CRITICAL MINERALS

Colorado School of Mines Research

COLORADO SCHOOL OF MINES

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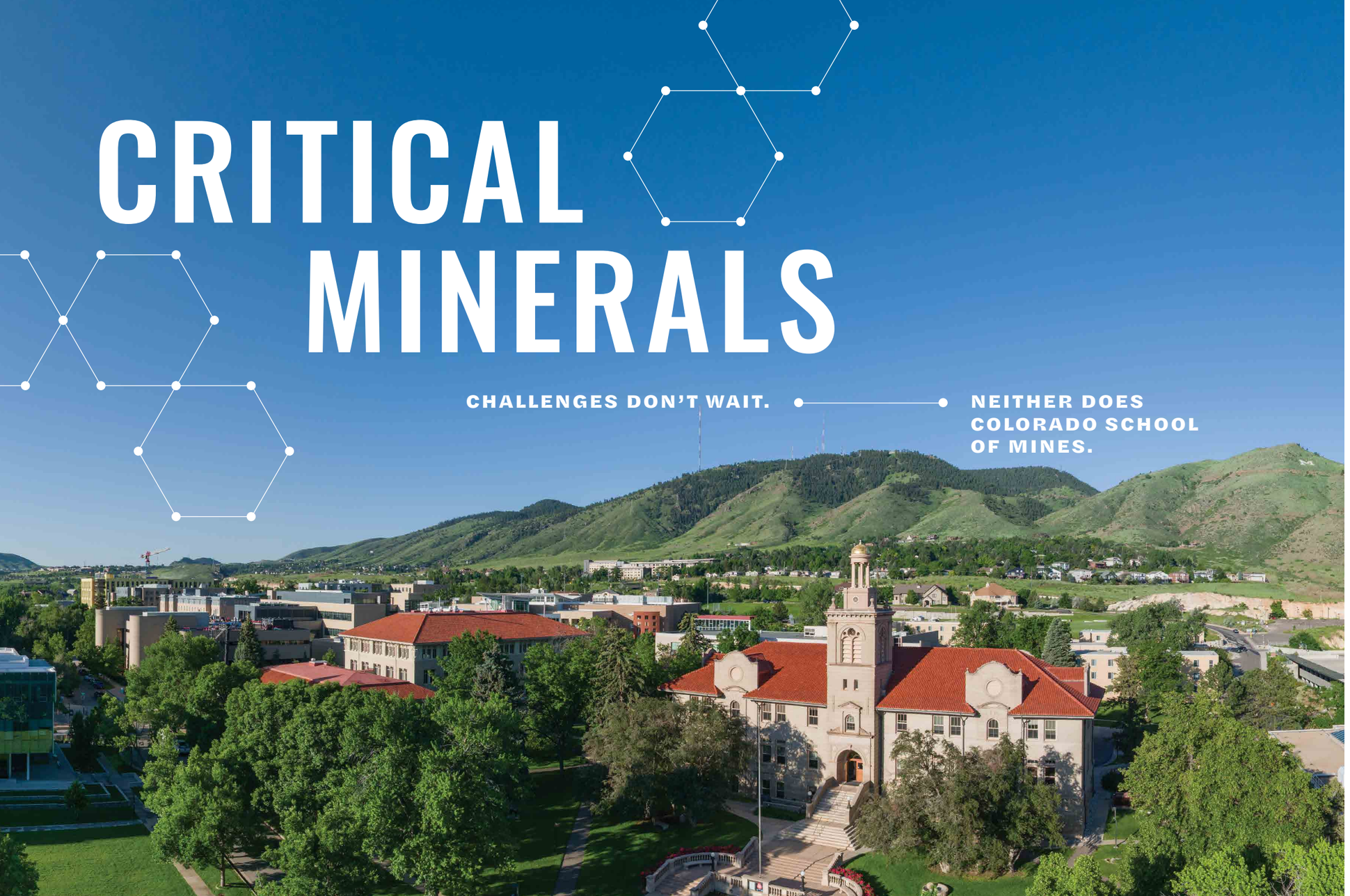
CHALLENGES DON'T WAIT.

NEITHER DOES COLORADO SCHOOL OF MINES.



Modern life runs on materials most people never see—rare earths, lithium, cobalt and other critical minerals power smartphones, satellites, energy systems, medical devices, defense technologies and more. As global demand spikes and supply chains become more complex, the race is on to secure these resources.

Critical minerals challenges don't wait. Neither does Colorado School of Mines.

Recognized by the prestigious Carnegie Classification as an R1 institution—among the top five percent in the U.S.—we aim higher and tackle the challenges that define our time. For more than 150 years, Mines has built a global reputation for providing solutions that incorporate an understanding of social, economic, policy and environmental impacts.

Nowhere is that clearer than in our critical minerals research. We advance every step of the critical minerals supply chain, from discovery and extraction to processing, recycling and policy development. Our dedicated faculty, students and partners work together on real-world solutions that secure reliable, sustainable supplies for the future. It's part of why we were named the No. 1 mineral and mining university by QS World University Rankings in 2025.

Through close collaborations, we help industry and government find answers to the world's toughest resource challenges. And it's how we continue to lead—not just by solving today's problems but by anticipating tomorrow's needs with relevance and results.

Explore how Mines is leading innovation in critical minerals at **mines.edu/critical-minerals-research**

INVESTED IN

IMPACT

At Mines, we invest in the people, projects and resources that drive breakthroughs in critical minerals research—leading the next step and the next mile. Our work is reshaping how we explore the Earth and build a more sustainable, secure future.

FUNDED RESEARCH

$9 MILLION

RAISED BY THE GROWING CONVERGENCE RESEARCH TEAM FOR THEIR PORTFOLIO OF PROJECTS

Mines researchers and Fort Lewis College—with support from the National Science Foundation—are reimagining U.S. critical mineral mining by exploring its technical, economic, social and political sustainability through an interdisciplinary lens through the Growing Convergence Research program.

GCR is evaluating three production pathways for critical minerals:

1. NEW MINES
2. BYPRODUCT RECOVERY
3. MINE WASTE

Read more about this work on **page 6**.

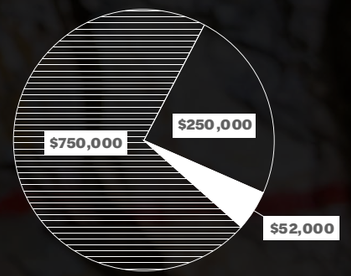
$1 MILLION+

ALFRED P. SLOAN FOUNDATION

$750,000 will help researchers gain a better understanding of the role of vertically integrated mine refinery projects in the domestic production of critical minerals for the energy transition.

$250,000 will fund a study of how energy researchers integrate societal considerations into their work.

$52,000 will help identify the electric vehicle charging and grid infrastructure needs of underrepresented communities and develop a better understanding of how different policies could be used to ensure vulnerable communities benefit from the transition to sustainable, electrified transportation.



Geological engineering student Wilson Garland collects photogrammetry and LiDAR data of an unsupported rock face in Mines' Edgar Experimental Mine.

RESEARCH EPICENTERS

CRITICAL MATERIALS INNOVATION HUB
Part of a larger U.S. DOE Energy Innovation Hub—led by Ames National Laboratory—CMI tackles key challenges across the entire critical materials lifecycle to support domestic, secure and sustainable supply chains for clean energy technologies.

ENERGY AND MINERALS RESEARCH FACILITY
Expected to open in 2027, this new addition to the Mines campus will provide more space and opportunities for researchers from both Mines and the U.S. Geological Survey to collaborate on key geological and mineral resource projects. Learn more about the new facility and how it will enhance critical minerals research and collaboration on **page 8**.

EDGAR EXPERIMENTAL MINE
An underground laboratory for engineers and scientists, the Edgar Experimental Mine is a Mines-owned classroom and research space that provides unique, hands-on experience for those being trained to find, develop and process natural resources, including solving challenges related to critical minerals.

BRINGING CRITICAL MINERALS STATESIDE

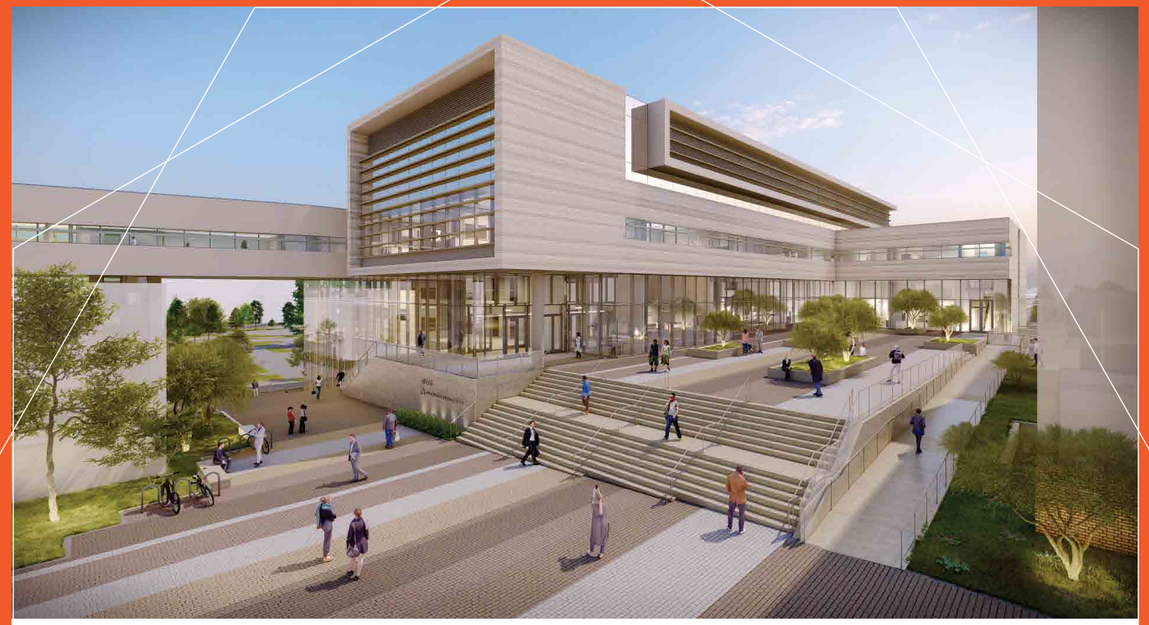
STORY BY SARAH KUTA

From smartphones to defense technologies, critical minerals are essential to everyday life.

But securing a stable, domestic supply is far from simple. At Mines, researchers from across disciplines are teaming up to tackle the technical, economic, environmental and social dimensions of producing more of these resources in the U.S. Their work spans new mining efforts, recovering minerals from waste and tapping overlooked byproducts—while also listening closely to community voices. By blending hard science with human insight, the team is helping shape a more resilient and responsible future for critical minerals.

Read the story and watch a video about the future of mining at **mines.edu/production-pathways**

Mines PhD student Karlie Hadden MS ’24 weighs out a sample of sparamine concentrate to run through a RO-tap machine.



A CRITICAL COLLABORATION

STORY BY JENN FIELDS

The U.S. Geological Survey and Mines have long worked side by side on everything from earthquakes to energy. Now, that partnership is expanding in a big way—with a new joint research facility and a shared focus on critical minerals. The Energy and Minerals Research Facility, opening in 2027, will house Mines and USGS scientists under one roof, enabling deeper collaboration on mineral mapping, geologic processes, resource recovery and more. For faculty, students and USGS researchers alike, it's a unique opportunity to advance mineral security and innovation together, in the same space.

Read the story and check out a time-lapse of the Energy and Materials Research Facility being built on the Mines campus at **mines.edu/energy-minerals-partnership**

TURNING WASTE INTO WORTH

STORY BY ASHLEY SPURGEON

Mine tailings—the leftover residue from mining—are often viewed as a costly waste problem. But at Mines, Associate Professor Reza Hedayat and his team are transforming this challenge into opportunity. By developing processes to convert tailings into durable, sustainable construction materials, they're tackling environmental impacts while helping to increase the efficiency of domestic critical minerals production and advancing a circular economy model. Bridging mineral recovery and material reuse, their work is helping reshape mining into a more sustainable and economically resilient industry.

Read the story and watch a video about the construction materials Hedayat is developing at **mines.edu/tailings-construction-materials**

Reza Hedayat, associate professor of civil and environmental engineering at Mines, is developing scalable processes to turn mine tailings into high-value construction materials—and the process is closely tied to critical minerals extraction.

ASKING THE RIGHT QUESTIONS—AND FINDING THE BEST ANSWERS

Addressing the complex challenges surrounding critical minerals requires an approach that spans economics, geopolitics and sustainable development. Mines student researchers in the Mineral and Energy Economics program are investigating key questions to provide actionable insights that inform policies and strategies that promote responsible sourcing, transparency and stability in the global critical minerals landscape. Here are some of the research questions they're exploring.

Q: How do geopolitical tensions and trade dependencies affect the resilience of global mineral supply chains, and what policies can help mitigate these vulnerabilities?

Q: How important are small-scale and artisanal miners to Zambia's production of key minerals like copper, cobalt and manganese, and how can this be quantified amid poor reporting?

Q: Why is sourcing some critical minerals—such as chromium, tantalite, tin and tungsten—often opaque and unstable, and what does this reveal about the need for responsible sourcing and supply chain stability?

Q: What is the long-term availability of critical minerals, what are the potential impacts of supply chain disruptions on key economic sectors and local communities, and to what extent are dominant players exercising market power over select materials?

Q: What is the economic impact of artisanal miners?

Find out how students are addressing these questions and learn about the impact of their research at **mines.edu/critical-minerals-questions**

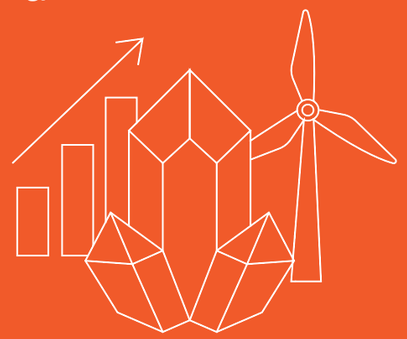
Every year, Colorado's Climax Mine, pictured here, produces approximately 30 million pounds of molybdenum, a critical mineral essential for manufacturing the high-strength steel used in many modern technologies.

LEADERS AT THE INTERSECTION OF ECONOMICS AND ENERGY

As demand for critical minerals grows, so does the need for experts who can navigate markets, assess supply-chain risks and help inform effective policy. Mines' Mineral and Energy Economics program—the only program of its kind in the U.S.—equips students with the resource economics expertise and skills to balance technical, economic and geopolitical realities. Graduates help inform effective decisions across government, industry and international development, securing reliable, responsible critical minerals essential for the energy transition and advanced technologies.

Mines is driving strategies to keep critical minerals accessible, sustainable and aligned with national security and economic priorities.

Learn more about how the Mineral and Energy Economics program is preparing the experts who make it possible at **mines.edu/mineral-energy-economics**



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research.mines.edu

At Colorado School of Mines, research means results.

As a leading public R1 university in applied science and engineering, Mines delivers the talent, breakthroughs and partnerships that power industry and serve society. Our researchers tackle real-world challenges with a collaborative, solutions-driven approach—working across disciplines and around the globe. From critical minerals to energy systems, Mines research is grounded in context, integrating technical innovation with social, economic, policy and environmental insight to build a more sustainable, prosperous future. Explore the impact at **research.mines.edu**

View this publication digitally and explore more content about how Mines is leading innovation in critical minerals at **mines.edu/critical-minerals-research**

Cover: A macro view of copper, one of the critical minerals essential to technology, energy and modern life.