THE WORLD NEEDS MORE METALS—MAYBE AI CAN FIND THEM

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Do you realize that[1]:

- A typical electric car requires six times the mineral inputs of a conventional car
- A typical onshore wind plant requires nine times more mineral resources than a gas-fired power plant
- Since 2010, the average amount of minerals needed for a new unit of power generation capacity has increased by 50% as the share of renewables has risen
- It's possible that by 2040, lithium will see its demand grow by about 40 times, whereas graphite, cobalt and nickel could see demand grow by 20-25 times.

Clearly, there is a need for 1) more natural resources and 2) more efficient means by which to use them.

WisdomTree has an established history of focusing on commodity markets and different thematic trends. Some of the most interesting concepts spring to light when these different types of initiatives intersect.

It's clear that:

1. The world is more focused on the reduction of carbon emissions than at any point in recent history, and it could lead to certain actions, like a massive growth in electric vehicle demand.
2. A massive growth in electric vehicle demand would lead to a massive growth in the demand for batteries, which require lots of raw materials.
3. If we as a global society are going to find more of these raw materials, new techniques will be required, in the same way horizontal drilling in shale was required to find more fossil fuel resources. What is the analogous new technique that can be used to find more cobalt, nickel or lithium, for example?

More Data Could Lead to More Effective Mining

Geologists have a limited capacity to digest rich data provided by the new generation of exploration, including various fields of science such as geophysics, hyperspectral imaging, geochemistry and minerology. Properly calibrated machine learning techniques can be used to detect patterns that indicate the best chances for the presence of certain types of ore—like lithium, copper, nickel or whatever might be desired. Imagine a given site as a series of blocks of earth. The computer model can track the data within each block of earth, potentially leading to greater efficiencies.[2]

These techniques presently require significant supervision, because algorithms may see certain patterns in lakes, golf courses or wastewater treatment plants as great potential exploration sites when processing satellite imagery.[2] There has already been a useful tool developed in Zambia to deal with mafic rock, which, to the inexperienced could look like signals for deposits of copper. The benefit of properly trained

algorithms can lead to recognition of these false signals.[3]

KoBold Metals—Notable Company Seeking to Disrupt the Finding of Important Minerals

KoBold Metals is a start-up backed by Bill Gates's Breakthrough Energy Ventures. The company aims to use artificial intelligence (AI) to find metals needed for the electric-vehicle boom. In a recent financing round, KoBold was able to raise $192.5 million.[4]

One data collection technique involves a 115-foot-wide copper coil dangled from a helicopter, sending electromagnetic currents deep into the earth. Minerals have different electromagnetic properties, and the signals that come back contain valuable information about the types of minerals in various places. The possibility of nickel or cobalt deposits will have certain visible characteristics identified by the detector. This approach could cover more than 100 miles on a good day. It is unlikely that any single technique will hold all the answers, but the capability to 1) collect more data more efficiently and 2) overlay different types of data to better understand given regional deposits could be helpful.[5]

Miners have indicated that new deposits will have to be found much deeper in the earth's crust if the world is going to be able to meet its green energy needs of the future. It's possible that certain patterns could be located in the upper layers of crust that signal the potential presence of ores in lower layers.

Mining Sector May Need to Be Disrupted

It can take more than 10 years for new mines to become operational after companies receive different rights and permits. Discovering the best possible place to explore can also take significant time. Most of the easily identifiable high-grade deposits have already been found, and investment in exploration has been declining. A rough rule of thumb is that for every 100 sites evaluated, one will turn up a profitable deposit. It's possible that in recent years the actual figure is closer to one in 1,000.[6]

KoBold believes that discovery rates can be boosted by a factor of about 20; there is also a benefit if fewer unprofitable holes need to be dug.[7]

A lot of initial work is being done in Canada. Canada has large amounts of survey data in the public domain, such as[7]:

- Narrative field reports
- Timeworn geologic maps
- Geochemical data on drill hole samples
- Airborne magnetic and electromagnetic surveys
- Lidar readings
- Satellite imagery spanning many decades of exploration

Once the information is compiled, KoBold explores the data using machine learning, for instance building a model that could predict which parts of ore deposits could have the highest concentrations of cobalt. It's also possible that data can be added to models as its collected, allowing for adaptive changes to exploration strategy in real time.

KoBold partners with Stanford's Center for Earth Resources Forecasting, which adds an additional layer of analytics to the mix in the form of an AI 'decision agent' that can map an entire exploration plan. In a sense, this can quantify the uncertainty in KoBold's model results and design a data collection plan that can lead to the reduction of this uncertainty. If the goal is set in this way, it could guide scientists and researchers to gather the types of data and information that could lead to the biggest impact on the result—the finding of ore deposits—and guide away from activities that could be less impactful.

Conclusion: Another Case of Possibly More Accurate Predictions

AI, at its core, is using the data available to give users the chance at more accurate predictions. There is no guarantee that AI will immediately revolutionize mining or suddenly find and catalogue all minerals in the earth's crust. However, in other fields there is no guarantee that AI will immediately find effective new drugs or be able to autonomously guide vehicles. In the near term, these are new approaches where researchers and practitioners will learn a great deal that could lead to possible breakthroughs from AI techniques being used in tandem with human experts.

[1] Source: "The Role of Critical Minerals in Clean Energy Transitions." International Energy Agency. May 2021.

[2] Source: Descharnais, Guy. "The Power and Pitfalls of Predictive Algorithms." CIM Magazine. 15 February 2018.

[3] Source: Rosen, Jonathan W. "Electric Cars are Powered by Rare Metals. Can AI Help Find Them?" KoBold Metals. 3 December 2021.

[4] Source: Hoyle, Rhiannon. "KoBold Metals Raises $192.5 Million to Use AI to Find Battery Minerals." Wall Street Journal. 10 February 2022.

[5] Source: Stone, Maddie. "The Big Tech Question to Find the Metals Needed for the Energy Overhaul." MIT Technology Review. 11 August 2022.

[6] Source: Stone 2021.

[7] Source: Stone 2021.

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Machine learning : The use and development of computer systems that are able to learn and adapt without following explicit instructions, by using algorithms and statistical models to analyze and draw inferences from patterns in data.

Artificial intelligence : machine analysis and decision-making.