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Strategic Planning for Critical Minerals

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The U.S. Geological Survey notes, "the average automobile contains more than a ton of iron and steel, 240 lbs of aluminum, 50 lbs of carbon, 42 lbs of copper, 41 lbs of silicon, 22 lbs of zinc, and more than thirty other mineral commodities, including titanium, platinum, and gold."[1]

When a combustion engine is replaced with the battery and motor of an electric vehicle, then 80% more copper, 70% more aluminum, 60% less iron and 7% less steel are used.[2] A typical 1000-pound battery alone could contain 110 pounds of graphite, 90 pounds of copper, 60 pounds of nickel, 30 pounds of cobalt, and 25 pounds of lithium. The electric motor will contain more than a mile of copper and around 2 pounds of rare earth elements, especially neodymium and dysprosium.[3]

If the current transition towards more electric vehicles continues, the quantities and types of minerals used to make them will also change. Five to ten times more battery minerals will be needed in the coming decades. Some estimates are even higher.[4,5,6] Such predictions are not limited to minerals used to make car batteries. The supply of dozens of minerals used in hundreds of high-tech applications critical to national security and a modern economy are the focus of strategic planning and global maneuvering to ensure their availability.

Lithium Fields in Northern Chile

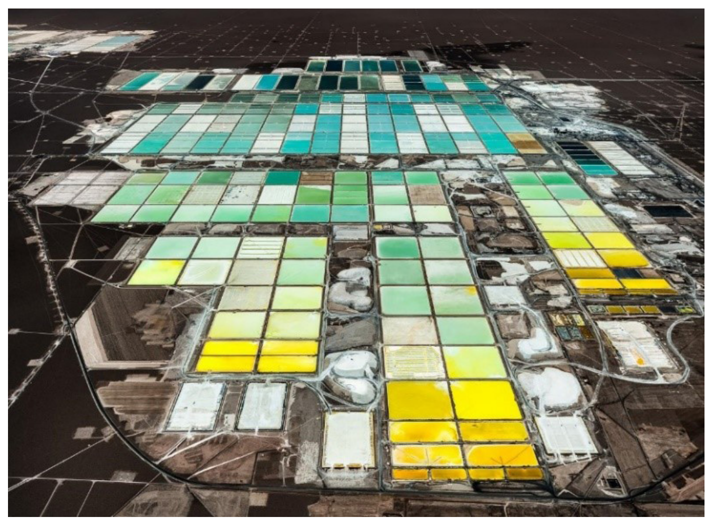


Image Credit: Euronews

The Defense Production Act

In 1950, during the Korean War and the heightened tensions of the cold war, the United States created the Defense Production Act (DPA), 50 U.S.C. § 4501 et seq. Modeled after the WWII War Powers Acts, its purpose was to ensure critical material supplies with a range of tools including cooperative agreements, financial incentives, and outright appropriation of private production capacity. Manganese supply had become a concern at the time because it was an essential ingredient in steel alloys used in military production and the Soviet Union had embargoed the primary global source in its Republic of Georgia.[7]

Manganese has again come into focus along with lithium, cobalt, graphite, and nickel - due to anticipated demand for use in high-capacity batteries. Nickel prices doubled in early March after the Russian invasion of Ukraine and Russia's decision to ban export of the metal.

The London Metal exchange then suspended trading for several days in response to the price run.[8] Weeks after the supply shock and price volatility, the DPA was invoked again due to U.S. dependence on "unreliable foreign sources" for these same five battery minerals.[9]

What Makes a Mineral Critical?

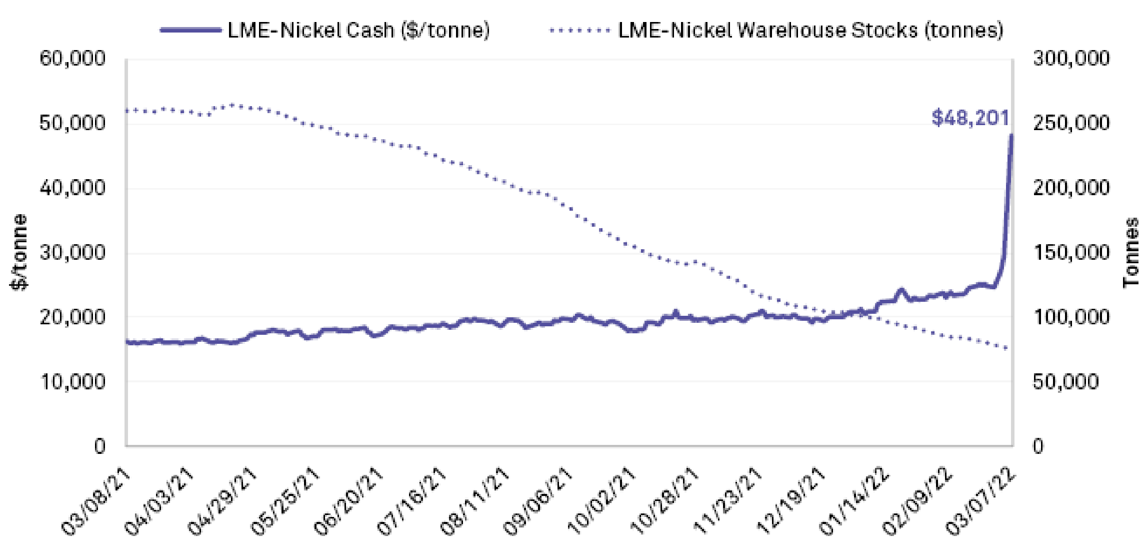
While the DPA and its directives are the result of strategic planning, the process begins with the designation of minerals deemed critical. The exercise is led by the U.S. Geological Survey in consultation with the Secretaries of Defense, Commerce, Agriculture, and Energy and the United States Trade Representative.[10] In the 2022 update,[11] five minerals were removed, while zinc and nickel were added. The additions reflect recent updates to the criteria used to determine whether a mineral is critical to the well-being of the U.S. economy.[12]

The strategic planning process for critical minerals was updated in the Energy Act signed into law by President Trump in 2020. That act defines critical minerals as those essential to economic or national security, serving an essential function in defense, agriculture, electronics, energy technology or other important sectors with a supply chain that is vulnerable to disruption from various sources, including: geopolitical conflict, protectionist behaviors, or abrupt demand growth, amongst others.[13]

The Energy Act also introduced new criticality criteria that were used to quantify risk and identify minerals for list inclusion. Criteria have always included analysis of existing supplies, reserves, stockpiles, use rates, and trade partner relationships. New criteria have been added that establish a more thorough process that considers net import reliance, production concentration, single points of failure, and abrupt demand surges due to the emergence of new technologies and uses for minerals.

In previous versions, nickel was excluded from the list because its supply chain was deemed relatively secure, with 61% of U.S. imports supplied by Canada, Norway, and Finland, all considered "friendly" trade partners. However, it was added in 2022 for two reasons. First, the U.S. currently has only one operating domestic mine and one domestic processor. New criteria now assign greater risk to imported minerals and to supply chains with single points of failure, like nickel.

Recent Spike in Nickel Prices



Source: S&P Global Market Intelligence; London Metals Exchange

Another reason nickel was placed on the list involves new criteria that contemplates the effect technological innovation and new uses might have on future demand. Nickel is still important to stainless steel production but, projected new use in large-capacity batteries is what drives future concern over supply constraints.[14]

Such concern helped produce the price volatility seen in the aftermath of the Russian invasion of Ukraine, when feverish trading on the London Mineral Exchange was halted for several days as the price of nickel doubled, this despite Russia's relatively small, 10 percent, share of global production.[15]

"Wall Street investors think Tesla is worth more than General Motors, Toyota, Volkswagen and Ford put together. And China, the world's biggest car market, recently ordered that most new cars be powered by electricity in just 15 years."[16]

Demand

In 2021, "the big three" U.S. automakers responded to industry developments by announcing production goals that would convert a major share of the transportation fleet to electric power. These, and other automakers around the world have backed up their announced goals with the capital investment plans necessary for retooling.[17]

In turn, demand for the materials needed to make electric vehicle (EV) batteries is expected to soar. In one scenario, The International Energy Agency (IEA) projects that by 2040, demand for nickel and cobalt could be two to five times higher than in the 2010s.[18]

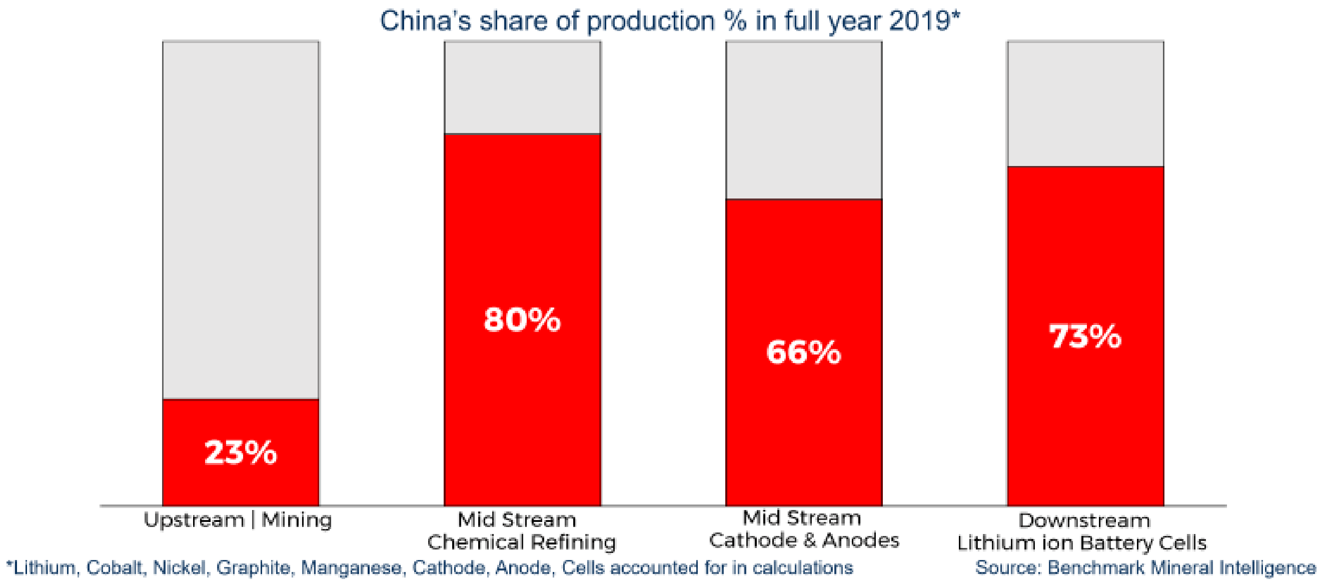
Competition for these same materials is coming from other strong demand sectors including consumer electronics, superconductors, and emerging clean energy technologies. This dynamic, competitive environment led one company to announce plans for direct-sourcing its supply of over 95% of the lithium hydroxide, 50% of the cobalt and more than 30% of the nickel used in its high energy-density cells.[19]

Supply

Besides the U.S., many other countries are also planning for critical mineral security and acting to secure supplies. The EU produced a critical raw materials list and an action plan for security and sustainability.[20] However, no country yet matches China's commitment to controlling the sources of battery minerals. It has consolidated access to cobalt, one of the most geographically concentrated minerals, by purchasing or investing in 15 of the 19 mines in the Democratic Republic of Congo (DRC).[21]

The DRC contains 50% of world reserves and produces almost 70% of the global supply of cobalt.[22] China is also dominant in processing and refining these minerals, accounting for 50-70% of lithium and cobalt processing. Its domestic share of nickel refining is around 35% but its companies are also involved in Indonesian operations.[23]

China's Battery Supply Chain Dominance



Source: Benchmark Mineral Intelligence via Mining.com

While minerals for batteries and clean energy technologies may be the headline of the day, there are many other critical minerals. The total number of designations grew from 35 to 50 after the 2022 list update.[24] Much of the increase was the result of the decision to separately list each rare-earth element (REE) and platinum group mineral due to expanding uses and recognition of their unique characteristics. Here, China dominates even more so, processing as much as 90% of mined output converted into oxides, metals, and magnets.[25]

Minerals Closer to Home in Nebraska

Nebraska is not considered a mining state, but it can claim deposits of niobium, scandium, and titanium. Although none are key in the race towards high-capacity batteries, each are designated critical minerals and are the subject of supply chain concerns and of U.S. strategic planning. Niobium is mostly used in steel and other superalloys making them lighter and stronger. Scandium is used in aluminum alloys and ceramics with projections for use in aerospace and fuel-cell applications. Titanium is also used in metal alloys and as a pigment.[26]

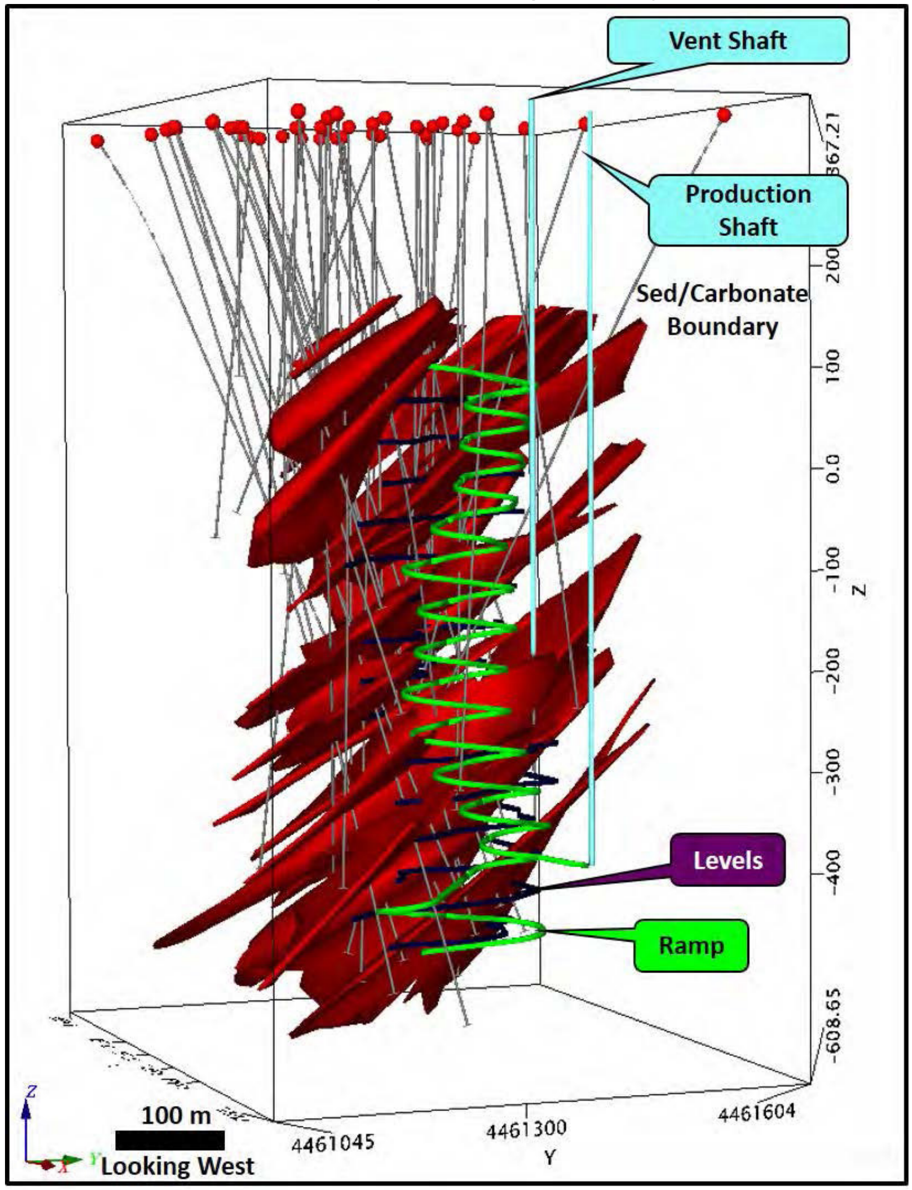
The presence of economically significant deposits of these important minerals has been known since the early 1970s. Field exploration was conducted in the 1970s and 1980s at a site near Elk Creek in southeast Nebraska. The current owner of the site, NioCorp, began detailed exploration studies and completed[27] a feasibility study in 2019. A 2022 report found that a significant amount of REEs may be present as well, suggesting Nebraska may have the second largest deposit in the United States.[28]

NioCorp has already spent $60 million for exploration, permitting, and feasibility studies on its Elk Creek Project.[29] It has secured all federal construction permits through the Nebraska Department of Environment and Energy, signed a contract with the Nebraska Department of Economic Development for $200 million in tax credits and secured purchase contracts for portions of its niobium and scandium output. One of these contracts with a German firm may make the project eligible for guaranteed loans from the German government. However, after years of preparation there is still no mine.

Challenges to Increasing Mineral Supply

NioCorp's experience with the Elk Creek site is not uncommon. One study looked at the major mines around the world which began producing during the last decade and found it took an average of 16 years to get from discovery to first production - 12 years for exploration and feasibility studies, and four or five years for construction.[30] Combining the 36-year estimated production life of the Elk Creek Project[31] with an average lag time and the strategic planning horizon for the investor becomes five or six decades, which poses great uncertainty and risk.

Elk Creek Project Drill Program Analysis



Source: NioCorp

Supply and demand dynamics is one likely source of risk and uncertainty. A decade ago, legacy auto makers were only offering a few electric vehicle options but, after several high-profile announcements, demand for key minerals is projected to grow several times over. By the time a new mineral source could be developed, emergent supply constraints could change price points for minerals and begin to favor new technologies.

Technological innovation can be another source. Years of research and development have brought lithium-ion technology to a tipping point where the cost to manufacture an electric vehicle is approximately equal to the gas-powered one.[32] Meanwhile, continued research into cathode-anode chemistry could alter the demand and use trajectory of EV battery materials, and for that matter, any of the critical and rare-earth minerals.[33] Other technologies including iron flow batteries,[34] hydrogen or other fuel cell technologies could also alter the landscape.

Government policy can also present strategic planning challenges by increasing production costs through tax policy as well as the regulation of worker and environmental safety. Government must balance its goal of having strong supply chains with many other goals.

The U.S. government has concluded the status quo is inadequate to ensure secure supply chains and invoked the DPA to address its concerns. With roots in the War Powers Acts of the 1940s, the DPA authorizes broad executive authority including its most well-known power to reprioritize or co-opt, private production capacity to address the needs of national defense. During the Korean War the U.S. opted to reassure producers and maintain steady supplies for critical materials like manganese by signing purchase contracts.[35]

In its most recent use, the Administration chose financial incentives to spur the mining, processing, and recycling of battery minerals through feasibility studies, plant modernization and efficiency improvements amongst other strategies. Nebraska has also contributed with tax and economic development tools. Some argue that while the measures discussed above will be helpful, they do not go far enough in addressing the associated lag time and the investment risk and that more steps should be taken to minimize regulatory obstacles by, for example, reform of environmental and safety regulations or of mining laws that date back to 1872.[36]

Conclusion: It’s a Balancing Act

Governments are not alone in having to balance competing goals. Investors also must weigh advantages and disadvantages when deciding between project sites. The production cost-advantage of a site with minimal regulation may be offset by risks from corruption or political instability. Cobalt mining in the Democratic Republic of Congo is often mentioned as a place where these trade-offs have resulted in corruption, dangerous conditions, and the use of child labor.[37]

Nebraska is familiar with tradeoffs having experienced both the economic benefits as well as the long-term environmental consequences resulting from lead smelting in Omaha.[38] Regardless which tool or tradeoff, strategic planning for critical minerals will be a vital exercise for both government and industry in the coming decades.

ASARCO Lead Smelting in Omaha

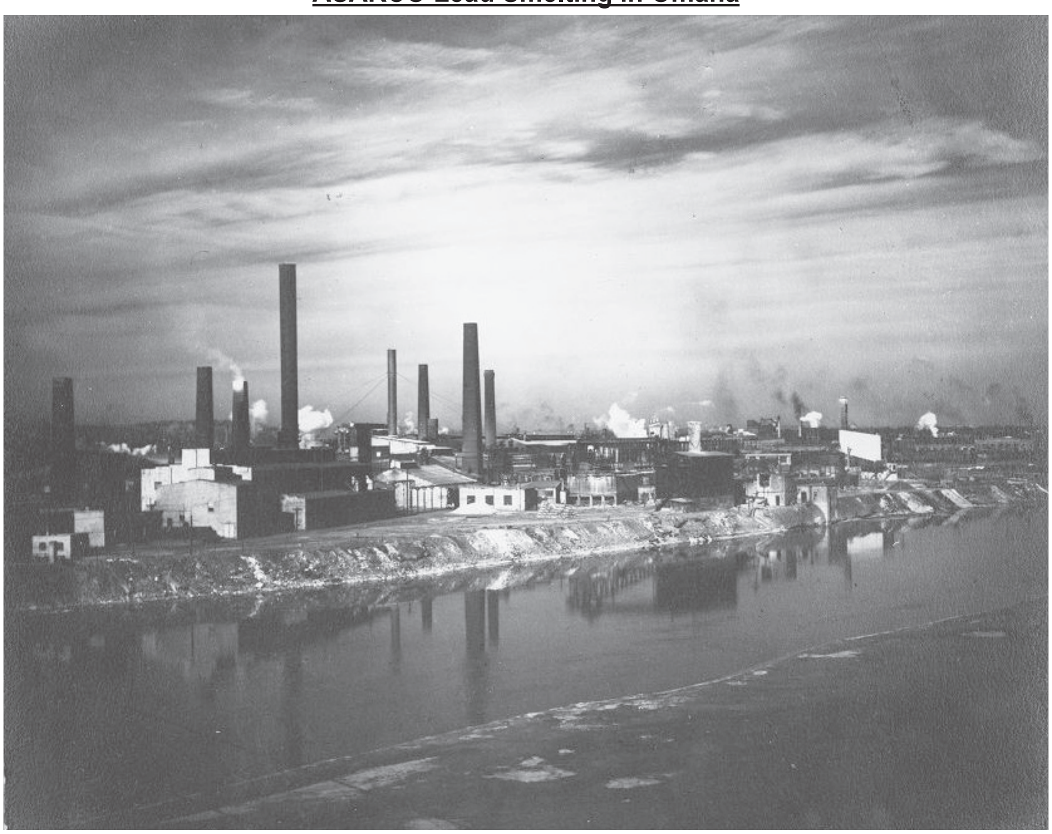


Image Credit: Durham Museum Archives

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