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Global critical metal resources; what we know, what we need to know, and implications for the Canadian critical metal sector

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Summary

The critical metals are crucial to our modern way of life and are used in key components that have permitted the development of numerous domestic, green and military high technology applications. However, these metals are also subject to issues surrounding the security of their supply, varying from geological and economic factors to technological evolution, the potential for substitutes, the environmental impacts related to extraction and processing, and the usage of these metals. Improving the security of supply of these metals can be approached in numerous ways, including the analysis of known mine supply chains to enable the economic extraction of critical metal by-products, the determination of the critical metal prospectivity of mining/mineral processing wastes, increased amounts of recycling, and the discovery of new and economic deposits of the critical metals. All of these approaches require more information in terms of mineral resource accounting, mineral economics, material flow analysis, mineral processing, as well as increased economic geology knowledge that would enable the making of future discoveries and increase the likelihood of critical metals being extracted as either primary or by-products. Without this information, significant parts of our knowledge base on the supply (and the security of this supply) of the critical metals will remain opaque.

Introduction and the concept of Criticality

The critical metals are a group of commodities that are vital to modern life, but whose secure supply is at significant risk of restriction. These commodities are vital components in the manufacturing of modern (e.g., computers, smart phones and touch screen technology) and green (e.g., wind turbines, solar panels, and large-scale batteries) technologies and have a wide variety of military and energy generation and storage-related applications. However, there is currently no clear and uniform identification of critical and non-critical metals and the elements considered to be critical vary as a function of supply and demand and strategic considerations. The degree to which a metal is considered critical is based on geological and economic factors, technological evolution, potential for substitutes, environmental impacts, and the usage of these metals. Their supply risks are assessed using (1) geological, technological, and economic, (2) social and regulatory, and (3) geopolitical factors. These factors vary from country (or group of countries) to country, between different government departments, and from industry to industry, reflecting the viewpoints of the organization considering criticality and demonstrating that in general there is no objective consensus about critical metals. One of the most recent compilations of a list of critical commodities is given in Table 1, with this list representing the 35 elements that are considered critical and strategic by the US Federal Government (US Department of the Interior, 2018). These elements are vital for both modern technology and sustaining modern standards of living but have resources that are often dominated by a single or a small number of dominant suppliers based in one or two countries. They are also generally produced in relatively small amounts (compared to base metals such as Cu and bulk commodities such as Fe) or almost entirely as by-products of other metals. They are also generally not recycled in significant quantities. All of these factors significantly increase the complexity of the security of the supply of the critical metals.

*Table 1. Compilation of critical commodities (US Department of the Interior, 2018) compared to top global producers and reserve holders in addition to Canada's ranking in production and reserves terms. N/A = Data not available. Data are for 2018 and are from USGS (2019) with additional information for 2017 from Brown et al. (2019, indicated by *), for 2017 from Robinson et al. (2017, indicated by **), for 2013-2014 from Weng et al. (2015, indicated by ***), and for 2017 from Grancea and Hanley (2018, indicated by ****). Note that resources significantly exceed reserves but are often not quantified or determined globally (e.g., Jowitt et al., 2019) and hence are not reported here.*

Critical commodity	Top producer	Top reserve holder	Canadian production (% of global)	Canadian reserves (% of global)
Aluminium	China (aluminium)	Australia (bauxite)	4.9 (aluminium)	0 (bauxite)
Antimony	China	China	0	0
Arsenic	China	N/A	0	N/A
Barite	China	Kazakhstan	<0.1*	N/A
Beryllium	USA	N/A	0	N/A
Bismuth	China (refinery)	N/A	0.16 (refinery)	N/A
Cesium	Zimbabwe	N/A	N/A	N/A
Chromium	South Africa	Kazakhstan	0	0
Cobalt	DRC	DRC	2.7	3.6
Fluorspar	China	Mexico	0	0
Gallium	China	China	N/A	N/A
Germanium	China	China	N/A	N/A
Graphite	China	China	4.3	0.38**
Halfnium	N/A	N/A	N/A	N/A
Helium	USA	USA	<0.625	N/A
Indium	China (refinery)	N/A	1.43 (refinery)	N/A
Lithium	Australia	Chile	0	0 (3.2 of resources)
Magnesium	China	China	0.7 (magnesite)*, <0.05 (metal)	N/A
Manganese	South Africa	South Africa	0	0
Niobium	Brazil	Brazil	10.3	17.6
PGE	South Africa	South Africa	8	0.44
Potash	Russia	Canada	28.6	20.7
REE	China	China	0	0 (8 of resources***)
Rhenium	Chile	Chile	0	1.3
Rubidium	Namibia	N/A	N/A	N/A
Scandium	N/A	N/A	N/A	N/A
Strontium	Spain	N/A	N/A	N/A
Tantalum	DRC	Australia	N/A	N/A
Tellurium	China	China	6.8	2.6
Tin	China	China	0	0
Titanium	Canada, China	Australia	15.7 (ilmenite)	3.5 (ilmenite)
Tungsten	China	China	N/A	N/A
Uranium	Kazakhstan*	Australia****	19.9*	8% of resources****
Vanadium	China	China	0	0
Zirconium	Australia	Australia	0	0

Global Critical Metal Resources and current and future Canadian critical metal production

A significant amount of publicly available and robustly reported information (e.g., resource and reserve data as well as more robust country and global resource assessments) is available for some critical metals. This information is primarily available for elements that are produced as primary rather than co- or by-products (e.g., the PGE and the REE; Mudd et al., 2018; Weng et al., 2015), or for those elements that have significant market sizes (e.g., cobalt; Mudd et al., 2013). However, as shown in Table 1, there are also significant knowledge gaps in terms of knowing exactly what resources we have for certain critical commodities. These gaps reflect situations such as those where significant amounts of metals are produced as byproducts from deposits where no critical metals are reported in either reserves or resources. This production is often reported by refineries or smelters, meaning that it is sometimes unclear which mines actually produced the resulting critical metals.

The data that are available indicate that Canada contains significant amounts of known reserves of a range of critical metals (Table 1), with large additional resources also known for some of these metals (as exemplified by the fact that Canadian mineral resources containing some 8% of global REE resources; Weng et al., 2015). However, as outlined above, these known resources do not reflect the entire picture given the uncertainties surrounding critical metal resource reporting and estimation. This presentation will outline key issues around the resources and future supply of these metals, including what data we have and need to more effectively address the issues surrounding these key commodities, and will focus on the potential for future Canadian critical metal production.

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