OurEnergyPolicy

Earthshot Foundation

Responsible Mining

Terranaut Programs

Minologues

Restoring Trust in Mining

January 2025

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Letters from Leadership

Earthshot Foundation hosted our first dialogues in 2008, declaring – we already know what we need to do – to protect and preserve our natural capital and livable planet. And how to do it – by accelerating the deployment of abundant, accessible, clean and affordable energy for all. A Terranaut® Dialogue begins with a Motive (why) and leads to a Mission (how). **Responsible, nature+ mining** is our motive as we explore the working definition for **true mining** and what it means to **restore trust in mining.** We are delighted to present the 2024 Minologues Series in collaboration with OurEnergyPolicy. The series convenes four cohorts of expert practitioners and stakeholders to discuss intelligent policy design across national security, supply chains, responsible mining and future-mining topics. The series finale will take place on October 7th in Washington, DC. This paper summarizes the consensus contributions from our second cohort. At Earthshot, we believe, "the aim of scientific work [and our work] is truth."

Chase Weir — Founder & Board Chair, the Earthshot Foundation

OurEnergyPolicy's mission is to bring experts together in civil, substantive dialogue to explore solutions to the energy challenges facing the United States. We have partnered with The Earthshot Foundation to explore the crucial questions regarding the availability of critical minerals for American energy needs in this Minologues Series. The Series is a nine-part program, and this paper contains the important insights and recommendations from a working session of leaders on critical mineral supply chains challenges. I want to thank our workshop participants and the staffs at OEP and Earthshot for their work on this document, and — consistent with OEP's non-partisan and open approach to addressing issues— I want to invite all energy stakeholders to read the paper carefully and contribute their views on this vitally important topic.

Bill Squadron — President, OurEnergyPolicy

Executive Summary

This report summarizes the discussion and recommendations of an expert working group on Responsible Mining. Responsible Mining is the third discussion topic in the Minologues, a series co-produced by OurEnergyPolicy and The Earthshot Foundation to address U.S. concerns over critical mineral accessibility for the energy transition.

The extraction of minerals from the earth can have detrimental effects on public health, community sovereignty, and both cultural and environmental protections.[1] More than 50 million gallons of contaminated wastewater pour out of abandoned mining sites across the United States into freshwater supplies that leach into agriculture, drinking water, and freshwater ecosystems.[2] Nearly 31% of natural World Heritage sites are impacted by extractive industries.[3] Responsible mining practices can mitigate these negative impacts. These approaches by mining companies include early community engagement, modern waste management, Good Neighbor Agreements (GNA), land reclamation plans, and proactive regulatory frameworks.

Environmental contamination from mining waste can poison drinking water and degrade ecosystems.[4] Reprocessing[5] and dehydrating waste tailings[6] reduces the mass of waste that needs to be managed. Properly storing and remediating waste tailings avoids groundwater and ecological contamination, thereby protecting public health.

Before higher environmental standards were developed, legacy mines were regularly abandoned after closure. Today, mines in the U.S. are required to have land reclamation and remediation plans once they reach the end of their life cycle.[7] Even though remediation plans are required, they are not consistently effective. Carefully considering the proactive measures that need to be taken before the construction of a mine, such as topsoil conservation,[8] is important for successful land reclamation efforts when mining activities come to an end.[9]

In the U.S., mining companies are not required to engage with impacted communities until they begin the National Environmental Policy Act (NEPA) process.[10] By then, initial mine plans are mostly solidified. Waiting until the NEPA process to engage with impacted communities reduces the potential for community leaders to provide input to the mine plan. It also allows for community opposition to a proposed mine to grow since their concerns are not being addressed.[11]

In addition to impacted communities, tribal communities with historical ties to public land should be notified of planned projects so their input can be collected to ensure issues of cultural preservation are addressed. Additionally, when mining projects occur on or adjacent to land governed by tribal governments, it is important to have them represented when conducting early community engagement with local leaders.[12]

Formal GNAs between mines and their surrounding communities help foster trust and partnership between mine operators and communities directly impacted by mine operations. The GNAs include the agreed-upon terms of mining operations that will allow the mine to operate with community support – or at least avoid strong community opposition. It also can ensure that mines hold true to the promises they make to local communities.[13]

The industry of seabed mining is already beginning production, and how it will be conducted, if at all, in federal waters must be addressed proactively. As of 2024, the International Seabed Authority (ISA) is preparing to adopt rules and regulations for seabed mining in international waters. Coastal nations like the U.S. should replicate these codes and adopt them so the ocean floor under their jurisdictions receive the same level of protection while fostering responsible seabed mining to power the energy transition.[14]

Lastly, responsible mining practices and technologies can increase project costs. To address competitive mineral markets that include miners with the only aim of producing minerals through the cheapest possible means, governments and mineral buyers should step in to support responsible mining with incentives and price differentiation.[15] The Initiative for Responsible Mining Assurance (IRMA) developed a scoring system for mining operations that can be used when implementing these incentives.[16]

The working group made the following recommendations for U.S. policy:

1. Incentivize Responsible Mining
2. Engage Early with Impacted Communities
3. Maintain Transparency with Data and Operations
4. Normalize Good Neighbor Agreements
5. Reprocess and Remediate Waste Tailings
6. Utilize Expertise in Restoration Science
7. Replicate ISA Rules and Regulations for Seabed Mining in International Waters

Introduction

Critical minerals are required for many aspects of battery power and storage, electrification, and renewable energy sources such as wind turbines.[17] Experts predict that the world will need over 3 billion tonnes of critical minerals to transition our energy systems away from fossil fuels to avoid a planetary temperature increase of over 2°C. Since there are not yet enough materials above ground and in circulation to be recycled, no climate change goal to transition away from fossil fuels will be met without mining.[18]

This report is the third installment of the Minologues, a series co-produced by the Earthshot Foundation and OurEnergyPolicy dedicated to addressing U.S. concerns over critical mineral accessibility for the energy transition.

The Minologues brings together experts in the field of National Security, Supply Chains, Responsible Mining, and Recycling and Innovation to explore challenges and opportunities to acquire enough critical minerals to fuel the energy transition. The Responsible Mining group discussed the core purpose of the Minologues: how to sustainably and responsibly source critical minerals for the energy transition. The value chain of these minerals starts at the beginning: the mine. A true mine earns and serves the public trust when its activities are responsible and regenerative.

The mining industry, along with the government, has a responsibility to address concerns over public health, land rights, sustainability and the preservation of sites with both environmental and cultural significance. Inclusive and transparent practices, along with modern mining techniques, provide pathways for mines to reduce negative impacts to both people and the planet. The following discussion and recommendations summarize the key takeaways from this expert working group session.

"A true mine earns and serves the public trust when its activities are responsible and regenerative."

Pollution & Waste Management

Mines can have hazardous impacts on air, water, land, and public health. Pollution from inadequate waste management and operation practices are the primary cause of these negative impacts.[19] It is important that companies utilize modern mining techniques to reduce the consequences associated with mining waste.

Traditional waste tailings for mines involve pools filled with wet mining waste. As the waste product of production, they include finely ground ore, water, and processing chemicals.[20] Two forms of waste management effective in reducing environmental harm are dry waste stacking and securing waste tailings underground.

Dry waste stacking removes all water from waste tailings and turns waste into condensed dry matter with a sandy feel and look. This method not only reduces the mass of waste, but also has shown to reduce the toxicity of the waste product.[21] Securing waste products underground removes them from surface ecosystems. So long as these tailings are secured properly underground to avoid groundwater contamination, underground storage is a safe long-term solution to avoiding pollution.[22]

There must be a shift in how we view "waste". In a circular economy, there is no waste. The cradle-to-cradle design philosophy and methodology creates a cyclical regenerative system that avoids waste.To move closer to a circular economy and reduce the need for secure waste tailing storage, mines can reprocess waste. This reprocessing both reduces the volume of waste tailings from mining and increases the recovery of valuable minerals.[23] The magnitude of additional minerals that could be recovered from reprocessing tailings is considerable. One study indicated that reprocessing tailings from copper mines alone could yield millions of tons more copper per year. In addition to reducing the mass of tailings, widespread adoption of this practice could reduce the number of mines needed to meet global demand.[24]

Land Reclamation

In the United States, new mines are required to have detailed land reclamation plans and cover the costs of restoring the land to productive ecological levels after a mine is decommissioned.[25]

Not all mining projects, however, put sufficient emphasis on the importance of initiating land reclamation efforts at the beginning of a mining project – not the end. It is important to have specialists available from inception to assess the environmental impacts of a mine and the steps that can be taken to best support restoring the land to post-mine productivity levels. Sometimes, proactive planning in this way can ensure the simplest mistakes can be avoided.[26] One such consideration is the preservation of topsoil.

Topsoil, the organically rich top layer of soil that covers the ground of productive ecosystems, is difficult to develop from scratch. Yet, it is a key component in the remediation of most land-based mines. Fortunately, land restoration research of mines discovered how they can conserve topsoil through proper storage techniques. Since topsoil is organically rich due to

the presence of organic matter and living microorganisms, it must be stored atop earth mounds so these organisms and geochemical materials do not suffocate and degrade beneath layers of dense, abiotic matter.[27]

Community Engagement

Mining companies often face an uphill battle obtaining community trust and support due to widespread negative biases against the heavy industry. First impressions are extremely important in establishing that trust in the early stages of a project.

The current permitting process for new mines does not formally require a company to engage with the applicable community until the initiation of the NEPA process. However, by the time the NEPA process is conducted, a mine could be years along in its planning and development. At this point, the foundation of the mine plan is already created and it is difficult to incorporate community input in any meaningful way.[28] Furthermore, if impacted communities are not engaged with until the NEPA process begins, then opposition to the mining operations could have already emerged over this lack of engagement and concerns over negative impacts to community health and environment.

Early engagement includes giving public notice to impacted regions of the proposed mining operation and developing a cooperative relationship with community leaders. When conducting engagement and outreach, mining representatives must treat community members with respect. There is a well-documented history of mining representatives conveying false information to local residents or withholding data due to concerns over misinterpretation.[29] For an honest, good-faith relationship to be maintained between community members and mining officials, outreach cannot appear to be a sales pitch, but must proceed as a genuine dialogue with transparency regarding all aspects of the project.

During this early engagement, mining companies and community leaders can also negotiate the terms of a GNA. While a successful GNA requires consistent and organized monitoring from community volunteers to maintain, it provides many benefits.[30] A GNA can include provisions for profit-sharing, funding independent monitors,[31] the preservation of cultural landmarks, adhering to higher water maintenance standards than required by law, transparency of activities and data, reducing traffic on local roads, and any other relevant terms that can assuage the concerns of community members. In return, the community can agree to partnering with the mine for mutual economic benefit and not campaign or litigate against its operations.

Lastly, it is strongly recommended that mining companies provide financial support for the community to establish an independent watchdog group for the mine. This watchdog group can improve trust within

Painting on an Old Train Station in Los Penitentes, Mendoza, Argentina against "megamining."

the region, make sure the mine maintains its responsible practices, and significantly reduce the risk of misunderstandings or resentment between the community and the mine.[32]

Indigenous Land Rights

Tribal governments in the U.S. have direct involvement in the approval of mining projects within the borders of their reservations. However, land with cultural significance to these tribal nations extends far past their borders. Even though this dilemma stems from historic displacement and issues far greater than the approval process of a single mine,[33] mining projects should still respectfully include indigenous voices in the pre-mine planning process so they can minimize impacts on land with cultural significance.

There is not currently enough formal inclusion of indigenous communities in the mining approval process. The DOI could develop a system that would formally include indigenous communities in mining approval processes and notify them of potential mining plans on lands with cultural significance, but mining companies should not wait for federal legislation to improve inclusivity of indigenous voices in mining project development.

For these reasons, it is important for mining companies to ensure indigenous peoples are included in early engagement plans. In addition to involving local leaders, a responsible mining project located on or adjacent to tribal land should include representation from the impacted indigenous tribes. This representation will help mining companies avoid disrupting land with notable cultural significance to indigenous communities.

Seabed Mining

Seabed mining is an increasingly important topic in the discussion around how to supply the energy transition with critical minerals. However, like with land-based mining, many stakeholders are highlighting the importance of responsible practices to consider proactively before diving into seabed mining without proper research guidelines and regulations.[34]

To understand the factors associated with establishing regulations and practices for responsible seabed mining, it can productively be compared to land-based mining. Unlike land based mining, seabed mining of nodules does not require excavation. Nodules lie unattached atop the sea floor. While there is potential for disrupting the seabed environment through the collection of nodules, it is possible that seabed mining could have lower life-cycle impacts than the expansion of terrestrial mining.[35] There are still concerns around the potential for disruption caused by more invasive technologies in the underwater environment. It bears noting, though, that not all mining techniques are the same, and they do not all use giant robot vacuums. Just as land-based mining techniques have variability in their environmental impacts, so do the techniques used in seabed mining. Proactive regulations for this burgeoning field that acknowledges the potential of seabed mining can distinguish among the various techniques, and prevent harmful practices from becoming the status quo by setting high standards.[36]

In the midst of uncertainty around this industry, the ISA aims to adopt a comprehensive set of regulations and rules for monitoring seabed mining activities in 2025.37 However, these regulations will only apply in international waters. The seabeds under the jurisdiction of coastal nations, including the United States, are not part of the governance of the ISA. It will be wise, however, for coastal nations to follow the leadership of the ISA in how they frame and implement their own regulations over the harvesting of seabed resources.

Costs of Responsible Mining

There are no current governments with enough regulations that require mining activities to use the most efficient and clean techniques, or to include all impacted communities in the planning process of mines. While many mining companies are going above the minimum requirements to undertake projects in a responsible manner,[38] they face issues competing in the marketplace against international operations flooding the market with cheap minerals obtained through substandard mining.

It is important to recognize mining operations that go beyond the bare minimum required of them towards the communities they work with and the environments they work in. The technology used by modern mining operations that curtail pollution and land degradation often carry additional expense, and the extra monitoring, community engagement, and assessments performed by responsible miners also require substantial costs. Consumers, manufacturers, and policymakers must understand that the cheapest material is not likely to be the most responsibly sourced, and must take that into account in making policy and purchasing decisions.[39]

"...Recognize mining operations that go beyond the bare minimum..."

Recommendations

1. Incentivize Responsible Mining

Responsible mining needs to be supported by international markets that do not only favor the cheapest commodity prices. The IRMA provides a scoring system for mines on how well they implement best practices and provides guidance for how current and future mines can become more responsible members of the communities that surround them.[40] This scoring system, combined with better provenance tracking, can provide the benchmark for price differentiation and incentivization mechanisms.

2. Engage Early with Impacted Communities

Engaging early with community members and including their input in the pre-mine planning process can both improve community relationships and reduce opposition to mine plans. Mining representatives should not wait until the NEPA process to engage with impacted communities. Engagement should be both early and inclusive. This engagement should typically include representation from state government, local government, and tribal governments of communities impacted by mining operations. It should also include representatives from indigenous communities that have cultural ties to the impacted land even if they no longer reside on it.[41]

3. Transparency with Data and Operations

Mining companies often face distrust and opposition to construction of new mines. This is why mining companies should be transparent with their operations and environmental data. The air, water, and soil surrounding mines should be regularly monitored either directly by mine staff or by a third-party watchdog group.[42] The specific terms for data transparency can be agreed upon in a GNA that can be developed when mines engage early with impacted communities.

4. Normalize Good Neighbor Agreements

GNAs reflect the negotiated and established terms between a mining company and community leaders to build and maintain constructive working relationships. A GNA establishes trust and transparency of mining activities by usually providing financial support for community members to hire independent watchdogs and experts to monitor mining activity and communicate complex data to community members. This independent monitoring ensures that when there are no negative impacts to drinking water or air quality, community members feel confident in trusting the data they receive because it is produced by an independent source.[43]

5. Reprocess and Remediate Waste Tailings

Waste from the mining process must be managed responsibly. Since this waste contains heavy metals and toxic pollutants, it can not be allowed to contaminate the surrounding environment. Contamination can lead to poisoned waterways, ecosystem degradation, and deteriorated public health.[44] Fortunately, there are multiple modern mining techniques that can reduce the environmental threats from mining waste leftover from the processing of ore.

Waste tailings include finely ground matter that can still contain up to 5%-15% concentrations of critical minerals.[45] Reprocessing waste reduces the mass of waste tailings and recovers more valuable minerals, doubly improving the efficiency of mineral recovery. Since these minerals can often be toxic when contaminating water and soil, the recovery of these minerals removes them from the potential to contaminate the environment.[46]

Until a completely circular economy is realized, waste from mining operations will still exist. Its proper management and disposal are important for long-term pollution mitigation. Two techniques used in modern mining include dry waste stacking and underground storage. Dry waste stacking removes the water from traditional wet waste tailings, reducing both the mass and toxicity of the waste.[47] This technique combined with the long-term storage of waste underground away from surface ecosystems and groundwater are effective ways of remediating mining waste tailings.[48]

6. Utilize Expertise in Restoration Sciences

Mining companies should consistently deploy the most effective practices in restoration science to ensure the development and implementation of effective land reclamation plans throughout the mining life-cycle. Proactive and creative land reclamation planning will provide blueprints for how mining operations can meet key environmental goals such as the preservation of topsoil.[49]

7. Replicate ISA Rules for Seabed Mining in National Waters

Experts and world leaders at the International Seabed Authority are poised to author and ratify the standard for seabed mining regulations internationally to protect marine life and enforce labor rights. Allowing the authors of these codes enough time to evaluate the impacts of seabed mining through scientific inquiry is important to ensure that the ensuing regulations set a high standard for responsible seabed mining. The United States and all other coastal nations would benefit from following the lead of the ISA for mutual and consistent protection of marine life and human rights in this burgeoning industry.[50]

Signatories Page

This document represents the collective effort of the working group, reflecting a range of perspectives and contributions. Each participant retains the right to their own opinions and reservations regarding specific aspects of the white paper. Endorsement of this document does not imply unanimous agreement with all content but rather signifies support for the overall objectives of the working group.

Bill Squadron, President of OurEnergyPolicy

Chase Weir, Founder and Board Chair of the Earthshot Foundation

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Brent Berg
Uranium Energy Corporation

Aimee Boulanger
Initiative for Responsible Mining Assurance

Judy Brown
South32

Stefan Debruyne
SQM

Steven Feldgus
U.S. Department of the Interior

Kristin Hengstebeck
The Metals Company

Dan Kammen
UC Berkeley

Julia Neilson
University of Arizona

Adele Rouleau
SFA Oxford

Michael Rowley
Stillwater Critical Minerals

Elizabeth Tate
Albright Stonebridge Group

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Appendix

The 2022 list of critical minerals and their uses includes the following:

- Aluminum, used in almost all sectors of the economy
- Antimony, used in lead-acid batteries and flame retardants
- Arsenic, used in semi-conductors
- Barite, used in hydrocarbon production.
- Beryllium, used as an alloying agent in aerospace and defense industries
- Bismuth, used in medical and atomic research
- Cerium, used in catalytic converters, ceramics, glass, metallurgy, and polishing compounds
- Cesium, used in research and development
- Chromium, used primarily in stainless steel and other alloys
- Cobalt, used in rechargeable batteries and superalloys
- Dysprosium, used in permanent magnets, data storage devices, and lasers
- Erbium, used in fiber optics, optical amplifiers, lasers, and glass colorants
- Europium, used in phosphors and nuclear control rods
- Fluorspar, used in the manufacture of aluminum, cement, steel, gasoline, and fluorine chemicals
- Gadolinium, used in medical imaging, permanent magnets, and steelmaking
- Gallium, used for integrated circuits and optical devices like LEDs
- Germanium, used for fiber optics and night vision applications
- Graphite , used for lubricants, batteries, and fuel cells
- Hafnium, used for nuclear control rods, alloys, and high-temperature ceramics
- Holmium, used in permanent magnets, nuclear control rods, and lasers
- Indium, used in liquid crystal display screens
- Iridium, used as coating of anodes for electrochemical processes and as a chemical catalyst
- Lanthanum, used to produce catalysts, ceramics, glass, polishing compounds, metallurgy, and batteries
- Lithium, used for rechargeable batteries
- Lutetium, used in scintillators for medical imaging, electronics, and some cancer therapies
- Magnesium, used as an alloy and for reducing metals
- Manganese, used in steelmaking and batteries
- Neodymium, used in permanent magnets, rubber catalysts, and in medical and industrial lasers

- Nickel, used to make stainless steel, superalloys, and rechargeable batteries
- Niobium, used mostly in steel and superalloys
- Palladium, used in catalytic converters and as a catalyst agent
- Platinum, used in catalytic converters
- Praseodymium, used in permanent magnets, batteries, aerospace alloys, ceramics, and colorants
- Rhodium, used in catalytic converters, electrical components, and as a catalyst
- Rubidium, used for research and development in electronics
- Ruthenium, used as catalysts, as well as electrical contacts and chip resistors in computers
- Samarium, used in permanent magnets, as an absorber in nuclear reactors, and in cancer treatments
- Scandium, used for alloys, ceramics, and fuel cells
- Tantalum, used in electronic components, mostly capacitors and in superalloys
- Tellurium, used in solar cells, thermoelectric devices, and as alloying additive
- Terbium, used in permanent magnets, fiber optics, lasers, and solid-state devices
- Thulium, used in various metal alloys and in lasers
- Tin, used as protective coatings and alloys for steel
- Titanium, used as a white pigment or metal alloys
- Tungsten, primarily used to make wear-resistant metals
- Vanadium, primarily used as alloying agent for iron and steel
- Ytterbium, used for catalysts, scintillometers, lasers, and metallurgy
- Yttrium, used for ceramic, catalysts, lasers, metallurgy, and phosphors
- Zinc, primarily used in metallurgy to produce galvanized steel
- Zirconium, used in the high-temperature ceramics and corrosion-resistant alloys.

Source: U.S. Geological Survey