

THE MINING RUSH IS ON

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In a lot of ways, Colorado School of Mines was made for the current moment.

More than 150 years ago, the university was founded to support Colorado's mining industry, building knowledge and solving challenges related to the state's top mineral concerns of the day, gold and silver.

Over the years, that mission has expanded to support the evolution of industries in Colorado. The constant all those years? A world-renowned expertise in mining engineering, extractive metallurgy, mineral economics and more.

Today, a new mining rush is on, for dozens of minerals deemed "critical" to U.S. national security and the broader global economy, including those needed for energy systems, satellites, transportation, medical devices and defense technologies.

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And through strategic focus and investments in world-class facilities, real-world innovation and workforce development, Mines is bringing to bear its legacy of tackling the world's toughest resource challenges to lead today's conversations on critical minerals in the U.S. and beyond.

"As a solutions-driven university with the top-ranked mining and metallurgy program, expertise and new graduates in all aspects of the critical minerals supply chain, and a 152-year history of working closely with industry, Mines is uniquely positioned to be the nation's top university partner in this space," Mines President Paul C. Johnson said.



A STRATEGIC VISION

The [2025 Critical Minerals List from the U.S. Geological Survey](#) identified 60 minerals from aluminum and antimony to the 15 rare earth elements to zinc and zirconium – as both essential to U.S. economic or national security and at risk for supply chain disruption. The U.S. [Department of Energy also curates its own list](#), nicknamed the “Electric Eighteen” for their importance to energy technologies.

The supply chain challenges for each mineral are unique, as are the amounts needed, how each is currently sourced, additional options for securing the necessary supply and current market conditions (or lack thereof).

Or as Elizabeth Holley, associate professor of mining engineering and one of Mines' critical minerals experts, puts it when she talks to government officials, policy makers and journalists: Critical minerals isn't just one challenge. It's 60 unique challenges.

"Today, more people in the world have heard of critical minerals than they had five years ago," Johnson said. "But few understand the complexities beyond maybe having heard of cobalt or lithium and knowing they're connected to vital technologies and complicated geopolitics."

"From a national standpoint, you need a secure and abundant enough supply of the minerals needed by manufacturers and the defense industry that is affordable and that your adversaries can't use against you," Johnson said. "The interesting point is that the expertise in the U.S. in this area has atrophied significantly – there just aren't that many people who know how to do this, and it's very easy to manipulate the markets."

That's where Mines has a unique value proposition to offer – expertise along the full mineral supply chain, from exploration and extraction to processing and manufacturing to economics and end use, all under one roof, said Alicia Polo y La Borda Caverio, Mines' new executive director for critical minerals strategy and advancement.

"There are not very many organizations that have an active presence in mining, extraction, processing, processing at different scales, processing of minerals and metals, manufacturing and end users," Polo y La Borda said. "That is pretty unique."

Fueling that expertise in exploration and mining is Mines' No. 1 mining and mineral engineering program in the world, as well as active faculty-led research groups such as the [Center to Advance the Science of Exploration to Reclamation in Mining \(CASERM\)](#), a National Science Foundation Industry/University Cooperative Research Center aimed at transforming the way that geoscience data is used in the mineral resource industry, and the [NSF Growing Convergence Research Team](#), which brings together 11 academic disciplines to evaluate new mines, byproduct recovery and mine waste as production pathways for critical minerals.

When it comes to mineral processing, the [Kroll Institute for Extractive Metallurgy \(KIEM\)](#) has been conducting research important to the minerals, metals and materials industries since 1974. In more recent years, KIEM has been a key partner in the [Critical Minerals Innovation Hub at Mines](#), improving primary mineral processing and recovery, as well as secondary recovery through recycling and material characterization.

On the economics and policy side, Mines is home to the only [mineral and energy economics graduate program](#) in the U.S., and its master's and doctoral students are active in CMI conducting economic analysis of material supply chains. Since 2021, the [Payne Institute for Public Policy](#) has been holding an annual Critical Minerals Symposium, bringing industry, government and academia together at Mines to discuss geopolitics, supply chains, sustainable mining, community engagement, permitting, investments, markets and more.

Downstream users – the manufacturers and tech companies who need rare earth elements for powerful magnets and gallium for high-performance semiconductors, for example – are increasingly becoming part of the conversation around critical minerals, as well, Polo y La Borda said.

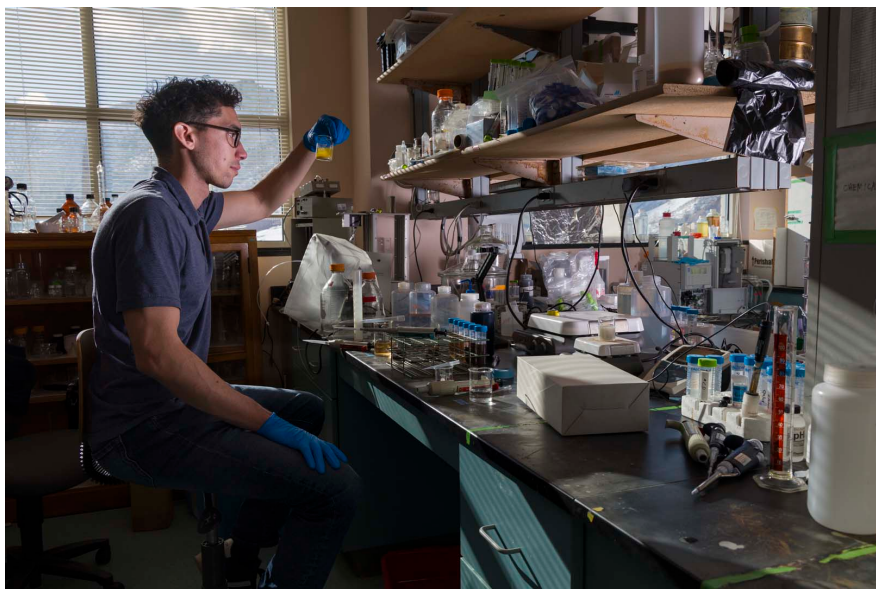
“If you want steel, there’s an established market – you can go and know the price and buy. If you are a producer, you know that someone will take your material because it has so many applications,” she said. “But in critical minerals, it’s not like you open a lithium mine and just sell it, because the brine needs different processes and the end products vary. Most likely, the production has already been committed. The downstream customers require materials in a certain way at a certain time and place.”

“The audience has changed,” Polo y La Borda said. “We should not only be thinking about the upstream miners, the traditional stakeholders. We need to think about the downstream – they are the ones that are guiding the conversation about critical minerals now because they are the ones that need these materials. The people producing them are a lot of startups that have some technical knowledge and are struggling for financing.”

A 25-year veteran of the mining industry, Polo y La Borda has broad experience in mineral economics and market analysis, business strategy and development, mining policy and project management, previously holding roles in the private sector, government and academia in the U.S., South America and Europe. Most recently, she served as the director of outreach and research at The Copper Mark, an independent assurance framework for the copper industry that verifies responsible production practices. She also served as program manager for Mines' Center for Mining Sustainability from 2019 to 2023.

"My job here at Mines is to connect what is happening in the labs with a wider audience," said Polo y La Borda, who rejoined Mines in December 2025. "What I see for Mines is opportunity – to interact across departments, to learn from each other and to leverage the work that is being done here to make a real impact on this global challenge."

That includes finding ways to amplify how Mines is positioned to make an impact, not only in terms of expertise on the end-to-end value chain but also the university's strengths in workforce development, innovation to commercialization and world-class facilities.



A STRATEGIC HUB FOR RESEARCH AND COMMERCIALIZATION

At the center of these efforts is a new facility that will act as a hub for university-industry-government-startup partnerships that lead to innovation and accelerated commercialization around critical minerals supply chain challenges.

Mines recently purchased the 50,000-square-foot building in Golden's Coors Technology Center. Located 10 minutes away from the main Mines campus, the facility includes laboratory, open room, and high-bay space, providing opportunities for all stages of innovation from bench-scale proof-of-concept tests to pilot/demonstration-scale projects.

"Our plan is to establish a dynamic hub that accelerates innovation and commercialization – to provide the solutions needed to solve our nation's materials supply chain challenges," Johnson said. "The key is to foster a collaborative environment where the co-location of startups, established companies, shared resources and the expertise Mines' faculty and alumni bring creates synergies that lead to faster creation of the critical minerals supply chains that U.S. industry needs."

Johnson likens the concept to a "critical minerals technology food court," where instead of choosing between burgers and pizza, entities with critical minerals-related challenges can come talk to multiple experts about potential solutions and partnerships, all in one central location.

"Why do you walk into a food court? You walk into a food court because you're hungry. You want something but maybe you're not quite sure what you want," Johnson said. "The analogy here is that people will be seeking help and connections to experts but perhaps don't know exactly what or who they need."

Mines is currently reviewing inquiries from potential industry partners, startups and other stakeholders interested in advancing their ideas and companies within the new hub.

"The vision is that a year from now, the rooms will be occupied by startups, some corporate R&D efforts, plus some Mines technology that is ready to move toward commercialization," Johnson said.

“This is not going to be a typical university research building – that’s the last thing that we want.”

The hub joins other unique Mines facilities – the Edgar Experimental Mine, Explosives Research Laboratory and the forthcoming U.S. Geological Survey Energy and Minerals Research Facility, as well as the Beck Venture Center, among them – to create a one-of-kind ecosystem for critical minerals innovation and commercialization.

To learn more about critical minerals at Mines, go to [**criticalminerals.mines.edu**](https://criticalminerals.mines.edu).

FROM SOURCE TO SOLUTION

Mines is shaping the conversation on critical minerals through groundbreaking research, real-world innovation and workforce development.

END TO END VALUE CHAIN

The demand dynamics for critical minerals is changing the rules of the game in the mining value chain at a fast pace. We have expertise spanning the full life cycle of critical minerals – from economics to extraction and processing to end use, our experts are shaping the conversation on a national and global scale.

INNOVATION AND SOLUTIONS

We collaborate with industry and government to solve real-world challenges, and we actively work to bring innovative solutions developed in our labs to market, with help from our dynamic entrepreneurship and innovation ecosystem.

WORKFORCE DEVELOPMENT

As a public R1 research university, training the next generation of problem solvers and leaders is central to our DNA. When it comes to critical minerals, Mines stands at the forefront, home to the No. 1 mining and mineral engineering program in the world (QS World University Rankings) and home to the only mineral and energy economics program in the U.S.

WORLD-CLASS FACILITIES

Solving the world's resource challenges requires the right research infrastructure, and Mines hosts world-class facilities for both lab-scale research and market scale-up.

- Edgar Experimental Mine
- Explosives Research Laboratory
- USGS Energy and Materials Research Facility
- Mines Critical Minerals Innovation & Commercialization Hub

A CATALYZING GIFT

Helping to stand up Mines' critical minerals initiative are lead gifts from Mines Board of Trustees chairman Bruce Grewcock '76 and Andy Swiger '78.

"The world needs new research and new ideas on how to produce critical minerals effectively, efficiently and in a sound environmental way. Mines has a real ability to make a difference in this space – we're the premier earth sciences university in the world. I am excited to help jumpstart this new initiative."

-Bruce Grewcock '76, chairman of Peter Kiewit and Sons', Inc

"Economic sourcing of critical minerals is one of the truly important strategic challenges of our time. Mines has decades of experience, expertise and know-how across the entire suite of capabilities that make up the critical minerals value chain. Additionally, Orediggers are known for a strong culture of problem solving. It is imperative that Mines attract the support necessary to assure a leading role."

-Andy Swiger '78, retired Exxon Mobil executive



Jerry Grandey '68

Board Chairman, Rare Element Resources

The opportunity to connect with other Mines alumni was what convinced Jerry Grandey '68 to get involved with Rare Element Resources, a strategic materials company that owns the Bear Lodge Rare Earth Project in Wyoming.

The former president and CEO of Cameco, one of the world's largest uranium mining and processing company, only knew a little about rare earth elements since they're often found with minor

concentrations of uranium. But the solvent extraction process used to separate the 17 elements from each other is similar to how uranium is recovered—except with a lot more steps, Grandey said.

“Experience taught me that you don’t go from finding a deposit to using a new processing technology—you need to go through the various bench, pilot and demonstration steps first,” Grandey said.

Rare Element Resources is developing a novel separation technology that is less capital and operationally intensive and more environmentally benign than traditional options. Initial operations at the company’s rare earth processing and separation demonstration plant in Wyoming began earlier this year. The company is also advancing permitting for the Bear Lodge deposit.

“Perseverance, technical acumen and the ability to handle a multitude of different things is ultimately what leads Mines graduates to be looked at to ‘be in the room,’” Grandey said. “Mines graduates are bright enough to understand there is a huge policy dimension to mineral development, as well.”



Kimberly Mills '06, PhD '14

Principal Metallurgist, SRK Consulting

Rare earths, cobalt, lithium, graphite, copper—Kimberly Mills '06 PhD '14 has worked on them all as a process engineer and metallurgist for the world's largest mining companies, smaller ventures and consultant firms.

"The critical minerals challenge is interesting to me because I feel like I'm making a difference," Mills said. "In the critical minerals space, I'm not just helping a company, I'm helping society."

No one was really talking about "criticality" when she first started working in the copper industry after earning her bachelor's degree in metallurgical and materials engineering. But copper's importance was clear—when she returned to Mines for her PhD, her industry-sponsored research with the Kroll Institute for Extractive Metallurgy focused on enargite, a copper arsenic sulfide mineral, and developing a hydrometallurgical process to remove the arsenic for a cleaner copper concentrate.

As the conversation and terminology have changed, Mills has translated that background across commodities. The metals and chemistry may be different, but whether copper or cobalt, the questions she asks about mineralogy, particle size and other factors are the same, she said. Today, Mills is principal metallurgist for SRK Consulting, an international mining consultancy firm, working on copper, gold and critical mineral projects around the world.

“People within the company come to me for questions on rare earths now,” Mills said. “The knowledge I developed at Mines—the options and typical flow sheets we see for these types of projects—it applies to all of these different minerals.”



Braeton Smith MS '14, PhD '18

Energy Economics Group Leader, Argonne National Laboratory

The increased attention to critical minerals is validating for Braeton Smith MS '14, PhD '18. An energy economist at Argonne National Laboratory, Smith is the co-author of the 2023 U.S. Department of Energy Critical Materials Assessment, which helps guide the department's research and development strategy.

"I'm excited that decision-makers at all levels are taking these issues seriously," Smith said. "Thoughts that have been floating in the ether for 10 years are finally starting to happen."

Smith, who earned his degrees in mineral and energy economics during the early days of the Critical Minerals Innovation Hub (CMI) at Mines, now leads a team of economists doing critical mineral supply chain research at Argonne. That team includes a growing contingent of Orediggers, not only because of their strong training

in computational economics but also their deep domain interest, he said.

"If you really care about minerals and markets, Mines is still the place to do those kinds of things," Smith said. "You learn how to be interdisciplinary. You learn how to listen to engineers and people doing other kinds of research. It makes you think about these problems more deeply."

Smith is currently working on the 2026 DOE Critical Materials Assessment, set for release this fall.

"Criticality is dynamic," Smith said. "To me, it's always interesting to think about which materials could create future problems."



Allie Anderson MS '15, PhD '17

Technical Expert, Nonferrous Metals, RHI Magnesita

Allie Anderson MS '15, PhD '17 caught the extractive metallurgy bug as an undergrad. Her professor at Gonzaga just happened to be a Mines alum—the late Pat Ferro PhD '94 became a mentor and encouraged her to attend Mines for a graduate degree.

“He put up a picture of a blast furnace in class one day, and I was hooked immediately—I knew I wanted to work with molten metal for the rest of my life,” Anderson said.

At Mines, Anderson conducted research in the Kroll Institute for Extractive Metallurgy, where she was first introduced to critical minerals. CMI funded her master's thesis on the primary production of rareearth metals, and she completed her PhD on lead recycling. Today, she works as a technical expert in nonferrous metals for RHI Magnesita, one of the largest refractory suppliers in the world, helping improve the efficiency, reliability and scalability of the high-temperature units necessary for pyrometallurgical processes. RHIM customers use pyrometallurgical processes to extract highly critical metals as well as industrial base metals like copper, lead, zinc and nickel from diverse feedstocks.

"It's one thing to mine the metal-containing material from the ground or post-consumer sources," Anderson said. "But if we don't have the plant infrastructure and the expertise to process that material, we still won't have a domestic supply of those metals."

In Anderson's mind, industry focus is what sets Mines apart. "Mines students are always in the room with industry and understand how to scale the kind of stuff they do in the lab to industrial-level work," she said.

"That mindset is attractive for the critical minerals discussion, because it's a real-world problem that requires practical, deployable solutions now."

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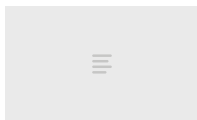
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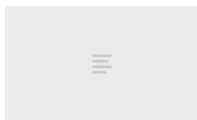
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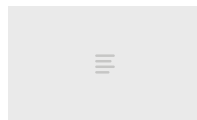
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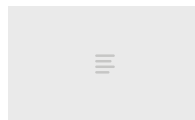
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