The Payne Institute for Public Policy
AT COLORADO SCHOOL OF MINES

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The Fastest Path to Strategic Mineral Security

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Securing the Supply of Strategic Minerals

The United States is facing a critical minerals emergency. Our national defense, semiconductor, heavy manufacturing, and advanced energy sectors all rely on mineral supply chains dominated by foreign sources. China controls much of the production and processing of key critical minerals and has already imposed export restrictions on materials essential to U.S. weapon syqstems and strategic industries (WSJ). While other nations also produce critical minerals, the U.S. currently lacks the domestic processing capacity to convert raw materials into usable products. Without modern infrastructure, even domestic or ally-sourced materials cannot reliably flow into U.S. markets.

Adding to this vulnerability is the painfully slow pace of traditional mine development. A new U.S. mine now averages *15 years from discovery to production* (S&P Global). Even when ore bodies exist domestically, the lack of modern midstream mineral processing capacity prevents the U.S. from quickly converting raw materials into critical inputs for defense and industry. In short, the challenge is not just access to mineral resources, but the ability to transform those resources into usable, strategic materials in a timely and cost-effective manner.

Next-Generation Midstream Infrastructure

The fastest path to strategic mineral security is building domestic processing infrastructure that can handle raw materials from both domestic and allied sources. Midstream assets - smelters, separation facilities, and refineries - are the linchpin of reliable supply. Simply having access to ore or waste is insufficient if domestic facilities cannot refine, separate, and purify the critical minerals U.S. industries require.

Solving this challenge presents the U.S. minerals industry an unprecedented opportunity in midstream facility development. Unlike China, whose aging processing infrastructure was built primarily to scale production with lower-cost labor, the United States can construct a next generation of mineral processing facilities that are:

- **Highly automated operations** that apply machine learning to maximize efficiency, minimize human error, and provide products that are optimized for the precise needs of each customer.
- **Flexible, modular designs** capable of switching between multiple feedstocks of ores, slags, and mineral wastes to maintain continuous supply and adapt to market demand.
- **Environmentally optimized systems** that incorporate energy recovery, water recycling, and low-emission processes that meet all U.S. regulatory standards.
- **Data-driven operational intelligence** that leverages AI, predictive analytics, and high-resolution mineral mapping to optimize recovery rates, reduce costs, and anticipate maintenance needs (Forbes).
- **Globally cost competitive** while producing the world's highest quality mineral products at a price that is**.**

Building this type of infrastructure in the United States would do more than secure domestic supply. It would reposition the U.S. as a global minerals leader, with capabilities and efficiencies that surpass those of traditional processing hubs in China, Australia or other mineral-producing nations. It is not about catching up - it is about leapfrogging to a new standard for midstream mineral processing.

Waste-to-Market: Tapping Domestic Feedstock

As new midstream infrastructure is being developed, many are recognizing that the quickest route to near-term production may come from existing domestic mineral waste resources (Mining.com). Commercial Waste-to-Market (W2M) pathways tap into legacy and operational mine wastes, slags, red mud, and fly ash to supply concentrated, accessible, and cost-competitive feedstocks without the long timelines and high costs of developing a new mine.

The idea of extracting target minerals from waste is not a new idea, but perhaps it is an idea whose time has come. What's changed? Consider our current situation:

1. **China's cost advantage is eroding.** Rising labor costs, stricter environmental regulations, and China's shift to net import status for certain mineral ores make domestic W2M projects increasingly competitive.

2. **Supply chain reliability is a national security imperative.** Domestic W2M ensures predictable, auditable, and politically secure sources for defense, semiconductor, and advanced energy industries.
3. **Technological maturity.** Processes to extract lithium, rare earths, scandium, nickel, cobalt, gallium, and other strategic minerals from mineral wastes are now commercially viable and scalable.
4. **Advanced data and AI.** High-resolution operational and geological data, combined with predictive modeling, enables precise identification of high-value waste deposits, reducing risk and accelerating project development.
5. **Capital and policy momentum.** Investors are beginning to recognize mineral wastes as concentrated and predictable, while federal incentives and permitting reforms are creating a more favorable environment for near-term deployment.

By pairing new midstream infrastructure with W2M feedstocks, the U.S. can immediately put processing capacity to work, bridging the gap until greenfield mines and new trade agreements to come online and creating a dynamic and resilient domestic supply chain. In other words, W2M is not the end goal but a strategically valuable enabler: fast, reliable, and economically viable feedstock for next-generation facilities.

Recommendations to Government, Industry, and Academia

Achieving domestic strategic mineral security requires coordinated action across government, industry, and academia.

For Government:

- **Incentivize midstream infrastructure development** through tax credits, low-interest loans, and grants for high-efficiency, automated processing facilities.
- **Streamline permitting and regulatory pathways** for new processing operations and W2M projects to reduce the 15-year mine development timeline bottleneck.
- **Provide commercial off-take agreements or backstops** to de-risk initial investments in infrastructure and accelerate the commercialization of advanced extraction technologies (DOE).

For Industry:

- **Invest in flexible, automated processing capabilities** to create a competitive edge and reduce reliance on foreign supply.
- **Collaborate on W2M opportunities** to provide feedstock for midstream facilities, reduce environmental liabilities, and create new revenue streams from legacy waste.

- **Leverage AI and data analytics** for predictive mineral recovery, process optimization, and operational intelligence.

For Academia:

- **Drive technology innovation** in extraction, separation, and processing methods that maximize recovery rates and minimize environmental impact.
- **Develop a skilled workforce** with expertise in AI-aided mineral processing, W2M technologies, and midstream infrastructure operation.
- **Provide research support** for pilot and demonstration projects, validating new processes and providing empirical data for industry adoption.

Coordinated action across these three sectors is essential. Government policy can catalyze investment, industry execution can deliver operational results, and academia can innovate and educate the next generation of engineers and scientists.

A Leapfrog Opportunity

The United States has a rare opportunity to redefine the sourcing and processing of critical minerals. The traditional mine-to-market model is too slow, costly and vulnerable to disruption. By investing in next-generation midstream infrastructure and feeding it with readily available, concentrated W2M feedstocks, the U.S. can establish a faster, more resilient and globally competitive supply of strategic minerals.

This is a strategically pivotal moment - not just to catch up to the current global leaders but to leapfrog them by building a domestic mineral processing system that is automated, flexible, efficient, and secure. Waste-to-Market is the catalyst that allows new facilities to start delivering critical minerals immediately, while the infrastructure itself ensures a long-term, resilient supply chain.

Immediate action is essential. Innovation, funding, innovation, policy advancements and collaboration must converge now to secure U.S. industrial and defense supply chains. Each ton of recovered waste and every new processing facility strengthens the nation’s strategic position, reduces dependence on adversaries, and advances the U.S. as a global leader in critical minerals.

The path to strategic mineral security is clear: build next-generation midstream infrastructure, feed it with W2M feedstocks, and ensure domestic supply chains that are both resilient and competitive. The U.S. has the capital, technology, and ingenuity to make it happen—and the world cannot afford delay.

About the Author

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Rick Tallman is a veteran entrepreneur, investment manager and philanthropist that leads TallmanPacific, an independent investment firm and strategic consultancy serving investors and companies in the critical minerals space. In 2007, he founded Renova Capital, a pathfinding private equity firm that invested in, developed, managed, and sold over $1B of resilient infrastructure across multiple industries. He was a founder, CEO & Chairman of Main Street Power Company (now AES Clean Energy), a pioneering solar company that developed thousands of distributed solar arrays while launching the industry's first residential solar leasing fund. Earlier in his career, Rick established a reputation as a successful entrepreneur by founding and leading a variety of early-stage companies through initial public offering or acquisition. This includes a leading superfund and mining reclamation firm and a pioneer of municipal water utility privatization. Rick also served as a Company Commander in the US Army during the Persian Gulf War. He frequently lectures on subjects of entrepreneurship and infrastructure development and has authored many published technical and opinion papers throughout his career. Rick holds bachelor's and master's degrees in geologic and hydrologic engineering from the Colorado School of Mines, where he serves on the Board of Governors and as a Senior Advisor to the Payne Institute for Public Policy.

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