

## Critical Minerals Production and the Future of Mining

Gregory R. Wessel,\* David H.M. Alderton, Ernesto O. Cordero, Jeffrey K. Greenberg, Etzigueri Góngora Ubeda, James A. Heller, Marli B. Miller, David K. Norman, Arthur Reis, and Tricia R. Sears†

### ABSTRACT

Current projections from within and outside the mining industry highlight the need for expanded production of metals necessary to facilitate a transition to renewable energy. Mining can negatively impact Indigenous peoples, rural communities, and pristine landscapes and habitats, with harm extending far into the future. The push for critical minerals, however, provides an opportunity for mining to be part of a circular economy. A paradigm shift is necessary along with higher standards to bring all those affected together around a twenty-first-century stance that values place, people, justice, and legacy.

### INTRODUCTION

Humanity is now at a unique moment in time, in which we realize that we are a destructive geologic force enabled by a reliance on fossil fuels. One solution is the acquisition of critical minerals to allow us to moderate our adverse environmental impact, but this comes with its own problems.

Pundits argue that “we need” these minerals, implying at all costs, but calling them “critical” is misleading. It is true that consumers want products constructed from these minerals, but their absolute necessity is another story. For example, a current Smithsonian exhibition on the “Cellphone: Unseen Connections” includes a display that explains, “If everyone in America uses their phone a year longer on average, it would equal the emission reduction of taking 636,000 gasoline-powered cars off the road.”

Future consumer demand will determine how much of these minerals we will need. With ongoing research into the recycling of critical elements, it is foreseeable that the need for them in 10 years may be very different than projected today. For the near future, mining is necessary, but there are alternatives to contemporary mining practices.

### ENHANCED STANDARDS FOR SUSTAINABILITY

Most of us are familiar with the definition of sustainability (Fig. 1). Current mining practices do not meet sustainability standards, but as we transition from a fossil fuel-based economy to one based on materials, it will be imperative for the critical minerals underpinning these future materials to be sourced and used responsibly with sustainability in mind.

Because the impacts of mining operations emanate from specific point sources, the industry is uniquely positioned to improve its performance and the public perception of its value. This can be achieved by first following the principles of

responsible mining as promoted by groups like the Initiative for Responsible Mining Assurance (IRMA). From there, society can continue elevating those standards to accomplish sustainability goals.

Raising standards will increase production costs of critical minerals because we have not attempted to count the true costs of mining until now. However, corporations now realize that serving the public good is also good for the bottom line (PwC, 2023).

For mining, the general standards that industry should meet include:

- All benefits and costs must be measured using full-cost accounting.
- Activities must be consistent with the United Nations Sustainable Development Goals.
- Only temporary or reversible impacts are allowed. There shall be no permanent contamination.

#### SUSTAINABILITY

Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

#### SUSTAINABLE MINING

Not possible given the way mining is done today, but that can change.

#### RESPONSIBLE MINING

“Planning, operating, and closing mines in a manner that manages specific social, economic, and environmental risks and impacts (or sustainability) at a given operation” (Jarvie-Eggart, 2015). *Negative impacts are reduced, not eliminated.*



Figure 1. Definitions: Sustainability vs. responsible mining. See Jarvie-Eggart (2015).

\* gwessel@publicgeology.org

† All authors: Global Network for Geoscience and Society.

- Mining must respect the priorities and preferences of Indigenous and other local residents.
- Mining must include restoration of habitat and topography to mimic preexisting conditions and eliminate legacy hazards that endanger humans or wildlife.
- Restoration shall include rewilding and habitat enhancement.

Implementing these standards would move the industry toward a sustainable circular economy by minimizing waste, recycling or repurposing discarded materials, and reducing the demand for new raw materials (Fig. 2). Miners can prioritize the following alternative sources of mineral resources in place of new discoveries:

- (1) Mining “anthropological resources,” also known as recycling. As pointed out by Sackett (2016), much if not most of the metal available to mining is already above ground, in use, in infrastructure, or in waste. For this reason, truly sustainable anthropological metabolisms must be part of a larger cycle in which waste is the first step to regenerating a future consumable.
- (2) Existing wastes, tailings, or waste streams at active mine sites: The waste streams produced in various stages of ore processing present an opportunity to optimize material reutilization through a circular economic approach.
- (3) Treating abandoned mine waste for the simultaneous purpose of remediation: Wastes may contain elemental concentrations that were once unappealing but are now valuable. These sites often require remediation to mitigate environmental impacts; reworking them can be part of the remediation.
- (4) Reworking existing districts or previously mined deposits: With rising metal prices, deposits with uneconomic concentrations may now be economically viable, and some deposits may host minerals that we did not value until now.
- (5) Exploiting virgin resources via conventional exploration and development practices is what we have always done, but this should be a last resort after exhausting the non-virgin alternatives above. When it is necessary, opening new mines in virgin areas should only be done if all

impacts and costs can be fully mitigated, with no long-term impact to society or the environment.

With these considerations, let’s examine three pending mining projects, including two that could become disasters and a third that might be a model for the near future.

**Pebble Mine, Alaska**

The Pebble Mine proposal called for an open pit in the middle of wetlands and watershed feeding into Bristol Bay, Alaska. The area is known as “America’s Fish Basket” because it is home to the world’s largest salmon fishery.

Developers wanted to excavate a pit 1 mile (1.6 km) wide and 0.25 miles (0.4 km) deep, destroying 3000 acres of wetlands and more than 21 miles (34 km) of salmon streams. Opposition to the project included the entire Alaska congressional delegation, a consortium of Native tribes that represent 80% of the people who live in the region, and the Environmental Protection Agency (EPA).

In 2023, the EPA issued a final determination that effectively precludes the mine’s development, and in April of this year, the U.S. Army Corps of Engineers reaffirmed that it would not issue a key permit. Ordinarily, that would mean the end of a project that was poorly conceived from the start, but now the developer and the State of Alaska are suing to invalidate the EPA’s findings (BBNC, 2024; Safina and Reynolds, 2023).

**Oak Flat, Arizona**

Discovered in 2004, the Oak Flat deposit in Arizona could not be mined unless the land was first transferred out of federal government ownership. For that reason, Resolution Copper, a joint venture of BHP Billiton and Rio Tinto, lobbied Congress to pass a law allowing a land swap. The current plan is to block-cave the deposit, creating a crater 2 miles (3.2 km) wide and 1000 ft (305 m) deep within an area sacred to the Western Apache people, including those at the neighboring San Carlos reservation. Several versions of a land-exchange bill were petitioned, but each received pushback until 2014, when proponents slipped the land exchange into a midnight rider to the National Defense Authorization Act. Few knew about it until it was unveiled after 11 p.m. the evening before the bill came up for consideration. It had been impossible for the land exchange to stand on its own feet; nevertheless, it was signed into law 2 weeks later (Redniss, 2020).

The fight is not over. The Biden administration withheld approval of the environmental impact statement but the project has also been working its way through the court system. Apache Stronghold, a 501(c)3 nonprofit dedicated to defending holy sites and freedom of religion, objected to a March 2024 appeals court ruling and they are now before the Supreme Court. A ruling there may come as early as December, 2024, but that may not decide the fate of Oak Flat (Smith, 2024).

**Thacker Pass, Nevada**

The Thacker Pass deposit in northern Nevada contains an estimated 3.7 million metric tons of lithium reserves. Lithium exists in unusually high concentrations (up to ~9000 ppm) within altered lake beds in the McDermitt Caldera.

Lithium Americas received authorization to begin mining after a rigorous permitting process, and it may turn out to be an

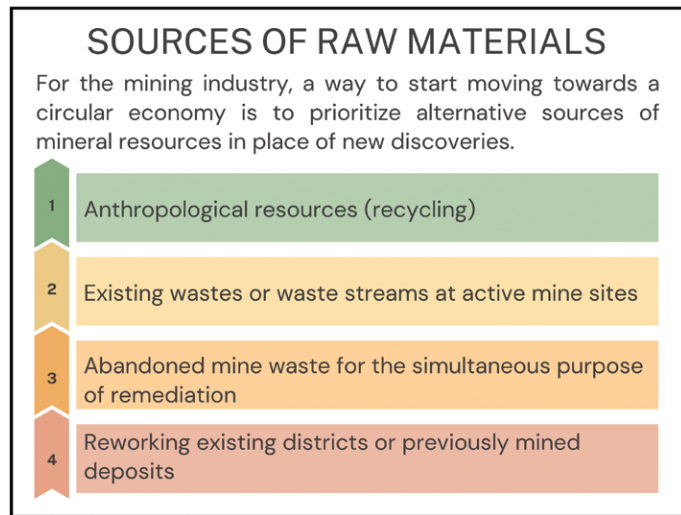


Figure 2. Sources of “ore” materials for the mining industry, ranked in the suggested order of importance.

example to which other operations can look for guidance. Continuous open-pit mining will occur entirely above the water table, with mined areas backfilled as the mining proceeds, allowing for a high degree of reclamation (NVDEP, 2023).

Lithium Americas is a pending member of IRMA. Thacker Pass may easily meet IRMA's standards for responsible mining and could very well surpass those standards if the enhanced standards described above are given priority.

## CONCLUSION

Because the impacts of mining last for generations, society needs to plan generations ahead. This is a paradigm shift for the industry, but not an unimaginable one. What we need is a universal protocol for mining that goes beyond responsibility and that can be applied everywhere on the planet. We are forming a team to address that need, with a goal of presenting a draft framework for twenty-first-century mining within 12 months. If you are interested in participating, we invite you to contact us ([info@thegnsgs.org](mailto:info@thegnsgs.org)).

## REFERENCES CITED

Bristol Bay Native Corporation (BBNC), 2024, Lawsuits, Legislation and Finances: Pebble News Roundup, <https://pebblewatch.com/lawsuits-legislation-and-finances-pebble-news-roundup/> (accessed September 2024).

Jarvie-Eggart, M.E., 2015, *Responsible Mining: Case Studies in Managing Social and Environmental Risks in the Developed World*: Englewood, Colorado, Society for Mining, Metallurgy, and Exploration Inc., 788 p.

Nevada Division of Environmental Protection (NVDEP), 2023, Thacker Pass Lithium Mine, Project Overview: <https://ndep.nv.gov/land/thacker-pass-project> (accessed September 2024).

PricewaterhouseCoopers (PwC), 2023, *Mine 2023: 20th Edition; The Era of Reinvention*: London, PricewaterhouseCoopers, 48 p., <https://www.pwc.com/gx/en/issues/tla/content/PwC-Mine-Report-2023.pdf>.

Redniss, L., 2020, *Oak Flat: A Fight for Sacred Land in the American West*: New York, Random House, 281 p.

Sackett, P.D., 2016, Elemental cycles in the Anthropocene: Mining aboveground, in Wessel, G.R., and Greenberg, J.K., eds., *Geoscience for the Public Good and Global Development: Toward a Sustainable Future*: Geological Society of America Special Paper 520, p. 99–116, [https://doi.org/10.1130/2016.2520\(11\)](https://doi.org/10.1130/2016.2520(11)).

Safina, C., and Reynolds, J., 2023, This Alaska mine would destroy the world's largest salmon fishery: *New York Times*, Guest Essay, 24 September 2023, <https://www.nytimes.com/2023/09/24/opinion/alaska-salmon-mine-court.html>.

Smith, N.L., 2024, Apache Group is Carrying a Petition to the Supreme Court to Stop a Mine on Land Sacred to the Tribe, <https://insideclimatenews.org/news/22082024/apache-supreme-court-petition-to-stop-mine-on-sacred-land/> (accessed September 2024).