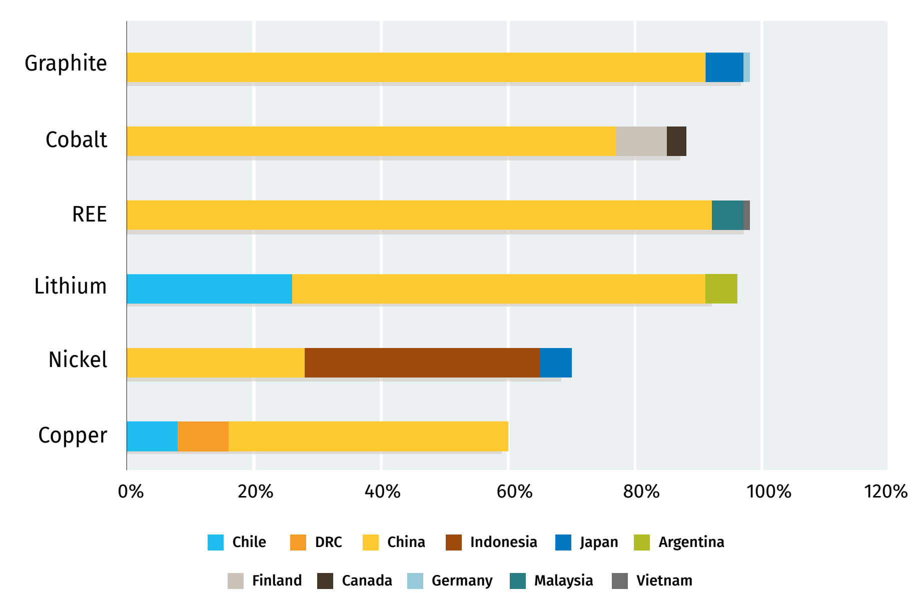
Top 3 suppliers as a percent of global supply, 2023




Source: IEA and RBC Thought Leadership

## And even more so for critical mineral refining, which is dominated by China

Top 3 suppliers as a percent of global supply, 2023




Source: IEA and RBC Thought Leadership



In foreign markets, Chinese state-owned miners have meaningful operations in Peru, the Democratic Republic of Congo and Indonesia (Chinese firms control almost 75% of Indonesia's nickel capacity).[19] The country also has established investment ties and is the largest trading partner for mineral producers/refiners across virtually every country in South America, Africa, Southeast Asia and Oceania (Australia).

**Playing catch-up in this rush for critical minerals will be difficult, and far more challenging than the West experienced with oil, for several reasons:**

1. **Exotic minerals.** Critical minerals are a varied, diverse set of both traditional and exotic minerals, with their own unique processes to both produce and refine. The process is far more complex than crude refining or natural-gas processing, which situate within a narrower molecular band of hydrogen and carbon compounds.

2. **End use matters.** In critical minerals, the end use predicates the type of production and level of refinement required. For instance, primary gallium is recovered as a byproduct of processing bauxite and even at refinement, high purity gallium is refined up to 99.99999% purity.

3. **Technology.** Decades of experience have allowed China to innovate refining techniques, such as perfecting the solvent extraction process to refine rare earth elements.

4. **Limited domestic resources.** The U.S. has limited domestic resources of critical minerals, with less than 1% of the world's reserves of cobalt, nickel and graphite and less than 2% of manganese and rare earth elements.[20]

5. **No state champions.** The Seven Sisters, ancestors of British-American siblings BP, Chevron and ExxonMobil, birthed the oil industry. The seven were provided immense political (and military) assurances to traverse foreign lands in pursuit of securing reserves. In contrast, most major North American miners have smaller global footprints relative to the U.S. oil majors, especially downstream (albeit less so for Barrick Gold, Teck Resources and First Quantum Minerals).

The U.S. will be challenged to catch up to Chinese dominance, at least on its own. As a result, it's creating new strategic spheres to secure the minerals critical to its global technological leadership, targeting resource deals – and perhaps deeper relationships – in the Ukraine, Greenland and Canada. The U.S. may even re-integrate unrestricted Russian commodities back into global markets, if that furthers its own ambitions for resource security.

Canada must be at the centre of this sphere. The country can de-risk critical mineral supply chains – reducing the reliance on China but also providing additional capacity to markets dominated by a handful of suppliers. Canada is a geologically rich, responsible mining nation with significant mineral potential including nickel, cobalt, zinc, aluminum, potash and more niche minerals such as indium, graphite, germanium and gallium. We are also a trading nation, the only G7 nation having comprehensive free trade agreements with all other G7 members, complemented by a historically strong security relationship with the U.S.

# How China gained the lead

The Trump Administration has made critical minerals a strategic priority. A renewed focus on defence is widely seen as a positive investment. The new administration's executive order immediately pausing the disbursement of funds through the Inflation Reduction Act, along with recent uncertainty around the Biden Administration's CHIPS and Scient Act, may be more problematic, as it threatens to freeze some critical investment plans at a time when Beijing is not slowing its pace. Put simply, the U.S. may need to embrace all demand drivers because China is embracing all demand drivers: batteries, renewable power, EVs, defence and AI.

We have identified four key drivers that led to China's dominance – some of which employ industrial and foreign policy approaches that the West may be forced to take to unbalance this great imbalance:

### Policy

Industrial policy targeting steel, aluminum and copper (initial industrialization) was followed by policies to further adoption of EVs and renewables. On the supply side, state assistance was provided to create national champions to compete with global majors. This was complemented with foreign policy objectives, such as One Belt, One Road, which invested $1 trillion (U.S.) in foreign, often resource rich, countries.[21] The Inflation Reduction Act was America's industrial policy response, and while successful in stimulating capital directed towards research, development and manufacturing, little has been put towards mineral mining or refining.

### Market

Today, China accounts for 70% of the value of global clean technology manufacturing[22] within an ecosystem that is often vertically integrated; minerals are mined, refined to the specificity of end components. Demand pulls supply, which is sourced by state-owned miners operating in lower cost jurisdictions, all while being provided state support. Western miners, in contrast, are beholden to higher standards by public investors, lacking in state subsidies, and are often subject to higher social license costs in foreign resource development, given the lack of political support (state-investor dispute, versus state-state dispute).

### Technology

In China, targeted state-support for both supply and demand fostered breakthroughs in technology and riding down the cost curve – especially in renewables and batteries. On the supply side, technological innovation in Chinese production and refining has allowed China to perfect the solvent extraction process to refine REEs.

### Mindset

China takes a war-time mindset to allocating capital and other resources to ensure security of supply and demand through an entire value chain approach. The U.S., in contrast, lacks such urgency. Its even moved away from strategic mineral reserves, by either not replenishing reserves relative to historical levels or, in the case of helium, selling reserves altogether. This is vastly different than the approach taken to crude oil, which maintains a strategic reserve and until 2015 had a continental export ban.



# **The big five:** Canada's non-fuel critical minerals

U.S. imports of all non-fuel mineral and metals reached $167 billion (U.S.) in 2024.[23] Canada remains the largest source of U.S. imports (US$40 billion, or 24%), and is the #1 provider of steel, aluminum, potash, nickel and zinc to the U.S. (#2 for copper).[24] Across the U.S.'s 50 critical minerals, Canada is also the largest source of imports (US$4.5 billion, or 20%).[25]

With that said, the U.S. remains reliant on China for many less commercial yet strategically important critical minerals. Even more, China has implemented export controls on a number of these minerals, such as gallium. The economic significance from this supply risk is material; the U.S. Geological Survey estimates a 30% supply reduction in gallium (China is 90% of global supply) alone could cause a $600 billion (U.S.) drop in U.S. GDP.[26]

In the near to mid-term, Canada has an opportunity to gradually displace Chinese supply, while also furthering a U.S.-Canadian strategy to secure production across a range of technologies and applications critical to both continental security and the Fourth Industrial Revolution.

**Below, we identify five key critical minerals best situated around this opportunity.**

### Gallium

Gallium has one of the highest thermal conductivities among metals. It is used in the production of highly specialized integrated circuits and semiconductors for AI and advanced computing. Gallium-based semiconductors are also vital to U.S. next-generation missile defence, radar systems and electronic communications.

The U.S. remains 100% import reliant for its supply of gallium.[27] In 2024, Canada was the #1 provider of gallium metal to the U.S., accounting for over 50% of imports, effectively displacing Chinese supply.[28] Current supply is sourced from recycled gallium at Neo Performance Materials' site in Peterborough, Ontario. Rio Tinto's Saguenay demonstration project could add another 5-10% of total global primary gallium metal production if it can reach commercial viability.[29] A proposed expansion at Teck Resources' Trail, B.C. operations could also increase production of germanium and add gallium and antimony.

### Graphite

High electric conductivity, temperature resistance, chemical inertness, and lubricity characterize this battery metal increasingly relevant in defence applications. Graphite's unique properties make it difficult – even impossible – to substitute in many applications, such as where thermal resistance is essential to equipment performance and durability.

Global demand for graphite is forecast to nearly double by 2035.[30] Canada has a unique opportunity to develop a full graphite value chain, a highly valuable proposition given China is 82% and 91% of global graphite production and refining, respectively.[31] Quebec is furthest along with Northern Graphite's operating mine in Lac des Iles, northwest of Mt. Tremblant, and Nouveau Monde Graphite's development projects underway for mining in Matawinie, north of Montreal, and refining in Bécancour, outside Trois-Rivières. Ontario offers another potential graphite mine, Northern Graphite's Bissett Creek, near the Ottawa River north of Algonquin Park, which is undergoing permitting.

## Nickel

Nickel has high ductility (flexible), toughness and strength. The mineral is used in lithium-ion batteries and in the production of stainless steel. Global demand is forecast to grow 70% by 2035, largely on the back of demand for batteries, both within transport and stationary (utility).[32]

The Dumont Nickel project (Nion Nickel) in Quebec's Abitibi region is vertically integrated and under construction. Canada Nickel's Crawford mine (world's second largest nickel reserve) north of Timmins, Ontario, is undergoing permitting. Canadian nickel provides much needed diversification of supply, with Indonesia and the Philippines together alone accounting for two-thirds of global production.[33] Canadian nickel could exceed 100% of U.S. import needs if all projects come online.[34]

## Tungsten

With the highest tensile strength (the maximum stress a material can bear without breaking) and melting point of all naturally occurring metals, tungsten-based alloys are key inputs for defence aircraft, naval vessels, and armour-piercing ammunition. Tungsten is also used within automobile x-ray machines, used in enhancing U.S. border security.

China produces 83% of the world's tungsten and accounts for 52% of global reserves.[35] Canada is a past producer, with substantial reserves that include some of the world's largest tungsten deposits. Northcliff Resources' Sisson project, northwest of Fredericton, and Fireweed Metals' Mactung mine, in eastern Yukon, are notable Canadian tungsten projects. In December 2024, the Canadian government and U.S. Department of Defense announced a joint investment of $35 million (U.S.) in the Mactung project, the world's largest high-grade tungsten deposit.[36]

## Germanium

The mineral has semiconducting characteristics comparable to those of silicon, but with superior optical and thermal properties. Its use is critical in night vision, space exploration, fiber optic cables, and semiconductors. The growing need for datacenters (fibre) has spurred demand in recent years.

Canada supplied 20% of U.S. germanium (oxide) imports in 2023.[37] Canada's Teck Resources holds an integrated germanium supply chain with zinc ores mined in Alaska and refined in Trail, B.C. The Trail facility has a proposed expansion to increase germanium production largely in response to China's germanium export ban late last year.



# Ensuring Canadian competitiveness

Canada's natural resource wealth has attracted natural resource investors and operators for over a century, backed by quality infrastructure, rule of law, robust environmental and labour standards, and deep trading relationships. Canada can build on those strengths, taking the following steps:

**Leverage government capital.** Critical mineral projects face capital shortages. Governments can help bridge this gap with either direct equity positions or by providing long-term offtake agreements. Defence procurement is a focal point, where Canadian, U.S. and allied nations defence departments can source future supply of critical minerals and stockpile reserve through "virtual inventories" or long-term purchase commitments. If Canada meets a commitment to spend 2% of GDP on defence, this could unlock as much as $17 billion of new capital, annually, for mine development.

**Limit price distortions from China.** The mining industry now requires a "China premium" to counteract market distortions – primarily to offset the risk of China oversupplying markets to suppress global pricing. A minimum price floor, supported by government purchase agreements and other intervenions, adds price transparency and establishes revenue certainty to buffer price fluctuations. Alternatively, restrictions on Chinese products could support domestic pricing. This includes restricting Chinese supply outright, or enacting price adjustments such as anti-dumping, countervailing duties, or border adjustments (environmental and human rights standards).

**Expand tax credits.** Canada's Critical Mineral Investment Tax Credit (ITC) excludes key defence critical minerals such as tungsten, indium, and beryllium. Eligibility could be further expanded beyond the current list of 15 minerals. Other options: allow for the stacking of tax credits, introduce Production Tax Credits (PTC) to support operating expenses (buffering against Chinese dumping) and enhance various government programs to more explicitly support critical minerals, including the Strategic Innovation Fund and Canada Growth Fund.

**Secure market access.** Tariff threats and Buy America programs hinder capital flows into non-U.S. jurisdictions. Minimizing tariff barriers abroad and investing in domestic refining and processing capacity ultimately secures demand for our products. On the supply side, securing our own supply chain is also critically important. Gallium is a Canadian success story, but relies on imported electronics from Taiwan (via the U.S.).

**Invest in human capital.** The Toronto Stock Exchange and TSX Venture Exchange are home to more miners than any other major developed world index, and with them comes a deep bench of mining talent. This talent is at risk, however, as engineers and a tech-minded generation increasingly looks to software and AI for careers. One startling fact: China has 39 university degree programs to train engineers in critical minerals; Canada has none.

**Reduce permitting times.** Canada needs to consolidate processes, where possible. Critical minerals are as strategic as transportation, and related projects can be declared to be in the national interest to accelerate their development. The same sort of pragmatism can be applied at the provincial level, where collaboration across departments, with local communities and with Ottawa can be improved. Lastly, and perhaps most importantly, we will need to find new ways to accelerate project approval processes while not undermining the duty to consult Indigenous communities. More Indigenous equity in these projects, including through the national and various provincial loan guarantee programs, can unlock greater Indigenous wealth and capital for re-investment in societal infrastructure and future resource projects.

**Enabling infrastructure.** Given the remote nature of many critical mineral deposits, the lack of existing infrastructure is problematic including rail, road, ports, power transmission, and cell towers. Increased collaboration by Federal and provincial governments to provide anticipatory, enabling infrastructure can support project economics and limit mine development times.

# Contributors

## RBC Thought Leadership

**Shaz Merwat,** Energy Policy Lead, RBC Climate Action Institute

**John Stackhouse,** Senior Vice-President, Office of the CEO, RBC

**Vivan Sorab,** Senior Manager, Clean Technology, RBC Climate Action Institute

**Caprice Biasoni,** Graphic Design Specialist

**Shiplu Talukder,** Digital Publishing Specialist

# References

[1]Natural Resources Canada

[2]Center for Strategic and International Studies, Critical Minerals and the Future of the U.S. Economy, February 2025; Natural Resources Canada

[3]Natural Resources Canada

[4]U.S. Geological Survey

[5]Deloitte, 2025 Global Semiconductor Industry Outlook

[6]Arrow Electronics, Silicon vs. gallium nitride (GaN) semiconductors: Comparing properties & applications, March 21, 2024

[7]IEA, Minerals used in electric cars compared to conventional cars, May 5, 2021

[8]Bloomberg New Energy Finance, RBC Thought Leadership

[9]IEA, Renewables 2024, October 2024

[10]Bloomberg New Energy Finance, RBC Thought Leadership

[11]Natural Resources Canada

[12]Science History Institute, Manufacturers Case Study, Using the Rare Earth Elements

[13]Wall Street Journal, What Scared Ford's CEO in China, September 14, 2024

[14]Center for Strategic and International Studies, Critical Minerals and the Future of the U.S. Economy, February 2025

[15]Ibid

[16]Natural Resources Canada

[17]IEA, Global Critical Minerals Outlook 2024, May 2024

[18]Ibid

[19]Reuters, Chinese firms control around 75% of Indonesian nickel capacity, report finds, February 5, 2025

[20]Center for Strategic and International Studies, Critical Minerals and the Future of the U.S. Economy, February 2025

[21]AidData, Power Playbook: Beijing's Bid to Secure Overseas Transition Minerals, January 28, 2025

[22]IEA, Energy Technology Perspectives 2024, October 30, 2024

[23]U.S. International Trade Commission, data accessed via DataWeb

[24]Ibid.

[25]U.S. Geological Survey Mineral Commodities Survey; U.S. International Trade Commission, data accessed via DataWeb; USA Trade Online, U.S. Census Bureau

[26]U.S. Geological SurveyAgricultural Supplier Faces Headwinds, 2022.

[27]Ibid.

[28]U.S. International Trade Commission, data accessed via DataWeb; USA Trade Online, U.S. Census Bureau

[29]Company website

[30]Natural Resource Canada

[31]IEA, Global Critical Minerals Outlook 2024, May 2024

[32]Natural Resources Canada

[33]IEA, Global Critical Minerals Outlook 2024, May 2024

[34]Company website

[35]IEA, Global Critical Minerals Outlook 2024, May 2024

[36]Natural Resources Canada

**Published by**

RBC Thought Leadership

https://www.rbc.com/tradehub/