## BUILDING CANADA'S EMERGING RARE EARTH ELEMENTS AND CHROMITE INDUSTRY THROUGH TECHNOLOGICAL INNOVATION

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In recent years, the steady, reliable, and secure supply of critical metals has become increasingly important to major industrialized economies that seek to sustain their industrial base and develop advanced technologies, such as clean energy. In light of this, Canada, with its significant critical metal reserves, has an opportunity to supply some of the global demand for critical metals. However, to transition from promising mineral deposits to marketable products, investment in fundamental R&D and expertise is needed to address the complex technological challenges around the production, separation and processing of critical metals, and to better understand the global market for these key commodities. For many small and medium enterprises, investing in R&D is extremely challenging with their limited resources; federal investment in R&D would catalyze the development and growth of new businesses and high-value jobs. As a result, the Government of Canada is investing \$23 million over six years to accelerate the production of rare earth elements (REE) and chromite/ferrochrome. This industryled program delivered by CanmetMINING, Natural Resources Canada has the goal to equip these emerging Canadian industries with the technological innovation needed to reach production.

Rare earth elements are critical minerals that represent an opportunity for Canada to enter an emerging and globally strategic market. Canada does not currently produce rare earth elements, but has deposits with significant potential. REE are differentiated into "light" or "heavy" rare earths based on their atomic number. Light REE, whose use is important to many low technology commercial products, typically comprise more than 95% of the available rare earths in any given deposit and are in surplus supply in the global marketplace. Heavy REE typically comprise less than 2% of the recoverable rare earths in a deposit and are considered to be critical to the manufacture of all high technology, clean energy, aerospace, automotive, defence and many other industrial products. A number of Canadian projects have relatively high levels of heavy rare earths. While rare earths are abundant geologically, they are economically recoverable in only a few mineral deposits. The metallurgy for Canadian ores containing rare earth elements involves a complex sequence of individual processing, separation, refinement, alloying and formation stages before they can be used in the production of permanent magnets, consumer electronics and other high value-added high-tech products.

According to the Technology Metal Research Group, there are currently there 53 advanced rare-earth projects located within 16 countries, and 19 of them are located in Canada (Figure 1), primarily in northern Ontario and Quebec, Newfoundland and NWT.

Chromite deposits located in Ontario's Ring of Fire have production potential that could make Canada a significant global producer, processor and supplier of products that contain the metal chromium. Over 90 per cent of global chromite production is used to manufacture stainless steel and other alloys. There is no substitute for this mineral in the production of stainless steel, which has unique corrosion resistance properties. Chromium-based alloys are also used in gas turbines, aircraft engines and other high temperature applications. The Ring of Fire is estimated to hold about 220 million tonnes of chromite. Global demand for stainless steel is forecast to grow at 4-5 per cent annually to 2020. Although major steel mills exist in North America, there is currently no chromite production in North America and has never been mined before in Canada.

The program utilizes both industry-led steering committees as well as numerous technical committees to help define technical work plans and to ensure that the R&D is well-focussed and address industry needs. The research will be strengthen by integrating comprehensive economic analysis of market conditions for rare earths and chromite, in order to increase the Government's understanding of the economic and market dynamics, and their implications for the business case for rare earth and chromite projects in Canada.

A key aspect to the success of this initiative is the involvement of stakeholders throughout the value chain in defining and deploying the technological innovation. Ongoing industry engagement will ensure that the program will de-risk processing challenges to reduce capital and operating costs, develop and commercialize technologies to separate REE and produce ferrochrome and evaluate secondary sources of these commodities as a means of accelerating production and minimizing environmental liability. Stakeholders are further engaged through attendance at annual workshops and through dissemination of reports and research findings online at http://www.reechromite.ca.

External research will complement the federal research by utilizing specialize expertise and addressing research and technological gaps with a multi-directional approach. Post-doctoral fellows, undergraduate and graduate students will work with federal researchers and universities to strengthen and support research teams and at the same time will accelerate the development of HQP for these emerging industries. External contracts will also be offered through standard government of Canada procurement channels such as Requests for Proposals and other Supply Arrangements. Processing challenges will look primarily at physical (beneficiation) and hydrometallurgical aspects for REE, and pyrometallurgical and efficiencies in rock breakage (comminution) for energy and cost savings. As separation is the most complex but most critical step in rare earth processing a significant R&D investment will be made in this area. Reprocessing examines options to secure a source of critical metals from secondary sources, mainly mining wastes. Environmental research will address a range of concerns from hexavalent chromium, to radioactivity, to aquatic and terrestrial contamination.



Figure 1: Rare Earth Element and Chromite Deposits in Canada.

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## PROCEEDINGS



Canadian Land Reclamation Association Association canadienne de réhabilitation des sites dégradés