Carbon mineralization's role in addressing legacy mine waste while improving critical mineral production

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Additionally, thank you to our Alliance members for their help reviewing this memo.

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The need to reshore American mineral production

American mineral production has waned for decades, allowing competitors abroad to control supply chains for national security, energy and food production, and more. As noted by the Department of the Interior, the United States has lost its position as the global leader in both total production and the development of cutting-edge mining innovations.

This decline has empowered countries like China to leverage its market dominance, utilizing export restrictions as a tool of political and trade power. Bipartisan congressional legislation and administrative action, including the 2025 executive order Immediate Measures to Increase American Mineral Production, recognize that we can no longer rely on other countries for these critical resources.

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The role of novel mining technology in recovering untapped resources

Conventional mining practices have largely ignored one of the important resources we have to help accelerate domestic mineral production: mining waste. Today, there are thousands of abandoned mines or mineral processing facilities on federal land, and the U.S. produces an additional 1.5 billion tons of new mine waste each year. This mine waste represents a significant environmental liability and public health risk, costing the taxpayers hundreds of millions of dollars to remediate.

At the same time, these sites have untapped economic potential including substantial deposits of critical minerals that are essential to American energy and supply chain security. In fact, recovering critical minerals already present in mine waste could supply nearly the entirety of U.S. critical mineral needs.

Capitalizing on this dual opportunity — environmental remediation and mineral recovery — requires highly specialized technology that is challenging to develop and commercialize.

Carbon mineralization can utilize mine waste and help access critical minerals

One emerging technology that can help the U.S. capitalize on existing waste minerals is called mineralization. Mineralization is a type of carbon removal that occurs when certain deposits — often the ones found in mining waste piles — react with carbon dioxide to form new minerals, called carbonates. Through the creation of these carbonates, atmospheric carbon is durably locked away. The chemical transformation that occurs in this process also facilitates easier extraction of critical minerals like nickel and cobalt.

Carbon mineralization can help us convert liabilities into assets, but the technology needs further validation for widespread adoption to occur in the mining industry. Developers need to test their technologies using real feedstocks, demonstrate their integrations with mining operations, and operate pilot-scale deployments to derisk their technologies. For carbon mineralization companies — and many other novel mining technologies — bridging this commercialization gap is a challenge.

THE IMPORTANCE OF MINERAL PRODUCTION FOR NATIONAL PRIORITIES

Critical minerals are in cell phones, medical devices, semi conductors, electric vehicles, defense applications, and more. When other countries restrict these exports, they directly threaten America's ability to produce the things we rely on. To meet domestic critical mineral needs, we must look to the 1.5 billion tons of material already extracted annually: American mining waste.

THE CURRENT SITUATION:

- Mines in the United States produce 400 times more waste than the total annual waste of New York City.
- There are around 500,000 abandoned mines in the United States
- At least 40,000 abandoned mines sit on federal land and nearly 100 are on the EPA's Superfund National Priority List. This costs the federal government hundreds of millions in remediation and public safety spending each year.

THE OPPORTUNITY:

- Recovering critical minerals already present in mine waste could supply nearly the entirety of U.S. critical mineral needs.
- The revenue potential from carbon mineralization on these sites is estimated at $100 billion globally.

Photo courtesy of Adobe Stock

Karbonetiq

COMPANY SPOTLIGHT

Karbonetiq is a carbon mineralization company that utilizes steel slag — a byproduct of the steel production process — to durably remove carbon dioxide. Their technology facilitates a chemical reaction between the slag and atmospheric carbon to create stable minerals, effectively locking the carbon away for thousands of years. Their process also enriches the processed slag, allowing for the isolation and recovery of critical minerals like nickel and chrome that were previously inaccessible.

Photo courtesy of Karbonetiq

WHY TECHNICAL VALIDATION MATTERS

American mining companies are hesitant to adopt new technologies without empirical data. The EMRTAI program acts as a bridge, providing mining technology with the performance data needed to de-risk processes for existing industrial players.

EMRTAI: A program to bolster American-made mining technology

PROGRAM SUMMARY

- Management: Co-managed by Battelle Memorial Institute and the Environmental Protection Agency, which performs technical assessments on third-party mining technologies
- Budget: Initially $3 million (2024 – 2027)
- Focus: Technical validation and field demonstrations of novel mining technologies at EPA-managed legacy mine sites

Launched in 2024, the Environmental Monitoring and Remediation Technology Assessment Initiative (EMRTAI) is a public-private partnership designed to test and assess a range of emerging technologies that recover critical minerals.

This EPA program supports technical validation, performance assessments, and field demonstration of new mining technologies, a critical bridge for wider commercial adoption of these technologies by the mining industry.

Technologies already working via the EMRTAI program

To date EMRTAI grantees have included companies that recover minerals from mining waste and others that have developed specialized filters to extract minerals and rare earth elements. We believe carbon mineralization companies could also support the goals of the EMRTAI program, alongside other mining technologies.

Carbon mineralization is a novel technology that can help advance EMRTAI program goals and more:

- Addressing environmental remediation — The process can destroy toxic asbestos fibers that pose an environmental and public health risk, while preventing acid mine drainage
- Enhanced mineral recovery — Carbon mineralization makes it easier to extract critical minerals that were previously unrecoverable or held in low-grade waste
- Permanent carbon removal — Atmospheric carbon dioxide is turned into stable minerals, sequestering it for thousands of years
- Advancing U.S. leadership — Advances both domestic energy and environmental stewardship goals

SPOTLIGHT: QUEBEC MINERALIZATION HUB

This newly launched project is the first dedicated hub for testing and scaling carbon mineralization. The Hub gives researchers and startups access to permitted land, shared infrastructure, and 500 million tons of mine tailings to accelerate pilot projects and generate performance data for their technologies.

Continuing EMRTAI's impact beyond 2027

To realize this industrial-scale opportunity, we are advocating for a three-year extension for EMRTAI to continue scaling this important program, develop new technology on American soil, and accelerate the commercialization of critical new mining technologies.

FY27 APPROPRIATIONS REQUEST:

- Funding Level: $10 million
- Timeline: Three-year expansion
- Report Language (Proposed): "Innovative Mining Technology — The Committee recommends $10,000,000 to continue the Environmental Monitoring and Remediation Technology Assessment Initiative for three additional years. The Committee recognizes the importance of advancing technologies with the purpose of critical mineral extraction or stockpiling enriched materials. The Committee supports coordination between the relevant offices at the Environmental Protection Agency, the Environmental Protection Agency Abandoned Mines Land Team, the Department of the Interior, the Bureau of Land Management, the Department of Energy, and the US Forest Service to prioritize sites with high economic potential. In carrying out this section, the Committee supports the prioritization of technologies that create multiple, diverse, revenue streams from the same waste material including carbon sequestration."

Extending and expanding EMRTAI would enable new American technologies to be tested and validated in real-world conditions, ensuring they perform as intended. At the same time, the program would generate trusted, federally backed data to help support their partnership efforts with mining companies. By focusing on sites with existing infrastructure and high economic potential, the expansion would also help accelerate deployment where it can be most effective.

The United States faces a clear choice: continue our reliance on foreign supplies of critical minerals or unlock the strategic minerals currently sitting in our own waste piles. Status quo extraction cannot close the global mineral gap alone. By continuing to support the EMRTAI program, public officials will ensure the U.S. creates its own feedstocks for fertilizers, advanced batteries, defense hardware, and more.

Photo courtesy of Travertine

Carbon Removal Alliance

This memo is part of a series of policy memos on industrial partnerships. To see the full suite of recommendations, visit the "work" section of our website carbonremovalalliance.org