HOUSE COMMITTEE ON
NATURAL RESOURCES
CHAIRMAN BRUCE WESTERMAN

To:	Subcommittee on Oversight and Investigations Republican Members
From:	Subcommittee on Oversight and Investigations Staff: Michelle Lane (Michelle.Lane@mail.house.gov), Annika Erickson (Annika.Erickson@mail.house.gov), and Sinclair Kouns (Sinclair.Kouns@mail.house.gov); x5-0500
Date:	Monday, December 1, 2025
Subject:	Oversight Hearing on "*Unleashing American Energy Dominance and Exploring New Frontiers*"

The Subcommittee on Oversight and Investigations will hold an oversight hearing titled "*Unleashing American Energy Dominance and Exploring New Frontiers*" on **Wednesday, December 3, 2025, at 2:00 p.m. in room 1324 Longworth House Office Building.**

Member offices are requested to notify Sinclair Kouns (Sinclair.Kouns@mail.house.gov) by 4:30 p.m. on December 2, 2025, if their Member intends to participate in the hearing.

I. KEY MESSAGES

- Technological innovation is crucial for the U.S. mining industry, as industry works to compete globally and satisfy U.S. domestic demand for critical minerals.

- Leveraging our nation's culture of innovation, American companies are harnessing new technologies, such as artificial intelligence (AI), lasers, advanced robotics, and sensor-based separation methods, to mine and process minerals domestically, reduce waste, lower costs, and extend lifecycles for mines.

- As the uses for, and applications of, mining technology rapidly advance and change, federal agencies and regulations must keep pace and remove unnecessary barriers put in place by the Biden administration.

- The Trump administration and Congressional Republicans are working to secure our domestic critical mineral supply chain and shore up domestic mineral processing through permitting reform and key investments in technology.

II. WITNESSES

Panel I (Outside Experts)

- **Mr. Daniel Donahue**, Head of Growth, Terra AI, San Francisco, CA
- **Mr. Mahesh Konduru**, Chief Executive Officer, Momentum Technologies, Carrollton, TX
- **Mr. Nicholas Lugansky,** Head of Mining, SLB New Energy, Houston, TX
- **Walter G. Copan, Ph.D.,** Vice President for Research and Technology Transfer, Colorado School of Mines, Golden, CO *[Minority witness]*

III. BACKGROUND

Mineral Production Landscape

In the 21st century, the importance of minerals—particularly those that the Department of the Interior's (DOI) U.S. Geological Survey (USGS) now includes on its lists of critical minerals—in our daily lives has grown exponentially. Critical and other hardrock minerals are used in countless applications, including consumer electronics, medical devices, satellites, batteries, and military technologies essential to national security. In the last two decades alone, annual trade in energy-related critical minerals like cobalt, copper, lithium, and nickel has increased from $53 billion to $378 billion.[1] Demand is likely to keep rising. The World Bank, for example, estimates that demand for minerals will increase by nearly 500 percent by 2050.[2]

Unfortunately, the U.S. has become dependent on foreign nations to meet its mineral needs. Championed by Democrats, permitting delays and legislative restrictions have hampered domestic mineral production, discouraging investment and restricting long-term American mineral supplies.[3] In fact, a 2024 study by S&P Global found that U.S. critical mineral projects take an average of 29 years from discovery to production.[4] Only Zambia is less efficient in mining minerals within its own borders.[5] Worse still, U.S.-based mining projects also lose over one-third of their value due to delays encountered during the permitting process.[6]

Accordingly, America imports more than half of its supply for 29 of the 50 minerals that the federal government deems critical and the entirety of its supply for 12 more.[7] China, by contrast, produces an overwhelming majority of the world's mineral output, supplying 5 billion tons of these minerals in 2022.[8] Moreover, not only does China dominate global mineral production, but

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[1] Monia Snoussi-Mimouni & Sandra Avérous, *High demand for energy-related critical minerals creates supply chain pressures*, WORLD TRADE ORGANIZATION (Jan. 10, 2024), https://www.wto.org/english/blogs_e/data_blog_e/blog_dta_10jan24_e.htm.
[2] Kirsten Hund, et al., *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition*, THE WORLD BANK (2020), https://documents1.worldbank.org/curated/en/099052423172525564/pdf/P16627806f5aa400508f8c0bdcba0878a3e.pdf.
[3] Duncan Wood, et al., *The Mosaic Approach: a Multidimensional Strategy for Strengthening America's Critical Minerals Supply Chain*, WILSON CENTER, https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/critical_minerals_supply_report.pdf.
[4] Bonakdarpour, et al., *Mine development times: The US in perspective,* S&P Global (June 2024), https://cdn.ihsmarkit.com/www/pdf/0724/SPGlobal_NMA_DevelopmentTimesUSinPerspective_June_2024.pdf.
[5] *Id.*
[6] *Id.*
[7] *Mineral Commodity Summaries 2024*, U.S. GEOLOGICAL SURVEY (Jan. 31, 2024), https://pubs.usgs.gov/periodicals/mcs2024/mcs2024.pdf.
[8] *Mineral Production by Country 2025*, WORLD POPULATION REVIEW, https://worldpopulationreview.com/country-rankings/mineral-production-by-country.

it also accounts for 85 percent of worldwide mineral processing and refining.[9] The risks of China's control of global mineral production, processing, and refining markets to America's economy and national security cannot be overstated.

As the mining industry continues to evolve and as emerging technologies enhance domestic mining capabilities, there will be a resultant increase in demand for minerals.[10] President Trump and Congressional Republicans are working to reduce regulatory burdens on America's mining industry and champion domestic mining innovation.[11] By leveraging the United States' culture of technological innovation and implementing essential regulatory streamlining, we can increase domestic mineral production, processing, and refining, and achieve energy and mineral independence.

The Mining Life Cycle

To understand why technological advancement is crucial to the mining industry's future, it is important to realize that mining is a complicated, multi-stage industrial process that extracts valuable minerals from the earth and transforms them into usable products.[12] The life cycle of a mine includes exploration, evaluation, development, production, and, after the resources are extracted, closure and reclamation of the land used for mining.[13] Emerging mining technologies can improve every stage of the mining life cycle.[14]

Exploration and evaluation—the first phase of a mining project—is a lengthy and complex process that takes an average of two to ten years to complete.[15] Exploration and evaluation include locating potential deposits, early-stage prospecting, surface exploration, core drilling, resource modeling, de-risking, and production decisions.[16] Once viable deposits are established with confidence, the development stage begins as project developers seek to obtain necessary permits, financing, and coordinate mining operation logistics.[17] Necessary logistics range from environmental impact statements and economic feasibility studies to mine development and construction.[18] Mine development includes obtaining project-specific mining equipment,

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[9] Bonnie S. Glaser & Abigail Wulf, *China's Role in Critical Mineral Supply Chains*, GERMAN MARSHALL FUND (Aug. 2, 2023), https://www.gmfus.org/news/chinas-role-critical-mineral-supply-chains.
[10] Linda R. Rowan, *Critical Mineral Resources: National Policy and Critical Minerals List*, CONG. RSCH. SERV. (Sept. 18, 2025), https://www.congress.gov/crs-product/R47982.
[11] Steven I. Suzzan & Craig S. Vogelsang, *US policy changes to critical mineral strategy included in "Unleashing American Energy" executive order*, NORTON ROSE FULBRIGHT (Jan. 2025), https://www.nortonrosefulbright.com/en-419/knowledge/publications/7946414d/us-policy-changes-to-critical-mineral-strategy.
[12] William Andrew Hustrulid & George B. Clark, *Mining*, BRITANNICA (Sept. 13, 2025), https://www.britannica.com/technology/mining.
[13] William Hughes, *The stages of mining: 5 lifecycle processes explained*, OPENS (June 17, 2021), https://www.opens.co/articles/the-stages-of-mining.
[14] *How Technology is Impacting the Mining Industry*, EMPIRE SOUTHWEST, https://www.empire-cat.com/company/news/how-technology-is-impacting-the-mining-industry.
[15] *Examining the Mining Industry Value Chain*, SAP, https://learning.sap.com/learning-journeys/introducing-the-mining-industry/examining-the-mining-industry-value-chain.
[16] Brian Goss, *8 Steps of Mineral Exploration*, RANGEFRONT (Mar. 9, 2022), https://rangefront.com/blog/8-steps-mineral-exploration/.
[17] *Examining the Mining Industry Value Chain*, SAP, https://learning.sap.com/learning-journeys/introducing-the-mining-industry/examining-the-mining-industry-value-chain.
[18] *The Mining Lifecycle*, BRITISH COLUMBIA MINE INFORMATION, https://mines.nrs.gov.bc.ca/lifecycle.

overburden removal, and constructing processing plants and other facilities such as roads, management offices, maintenance facilities, and employee housing.[19]
The production phase follows development and is typically the longest phase of a mine's lifespan.[20] During production, ore extraction takes place via mining operations, which involve implementing mine planning strategies, executing mining functions, and managing the early-stage supply chain of extracted minerals.[21] Mineral extraction may take place via various surface mining techniques or underground mining techniques that are used to obtain raw minerals.[22] The two main types of ore deposits are:[23] placer deposits, which are found in rivers, streams, and beach sands, and lode deposits, which are contained in layers, veins, or mineral grains within rock bodies.[24] Following extraction, mining project operators must handle the minerals by sorting them from waste materials called tailings.[25] The final stage of production is mineral processing. This process involves crushing, grinding, smelting, or refining the materials that become the final mineral products to be distributed.[26]

After mineral production is complete, the mining project must be closed and reclaimed. This phase requires mining companies to restore and redevelop the mining area by removing infrastructure and reestablishing vegetation.[27] Of course, mining companies must also comply with the closure regulations of the jurisdictions in which their mines are located.[28]

Artificial Intelligence in Mineral Exploration

The mining industry's most disruptive bottleneck exists not in development, but in exploration.[29] Currently, it takes an average of 17 years after discovery to start production at a new copper mine, and, unfortunately, this timeline is only growing longer.[30] Seventy-five percent of a project's exploration cost is incurred after initial discovery.[31] Accordingly, mining companies are looking to utilize burgeoning AI technologies to help expedite mineral exploration. Sophisticated AI models optimize large-scale natural resource development projects in critical mineral production, low-carbon subsurface reservoir management, and alternative energy generation for mining projects.[32]

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[19] *Mining Industry: A Complete Guide*, FLYABILITY, https://www.flyability.com/blog/mining-industry; William Hughes, *The stages of mining: 5 lifecycle processes explained*, OPENS (June 17, 2021), https://www.opens.co/articles/the-stages-of-mining.
[20] *Examining the Mining Industry Value Chain*, SAP, https://learning.sap.com/learning-journeys/introducing-the-mining-industry/examining-the-mining-industry-value-chain.
[21] *Id.*
[22] *Mining Industry: A Complete Guide*, FLYABILITY, https://www.flyability.com/blog/mining-industry.
[23] *Id.*
[24] *Id.*
[25] *Id.*
[26] *Id.*
[27] *Examining the Mining Industry Value Chain*, SAP, https://learning.sap.com/learning-journeys/introducing-the-mining-industry/examining-the-mining-industry-value-chain.
[28] *Id.*
[29] *About*, TERRA AI, https://www.terraai.com/about.
[30] *Id.*
[31] *Id.*
[32] *Id.*

The mining industry has used autonomous fleets since the 1990s.[33] New developments in machine learning and generative AI, however, will enable these fleets to respond in real time to rapidly changing mining operations, increasing mine safety and securing mineral outputs.[34] Caterpillar Inc., the mining industry's largest original equipment manufacturer,[35] has emerged as the preeminent leader in applying AI to industrial mining technology.[36] By focusing on customer-led research and development in collaboration with the major mining companies, this Texas-based company can create AI-enabled autonomous and semi-autonomous machinery that meets specific needs across the mineral supply chain.[37]

Ultimately, AI's mining applications are extensive. From operational efficiency and autonomous technology to mineral exploration and data processing, the technology sector is bringing rapid advancements to mining companies at a time when the need for minerals is growing faster than ever.[38]

Mineral Separation and Metal Recovery

Mineral separation technologies, such as decanter centrifuges, gravity separation equipment, flotation machines, magnetic separators, and electrostatic separation, are also crucial to pushing the mining industry forward.[39] Separation is necessary to extract elements from ores, including copper, iron, gold, silver, and zinc.[40] One of the most promising new technologies in the emerging mining technology sector uses high-voltage electrical pulses to generate fractures along the grain boundaries between valuable minerals and waste rock, thus enhancing metal liberation and reducing environmental footprint.[41] The solution is particularly useful for minerals that would otherwise require intense thermal or chemical separation, offering preferential liberation and the potential for water and energy savings.[42] This technology creates a more sustainable mining industry by enabling more efficient processing of complex ore bodies with reduced energy and water demand, supporting the industry's overall transition toward greener operations.[43]

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[33] *Autonomous Haulage Systems – The Future of Mining Operations*, FUTUREBRIDGE (Oct. 17, 2024), https://www.futurebridge.com/industry/perspectives-industrial-manufacturing/autonomous-haulage-systems-the-future-of-mining-operations/.
[34] *The Future of Artificial Intelligence (AI) at Caterpillar*, CATERPILLAR (Apr. 16, 2024), https://www.caterpillar.com/en/news/caterpillarNews/2024/future-of-ai-at-caterpillar.html.
[35] *See* Marcus Law, *Top 10: Mining Equipment Manufacturers*, MINING DIGITAL (Aug. 8, 2024), https://miningdigital.com/top10/top-10-mining-equipment-manufacturers.
[36] *See* Dany Kitishian, *Caterpillar's AI Strategy: Analysis of Dominance in Construction, Mining, Energy, Rail*, KLOVER.AI (July 19, 2025), https://www.klover.ai/caterpillar-ai-strategy-analysis-of-dominance-in-construction-mining-energy-rail/.
[37] *Id.*
[38] Jasper Ivan Madlangbayan & Tamara Thorne, *A peek at AI revolution in mining: promise meets peril*, S&P GLOBAL (Feb. 5, 2025), https://www.spglobal.com/market-intelligence/en/news-insights/research/a-peek-at-ai-revolution-in-mining-promise-meets-peril.
[39] *Separation Solutions: Enhancing Efficiency in the Mining Processes*, KENNAMETAL (Feb. 29, 2024), https://www.kennametal.com/us/en/resources/blog/wear-protection/separation-solutions-enhancing-efficiency-in-the-mining-processe.html.
[40] *Id.*
[41] H. Gupta & R. Bracey, *Pivots and Progress: Advancing comminution solutions in an open innovation framework*, MEI CONFERENCES, https://www.min-eng.com/comminution25/drafts/session5/gupta.pdf.
[42] Miranda Barker, *Innovation can disrupt the mining industry. These sustainable start-ups are leading the way*, WORLD ECONOMIC FORUM (Nov. 29, 2024), https://www.weforum.org/stories/2024/11/13-innovations-making-the-mining-and-metals-industry-more-sustainable/.
[43] *Id.*

X-ray sorting can also be used for mineral separation. For example, one technology, "DriJet," uses X-ray sorting to measure the atomic mass of individual pieces of coal before employing pneumatic jets to separate coal and ash fractions without any water or consumable chemicals.[44] Additionally, when paired with AI, sensor-based ore sorting can use deep neural networks to classify individual particles in high-throughput X-ray transmission sorting for better recovery.[45]

Technological advancements are also reshaping smelting. From heap-leaching processes that recover copper from low-grade sulfide ores to experimental mineral separation reactors that use vanadium to extract critical minerals, the considerable innovation and investment in smelting augur promising results in the near future.[46] These processes, while still confined to small-scale applications, would produce far less pollution and carbon emissions than would traditional forms of smelting.[47]

Direct Lithium Extraction

Unlike traditional methods of lithium mining, such as solar evaporation brine extraction and hard rock mining, direct lithium extraction enables lithium ions to be extracted from brines.[48] Direct lithium extraction may offer significant advantages over traditional methods, including faster production, higher recovery rates, and smaller environmental footprints. Direct lithium extraction technologies, for example, can recover up to 90 percent of lithium in hours or days compared to the traditional 40 percent lithium yield after two to three years for solar evaporation.[49]

Only a handful of direct lithium extraction technologies, including sorbent-based, ion exchange-based, solvent-based, and membrane-based, have progressed beyond the early stages of development and refinement.[50] For example, in 2024, Schlumberger Limited (SLB) announced that it had successfully used direct lithium extraction at its demonstration plant in Clayton Valley, Nevada.[51] SLB's demonstration plant, operating at one-tenth the size of a commercial-scale facility, produced lithium 500 times faster than it would have using conventional methods and achieved a 96-percent lithium recovery rate from brine.[52] In 2024, Controlled Thermal Resources Holdings, Inc. (CTR) also began developing a direct lithium extraction plant near the Salton Sea in California, with a target goal of producing 25,000 metric tons of battery-grade

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[44] *Our Product*, MINERAL SEPARATION TECHNOLOGIES, http://mineralseparationtechnology.com/OurProduct.html.
[45] *How Artificial Intelligence is powering up sorting in mining and entering a new era with Deep Learning*, TOMRA (Feb. 5, 2024), https://www.tomra.com/mining/media-center/news/2024/obtain---ai-powered-ore-sorting.
[46] Maddie Stone, *New technologies could refine the copper the world needs — without the dirty smelting*, GRIST (Dec. 3, 2024), https://grist.org/technology/copper-energy-transition-refining-smelting-pollution-heap-leaching/.
[47] *Id.*
[48] *Lithium Extraction Methods - From Traditional to Innovative Approaches*, LITHIUM HARVEST (Mar. 12, 2025), https://lithiumharvest.com/knowledge/lithium-extraction/lithium-extraction-methods/.
[49] *Id.*; Amir Razmjou, *Direct Lithium Extraction (DLE): An Introduction*, INTERNATIONAL LITHIUM ASSOCIATION (June 2024), https://lithium.org/wp-content/uploads/2024/06/Direct-Lithium-Extraction-DLE-An-introduction-ILiA-June-2024-v.1-English-web.pdf.
[50] *Critical Minerals: Status, Challenges, and Policy Options for Recovery from Nontraditional Sources*, GOVERNMENT ACCOUNTABILITY OFFICE (July 2024), https://www.gao.gov/assets/gao-24-106395.pdf; Amir Razmjou, *Direct Lithium Extraction (DLE): An Introduction*, INTERNATIONAL LITHIUM ASSOCIATION (June 2024), https://lithium.org/wp-content/uploads/2024/06/Direct-Lithium-Extraction-DLE-An-introduction-ILiA-June-2024-v.1-English-web.pdf.
[51] *SLB achieves breakthrough results in sustainable lithium production*, SLB (Sept. 10, 2024), https://www.slb.com/news-and-insights/newsroom/press-release/2024/slb-achieves-breakthrough-results-in-sustainable-lithium-production.
[52] *Id.*

lithium from geothermal brine annually.[53]

A recent GAO report found that there are significant challenges to developing an effective direct lithium extraction technology, such as high initial investment costs, scalability, and overcoming technical issues.[54] For example, less advanced technologies will need to resolve how to extract lithium while leaving behind other substances like iron, manganese, or silica.[55] Additionally, each brine source can have distinct characteristics, such as different types of minerals at varying concentration levels, and thus may require a unique lithium extraction process.[56] Despite these challenges, the prospects for direct lithium extraction remain promising.

Congressional Actions and Presidential Executive Orders

On March 20, 2025, President Trump issued Executive Order (EO) 14241, titled "Immediate Measures to Increase American Mineral Production."[57] Recognizing America's reliance on foreign nations for critical minerals and mineral production, President Trump ordered agencies to review relevant federal laws, lands, leases, and investment opportunities related to mining and mineral processing.[58] By identifying federal lands suitable for leasing and development, agencies can allow mining projects to move forward and encourage technological advancements to match the scope and scale of the American mining industry.

EO 14241 built upon EO 14156, which was issued on January 20, 2025, and titled "Declaring a National Energy Emergency." EO 14156 highlighted the dangers of America's current inadequate mineral supply and infrastructure and our need for "a reliable, diversified, and affordable supply of energy to drive our Nation's manufacturing, transportation, agriculture, and defense industries, and to sustain the basics of modern life and military preparedness."[59]

Similarly, on April 24, 2025, President Trump issued EO 14285, titled "Unleashing America's Offshore Critical Minerals and Resources," which made clear that the U.S. must immediately accelerate the development of seabed mineral resources and invest in deep sea mapping.[60] The U.S. Department of Energy (DOE) released an announcement on August 13, 2025, declaring its intent to issue notices of funding opportunities to advance mining, processing, and manufacturing technologies across key stages of the critical minerals and materials supply

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[53] L.L. Poirier, *Groundbreaking Lithium Extraction Plant Launches in California*, ENR WEST (Feb. 6, 2024), https://www.enr.com/articles/58102-groundbreaking-lithium-extraction-plant-launches-in-california; Carlo Cariaga, *Controlled Thermal Resources provides updates on Hell's Kitchen geothermal project*, THINK GEOENERGY (Aug. 11, 2025), https://www.thinkgeoenergy.com/controlled-thermal-resources-provides-updates-on-hells-kitchen-geothermal-project/.
[54] *Critical Minerals: Status, Challenges, and Policy Options for Recovery from Nontraditional Sources*, GOVERNMENT ACCOUNTABILITY OFFICE (July 2024), https://www.gao.gov/assets/gao-24-106395.pdf.
[55] *Id.*
[56] *Id.*
[57] Exec. Order No. 14241, 90 Fed. Reg. 13673 (Mar. 20, 2025), https://www.federalregister.gov/documents/2025/03/25/2025-05212/immediate-measures-to-increase-american-mineral-production.
[58] *Id.*
[59] Exec. Order No. 14156, 90 Fed. Reg. 8433 (Jan. 20, 2025), https://www.federalregister.gov/documents/2025/01/29/2025-02003/declaring-a-national-energy-emergency.
[60] Exec. Order No. 14285, 90 Fed. Reg. 17735 (Apr. 24, 2025), https://www.federalregister.gov/documents/2025/04/29/2025-07470/unleashing-americas-offshore-critical-minerals-and-resources.

chains.[61] These funding opportunities will total nearly $1 billion and addressing areas including "processes in the rare-earth magnet supply chain; processes to refine and alloy gallium, gallium nitride, germanium, and silicon carbide for use in semiconductors; cost-competitive technologies for direct lithium extraction and separation; and critical-material separation technologies that allow for the co-production of useful products from byproducts and scrap."[62]

Congressional Republicans have also taken steps to unleash America's mineral independence. For example, H.R. 4090, introduced by Rep. Pete Stauber (R-MN), will remove legal and regulatory bottlenecks to domestic mining by directing DOI to revise or rescind agency actions that hinder mining projects, recommend changes to streamline current mining laws, and conduct a nationwide review of state and local laws impeding mineral exploration and development.[63] The bill also codifies key portions of President Trump's energy EOs.[64] H.R. 4090 was favorably reported out of the House Committee on Natural Resources on September 17, 2025, by a vote of 26 to 16.

As the White House and Congress signal support for permitting reform and unleashing America's domestic resources and supply chains, companies supporting the mining industry with innovative novel technologies can allow domestic mining to thrive. With U.S. companies leading the way, new technologies will continue to drive the mining industry, and federal laws and agencies must keep up. Accordingly, President Trump and Congressional Republicans are taking action to ensure that America's mining industry is no longer thwarted by unnecessary federal restrictions and delays.

[61] *Energy Department Announces Actions to Secure American Critical Minerals and Materials Supply Chain*, U. S. DEPT. OF ENERGY (Aug. 13, 2025), https://www.energy.gov/articles/energy-department-announces-actions-secure-american-critical-minerals-and-materials-supply.
[62] *Id.*
[63] H.R. 4090, 119th Cong. (1st Sess. 2025), https://www.congress.gov/bill/119th-congress/house-bill/4090/text.
[64] *Id.*