

# Canada's Strategy for Key Critical Raw Materials. Case Study: Copper and Graphite

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*Abstract: Critical minerals are of strategic importance in the new economy based on innovation and sustainability, as their unique properties make them essential for a wide range of advanced technologies. The expansion of technology and the demand for high-tech products are driving major world powers to actively seek access to a stable supply of rare minerals, especially in light of the overdependence on some countries or regions for key-resources. Canada is one of the major global players in the production and supply of critical minerals and has recognized their importance through country strategies. This article proposes a qualitative approach, an analysis of two of the most important key minerals –copper and graphite – that are priorities for Canada's critical resource strategy. The research is based on documentary analysis, the results of which are presented in the form of two independent case studies focusing on aspects such as mineral description and use, supply chain, production, Canada's access to resources, and trade. The global competitive component with China, the main player in most critical rare metals markets, is also considered.*

*Keywords: critical minerals, Canada's strategy, Cooper, Graphite, supply chain, trade*

*JEL Classification: E23, F13, F23, L70*

## 1. Introduction

Canada currently extracts 60 minerals and metals from 200 mines and 6,500 sand and gravel quarries, and is home to nearly half of the world's publicly traded mining and mineral exploration companies, with a presence in over 100 countries and a cumulative market capitalization of these companies of \$520 billion (Government of Canada, 2022a). In the National Critical Mineral Strategy, experts recognise that the North American country faces an opportunity as the energy transition and industries of the future depend on access to critical minerals (Government of Canada, 2022b).

Currently, the Canadian list of essential minerals includes 31 resources: aluminum, antimony, bismuth, cesium, chromium, cobalt, copper, fluorine, gallium, germanium, graphite, helium, indium, lithium, magnesium, manganese, molybdenum, nickel, niobium, platinum group metals, potassium, rare earths, scandium, tantalum, tellurium, tin, titanium, tungsten, uranium, vanadium, zinc (Government of Canada, 2022c).

Critical mineral mines, smelters, refineries, or advanced projects are located in all Canadian provinces and territories except Prince Edward Island (Government of Canada, 2022a):

- Alberta: advanced projects and smelters or refineries for the production and processing of lithium, nickel, cobalt, and titanium;
- British Columbia: advanced projects, smelters or refineries, and mines for molybdenum, niobium, aluminium, copper, zinc, bismuth, indium, and germanium;
- Manitoba: advanced projects and nickel, copper and cobalt mines;
- New Brunswick: advanced projects with access to tin, tungsten, indium, and gallium;
- Newfoundland and Labrador: advanced projects, mines, and smelters or refineries that mine or process rare earths, nickel, cobalt, antimony, and fluorspar;
- Northwest Territories: advanced projects mining minerals such as rare earths, cobalt, bismuth and copper;
- Nova Scotia: advanced projects for resources such as tin, tungsten, indium and gallium;
- Nunavut: advanced projects for zinc, copper, nickel, cobalt and platinum;

- Ontario: advanced projects, mines and smelters or refineries for chromium, graphite, nickel, cobalt and platinum;
- Quebec: advanced projects, mines and smelters or refineries for lithium, magnesium, rare earths, graphite, titanium, nickel, cobalt, platinum group metals, vanadium, niobium and aluminium;
- Saskatchewan: advanced projects, mines and smelters or refineries for uranium, potassium and helium deposits;
- Yukon: advanced copper and tungsten projects.

Canadian experts prioritized the minerals on the list, taking into account the urgent need to build supply chains, emphasizing the need to focus efforts on six key minerals: lithium, graphite, nickel, cobalt, copper, and rare earths (Government of Canada, 2022a).

## 2. Methodology

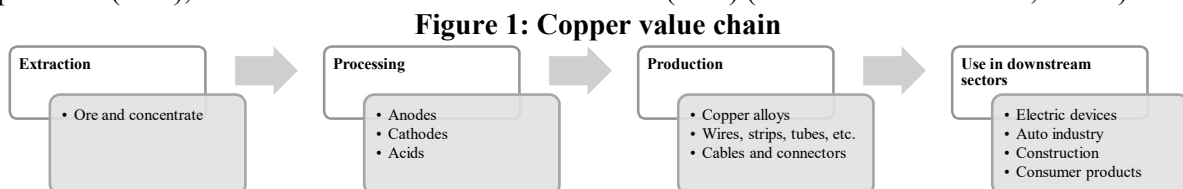
Based on the classification of critical resources in the Canadian strategy, we propose a qualitative analysis by the case study method for 2 of the 6 minerals in the priority category.

The objective of the analysis is to show Canada's position in the world, focusing on strengths, weaknesses, opportunities and existing threats. The following aspects are taken into account: the current situation of exploration and projects, Canadian production and main producers worldwide, trade and main partners, but also competition with China and its impact on global markets.

The case studies were organised as follows: Description and use (including supply chain), Production, Canada's access to resources, Trade.

## 3. Case study 1: Analysis of priority critical minerals for Canada: Copper

**Description and use.** Copper is a soft, corrosion-resistant metal that conducts heat and electricity well and is used in construction, power generation and transmission, electronics manufacturing, industrial machinery and transportation vehicles. This makes it an essential component of telecommunications, the automotive industry, and also many environmentally friendly technologies (e.g., electric vehicles) (Geology.com, 2022a). According to Canadian government statistics, the largest shares of global copper consumption in 2020 were in electrical equipment manufacturing (31%) and building construction (28%), followed by infrastructure projects (16%), transportation (12%), and other miscellaneous industrial uses (13%) (Government of Canada, 2022d).



Source: Author representation, based on Ontario Mining Association (2022).

**Production.** Globally, copper production is relatively geographically concentrated in South America - Chile was first with 28.5% market share, Peru second with 11%). China closed the 2021 production podium with an 8.5% share of total global production, nearly three times that of Canada (Table 1).

**Table 1: Worldwide copper production and reserves in 2021, in thousands of tons and %**

Country	Production (thousand tons)	% production in total	Reserves (thousand tons)	% reserves in total
Chile	5600	27.2%	200000	23%
China	1700	8.3%	26000	3%
Canada	570	2.8%	9800	1.1%
<b>Total</b>	<b>20600</b>	<b>100%</b>	<b>880000</b>	<b>100%</b>

Note: The table shows the production and reserves of the leading countries (2021 production), China and Canada.

Source: Author's compilation based on U.S. Geological Survey (2022a).

The world's leading producer, Chile, also has the largest copper reserves, estimated at 200 million tonnes in 2021, accounting for nearly a quarter (23%) of the global total, followed by Peru (11%) and Australia (10%), with Russia (7%), Mexico (6%), the United States (6%), and Poland (4%) also holding significant shares. China,

while leading in production, has reserves representing only about 3% of the world total (in 2021), while the remaining countries accumulate the remaining 31% of total reserves in a fragmented manner, including Canada with a share of only 1.1%.

### 3.1. Canada's access to resources

Canadian mines produced nearly 570,000 tons of copper concentrate in 2021, or about 2.8% of total world production. Data released by the Canadian government for 2020 show that British Columbia accounts for more than half of national production, and there are other Canadian regions where copper projects are being developed: Manitoba, Northwest Territories, Nunavut, Yukon (Government of Canada, 2022d). According to GlobalData's mining database, the five largest copper mines by production in Canada are located in British Columbia and are open pit mines: (1) Highland Valley Copper Mine - owned by Teck Resources, which produced about 119.3 thousand tons of copper in 2020 and will be in operation until 2040; (2) Gibraltar Mine - owned by Taseko Mines, which produced about 62.78 thousand tons of copper in 2020 and will operate until 2039; (3) Red Chris - owned by Newcrest Mining, produced approximately 40.07 thousand tons of copper in 2020 and will operate until 2043; (4) Mount Milligan Mine, owned by Centerra Gold, produced approximately 37.56 thousand tons of copper in 2020 and will operate until 2029; (5) Copper Mountain - owned by Copper Mountain Mining, produced approximately 35.177 thousand tons of copper in 2020 and will operate until 2051 (Mining Technology, 2021a).

The main copper mining company based in Canada is First Quantum Minerals, which owns its main project in Panama - Cobre Panama (a project that produced more than 715,000 tons of copper in 2020 despite interruptions during the pandemic restrictions), but also two other important projects, both in Zambia - Kansanshi and Sentinel (NS Energy, 2021a).

Chile is a key country in the race for copper (and more) as a resource. The South American country's pioneering relationship with its main partner, China, has turned into one of dependency, with the advance of Chinese investment in strategic sectors such as energy, mining, technology and telecommunications, banking, and health, a pressing issue pointed out by both economists and policymakers (Merics, 2022). The case of the Chilean state-owned company Codelco is also a major controversy (Global Americans, 2021): in 2005, the Chinese company China Minmetals signed a forward purchase agreement that gave it an initial \$550 million loan at a 6% interest rate in exchange for preferential interest rates on future copper deliveries. The deal was criticized mainly because the price of Chilean copper was below market levels while international prices were rising.

As a result of situations as the one described above, but also because of political changes, the Chilean state has changed its view on mineral resources, with the new regulations in force or proposed being more restrictive than those of the South American state we were used to. In particular, Article 145 of the new Constitution (proposed but rejected in the referendum) (Forbes, 2022) would have provided that the State exercise absolute control over mines and mineral, metallic and non-metallic substances present in the national territory, as well as over deposits of fossil substances and hydrocarbons. Since the new legislation provides that the exploration, exploitation, and use of these substances will be subject to regulation that takes into account their limited, non-renewable nature, intergenerational public interest, and environmental protection, mining companies may be forced to devote more resources to environmental protection, which would mean higher costs (Financial Post, 2022). Although the constitution has not yet been adopted, the trends are obvious, and in this context, Chilean resources could even be an opportunity for Canada, which is known for its policies on environmental requirements. About 55 Canadian mining companies are present in Chile, and the country hosts about 11% of Canada's international mining assets, making Chile Canada's second largest mining market after the United States. While about 28% of Chile's mines are state-owned (operated by Codelco), there are many private mining companies, including from Canada: Teck Resources Ltd. and Los Andes Copper Ltd. are both based in Vancouver, as are Barrick and Yamana Gold Inc. in Toronto. Canadian mining assets in Chile are estimated at about \$21.3 billion, according to the Department of Natural Resources (Financial Post, 2022). Notable projects include Vizcachitas, one of South America's largest advanced copper deposits with a copper equivalent of 13 billion pounds, wholly owned by Canadian company Los Andes Copper (Mining Watch Canada, 2022a).

In Peru, another country with significant copper deposits, China has two major projects: (1) the Las Bambas project in Apurimac, owned by China Minmetals (production of approx. 263.396 thousand tons of copper in 2020), which will be in operation by 2038; (2) the Toromocho project, owned by the Aluminum Corporation of China, is an open-pit mine in Junin (production of about 190,074 thousand tons of copper in 2020) that will be in operation by 2056 (Mining Technology, 2021b).

In terms of Canada's opportunities in Peru, the fundamentals for long-term projects are favorable: the two countries have existing trade relations through the Canada-Peru Free Trade Agreement (2009) and the

Comprehensive and Progressive Agreement for the Trans-Pacific Partnership (2021), and Peru is Canada's second largest bilateral trading partner and Canada's second largest destination for direct investment in Central and South America (Government of Canada, 2022e).

### 3.2. Trade

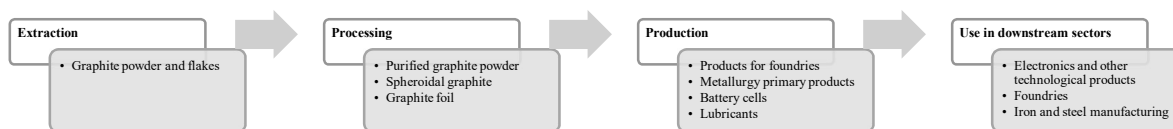
In terms of trade in copper (gross, products only), according to the Observatory of Economic Complexity, Canada exported \$1.13 million worth of raw copper in 2020, with the main destination being almost exclusively India (\$1.11 million). In contrast, Canada imported \$525 million worth of unwrought copper, making it the eighth largest importer of unwrought copper in the world. Canada imported unwrought copper primarily from Chile (\$439 million), but also from Zambia (\$69.9 million), the United States (\$9.92 million), and Macau (\$5.58 million) (The Observatory of Economic Complexity [OEC], 2022a).

In comparison, China's position in copper trade shows that exports in 2020 were only \$4.53 million in raw copper, with the main destinations being Malaysia (\$1.03 million), Singapore (\$1.02 million), Burma (\$597 thousand), the Netherlands (\$568 thousand) and Thailand (\$489 thousand), while imports amounted to \$5.34 billion - the largest importer worldwide, had as source markets Zambia (\$1.19 billion), Chile (\$1.05 billion), Namibia (\$933 million, but also the Democratic Republic of Congo (\$566 million) or Belgium (\$373 million) (The Observatory of Economic Complexity [OEC], 2022b).

## 4. Case study 2: Analysis of priority critical minerals for Canada: Graphite

**Description and use.** Graphite is an extremely soft, non-metallic mineral that has a very low specific gravity but is extremely heat resistant and nearly inert in contact with almost all other materials; these extreme properties give it a wide range of uses (Geology.com, 2022b). For example, graphite (natural or synthetic) is used for electrodes, refractory materials, batteries (including lithium-ion batteries), and lubricants, as well as fuel cells, semiconductors, LEDs, and nuclear reactors. Synthetic graphite (about 38% of total graphite) is used for electrodes (32%), carburizing (10%), graphite forming (4%), lubricants (4%), and other purposes (12%), while natural graphite (about 62%) is used for refractory materials (16%), batteries (8%), foundries (5%), and other purposes (9%) (Government of Canada, 2022f).

**Figure 2: Graphite value chain**



Source: Author representation, based on Ontario Mining Association (2022).

**Production.** In 2020, global graphite consumption reached 2.7 million tons, with synthetic graphite accounting for about two-thirds of consumption (Government of Canada, 2022g). In 2021, China was the world's largest graphite producer, accounting for over 80% of total global production. In 2021, graphite supply began to recover and China expanded its dominant position on global markets (from around 70% in 2020).

**Table 2: Worldwide graphite production and reserves in 2021, in thousands of tons and %**

Country	Production (thousand tons)	% production in total	Reserves (thousand tons)	% reserves in total
China	820	82%	73000	22.8
Brazil	68	6.8%	70000	21.9
Canada	<b>8.6</b>	<b>0.86%</b>	:	:
<b>Total</b>	<b>1000</b>	<b>100%</b>	<b>320000</b>	<b>100%</b>

Note: The table shows the production and reserves of the leading countries (2021 production), China and Canada.

Source: Author's compilation based on U.S. Geological Survey (2022b).

In 2021, global graphite reserves were estimated at around 320 million tonnes. Although Turkey has not had a significant share of production in recent years, it has the largest graphite reserves (90 million tonnes), followed by China and Brazil (the world's second largest producer, but with a share of only 6.8%). Together, Turkey, China and Brazil hold almost three quarters of the world's currently estimated graphite reserves.

#### **4.1. Canada's access to resources**

Canadian production in 2021 was estimated at 8.6 million in United States Geological Survey (USGS) statistics, which differ from those published by the Canadian government, representing less than 1% of world production, while Canadian reserves are insignificant relative to world production (U.S. Geological Survey, 2022b).

The main mining companies in Canada engaged in exploration and development of new projects are (Graphene-info, s.a.): Alabama Graphite (active projects in two graphite mines in Alabama, USA), American Graphite Technologies (AGT) (owns mineral resource claims in the state of Quebec), Focus Graphite (formerly Focus Metals) - an Ottawa-based mine development and technology company that owns high-grade technological graphite resources at Lac Knife in Quebec (about 16%), Gratomic - with projects to extract and market graphite products - especially graphene-based nanomaterials. The newly established company Lomiko Metals Inc. with new projects in exploration Mason Graphite is developing the Lac Gueret graphite project (wholly owned) in northeastern Quebec Northern Graphite Corporation with the Bissett Creek graphite project, Saint Jean another publicly traded mining exploration start-up that owns five mining properties in the Canadian province of Quebec (Walker, Wallingford, Zentek Ltd, an Ontario-based mineral exploration and development company developing the Albany graphite deposit - a rare hydrothermal graphite deposit with the potential to produce high-purity natural graphite competitive in the high-tech markets where synthetic graphite is traditionally traded.

Canadian companies also have a number of significant projects outside the country:

- Leading Edge Materials Corp. is a Canadian company that owns a portfolio of critical resource projects in the European Union (the company has 100% ownership of the Woxna graphite mine and processing plant in Sweden) (Investor Intel, 2021);

- NextSource Materials Inc. has developed the Molo graphite project (100% owned) in Madagascar; the Molo processing plant is capable of processing 240 thousand tons of ore per year to produce an average of 17 thousand tons of graphite concentrate; NextSource also has project plans to build battery anode production facilities and to collaborate with Panasonic-Tesla (Mining.com, 2022a).

- The Santa Cruz graphite project is an open-pit graphite mine in the Brazilian state of Bahia being developed by Canadian company South Star Mining, which owns the property through its wholly owned subsidiary Brasil Grafite (Mining Technology, 2021c).

#### **4.2. Trade**

According to government statistics, the value of Canadian graphite exports in 2020 was \$31.6 million, down 9% from the previous year. Imports also decreased by 33% to \$20.9 million in 2020. Natural graphite accounted for 46.7% (\$14.8 million) of the value of Canadian graphite exports and 13.5% (\$2.8 million) of Canadian graphite imports in 2020 (Government of Canada, 2022f). Synthetic graphite accounted for 53.3% (\$16.9 million) of Canadian exports and 86.5% (\$18.0 million) of imports. The United States is the top destination for Canadian exports of natural and synthetic graphite, accounting for 85% and 42% of total exports, respectively (in 2022).

According to the The Observatory of Economic Complexity [OEC] (2022c), Canada exported \$11.3 million worth of graphite, making it the tenth largest graphite exporter in the world. The main destination of Canadian graphite exports was the United States (\$8.78 million), while other markets were rather insignificant in terms of volume (e.g., Germany - \$787,000 or Japan - \$336,000). In terms of imports, the OEC shows that Canada imported \$2.47 million worth of graphite in 2020, mainly from the United States (\$1.22 million) and China (\$633,000), but also, to a lesser extent, from Germany (\$198,000), Madagascar (\$139,000), and the United Arab Emirates (\$126,000).

China's position in copper trade shows that the Asian country exported \$290 million worth of graphite in 2020, making it the world's leading graphite exporter. The main export destinations were South Korea (\$101 million), Japan (\$91 million) and, to a lesser extent, India (\$14.6 million), the United States of America (\$14.2 million) and Germany (\$10 million). Imports totaled \$18.3 million (seventh largest importer), mainly from Madagascar (\$6.94 million), Japan (\$3.29 million), Germany (\$1.1 million), Mozambique (\$1.09 million), and the United States (\$987 million) (The Observatory of Economic Complexity [OEC], 2022d).

### **5. Conclusion**

The copper price was relatively stable in 2016-2019, but experienced significant fluctuations after 2020, reaching a low in March 2020 compared to recent years, followed by a continuous increase in the following 12

months, which then followed fluctuating dynamics (Macrotrends, 2023). The transition to green energy will increase copper demand due to its benefits for the necessary expansion of electrification networks and technologies. However, new projects in Chile, Congo, Indonesia, and Peru are in progress over the next 5 years, which could (re)stabilise prices (Ontario Mining Association, 2022).

Although China supplies just over 40% of refined and smelted copper, the proportion is not as much of a concern as for other minerals, although there is significant spatial concentration globally (South America). Since copper is generally not included in the list of critical minerals, risks are effectively mitigated, although copper substitutes generally have poorer properties, making them an important material for downstream industries (Ontario Mining Association, 2022). In the short term, graphite prices may continue to face downward pressure as Chinese producers have ramped up production to fill the supply gap created by the COVID -19 pandemic. In the medium to long term, the price is expected to remain relatively stable due to large production capacities, despite expected higher demand (for lithium-ion batteries and high-tech applications). Although production from the main producer, China, has increased with the lifting of restrictions, accelerated electrification in the automotive industry will create strong demand in the short term, while the impact of the expansion of innovative refining technologies will be felt in the medium to long term.

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