



**Critical Ocean Minerals  
Research Center**

**EXECUTIVE SUMMARY**

# **A Deadly Moratorium**

**WWF's proposed moratorium on seabed nodule collection comes at the cost of human lives and vast environmental destruction**



# A Call to WWF and Other eNGOs

Environmental organization, WWF, has attracted support from sovereign governments and large corporations for a moratorium on seabed mineral extraction. But the moratorium is forcing the world to double down on some of the deadliest mineral extraction practices known, in the most biodiverse ecosystems on the planet, directly adjacent to human settlements. It is bringing death, disease, and displacement to many vulnerable indigenous people each year that could be avoided. It is also impeding efforts to decarbonize while increasing our greenhouse gas emissions. This report is a call for signatories to the moratorium to reconsider their stance in the name of a more just energy transition and a healthier planet.

It is our hope that this report will spark debate and discussion within organizations that have signed WWF's moratorium and across eNGOs such as WWF and others. Several eNGOs have told us that they are in favor of careful nodule collection. While most of these groups are reluctant to publish anything that would undermine the fundraising campaigns of big, corporate NGOs such as WWF and Greenpeace, at least one, The Breakthrough Institute, has already broken ranks (Wang, 2024). We know that others have followed, and we are confident that more will come along as they critically analyze the scientific research and the data. In the meantime, we think dialogue and debate can be helpful, and we encourage eNGOs to talk with us about the issues. Because nodule collecting can produce a win-win outcome for society and the environment, there is a lot of common ground to be found.

Please visit [comrc.org](https://comrc.org) to download the full report and learn more.



## Critical Ocean Minerals Research Center

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*Cover image: WWF flag at Policoro, Italy, July 17, 2011. WWF has called for a deep-sea mineral moratorium that could have catastrophic consequences for wildlife, people, and our planet. (iStock/Angelafoto)*

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*Democratic Republic of Congo, May 2009. "In the Democratic Republic of Congo around 1,500 people die every day over fighting to control the lucrative trade in minerals." Note that these figures tie to conflict conditions which vary from year to year. (Tom Stoddart/Getty Images)*

## Executive Summary

Imagine a vast source of energy transition minerals (ETMs) which could be extracted non-invasively from a remote region holding relatively little life and biodiversity. Tapping this resource could save many human lives per year, drastically cut the CO<sub>2</sub> footprint from ETM extraction, accelerate decarbonization, vastly reduce toxic mine tailings, reduce supply chain dependence on China, and protect the world's most biodiverse and endangered ecosystems. Such a breakthrough would be a monumental victory for both humanity and the environment. Fortunately, this isn't a distant dream. Polymetallic nodules on the deep ocean floor offer such a resource.

Polymetallic nodules are ETM-rich rocks formed from dissolved metals in the seawater and sediment in the deep ocean (~3 miles deep). Nodules grow over tens of millions of years and sit loose on the ocean floor. The plains are inhospitable, characterized by perpetual darkness, extreme cold, and immense pressure. Devoid of plant life, this environment is inhabited principally by microscopic organisms that are invisible or barely visible to the human eye. Nodules may be gathered in a non-invasive fashion by remote-controlled crawlers, specifically designed to minimize sediment disruption as they pass along the plains and send nodules to the surface (Jia, 2023).

While nodule collecting offers society an innovative solution to address our growing need for lower impact ETMs, WWF and other environmental non-governmental organizations (eNGOs) have called for a moratorium on the practice. These groups have chosen to ignore the science that firmly supports collecting's net benefits, and instead are steering us toward a path that exacerbates our



reliance on destructive strip mining in endangered tropical rainforests adjacent to human settlements.

The Critical Ocean Minerals Research Center (“COMRC”) has spent years reviewing research and studying polymetallic nodules and their extraction—from collection and lift technologies to processing flows and financial projections to environmental considerations. COMRC occupies a well-informed position to consider the impacts from WWF’s call for a moratorium.

This report demonstrates that WWF’s call for delay and inaction is costing human lives and perpetuating suffering every day, while encouraging all manner of environmental destruction that is more damaging than the alternative. And while the list of harms from the moratorium is substantial, most stunning is the magnitude of those harms. The benefits of switching to nodule collecting are too profound to be ignored. The empirical data and scientific studies which back these statements are highlighted in detail later in this report.

The evidence will show the immense damage WWF’s moratorium is having on people and our planet include the following:

- **Increasing human death, disease, and suffering in indigenous populations**

- Terrestrial mining’s toll on humanity is deadly. More than 15,000 miners are killed each year, but the indirect impacts are far more widespread and threaten death and disease for millions of people, most of them indigenous (World Counts, 2024). An estimated 23 million people live on toxic floodplains contaminated by mining (Macklin, 2023). Air pollution from mining is known to cause respiratory, cardiovascular, inflammatory, and neurological diseases in human populations (Silva-Rego, 2022).
- There is no mechanism by which nodule extraction would negatively impact human health directly (outside the risks to workers inherent in commercial marine operations). The potential for indirect human health impacts from collecting is orders of magnitude lower than in terrestrial mining (Paulikas, 2020).

- **Increasing destruction of endangered tropical rainforests**

- Many ETMs are strip mined from underneath rainforests. Research shows that deforestation associated with mines extends the mine footprint by ~12x (Sonter L. J., 2017). Minerals can be produced from nodules without any rainforest loss, and the observed damage to the ocean floor from non-invasive collecting is modest by comparison (O’Malley, 2023).
- Scientists estimate approximately 4.35 million species inhabit rainforests, the vast majority of which are undiscovered, and these ecosystems are highly endangered (Mora, 2011) . Scientists estimate 8,000 metazoan species inhabit the abyssal plains, most also undiscovered, where nodule collection will take place (Rabone, 2023).

- **Displacing humans and loss of indigenous land rights**

- Over half of ETM mining activities are based in or near lands of Indigenous people whose rights and protections are embedded in United Nations declarations (Owen, 2022).

- Tapping seabed nodule resources can relieve the pressure to compromise our ideals as we attempt to decarbonize. This will afford the Western world the opportunity to divest from mining companies who do not practice free prior and informed consent, and who abuse human rights.

- **Dramatically greater toxic waste streams and pollution of freshwater resources**

- Terrestrial mines generate large quantities of toxic solid waste. That waste is dangerous, difficult to store or dispose of, and represents a significant and often deadly threat to human health. Terrestrial mine waste frequently contaminates freshwater resources (Macklin, 2023) (Lakshman, 2024).
- Taking nodules avoids each of these consequences because nodules generate little/no solid waste (no overburden removal, 100% commercial material).



*Open pit mine in Mindanao, Philippines with clearly visible tailings. (iStock/Mary Grace Varela)*

- **Hindering efforts to decarbonize**

- Efforts to decarbonize the world's economies require a large increase in the production of ETMs, and many analysts predict looming shortages. Recycling and innovation will help reduce some of the burden, but even with aggressive assumptions for these sources, experts believe we will still require significant production increases from the mining sector.
- Artificially constraining the mineral supply of certain ETMs by imposing a moratorium on the largest and lowest impact resources in the world will result in higher mineral prices and slower clean energy adoption. Consumer backlash against high impact ETMs is already evident.

- **Dramatically more CO<sub>2</sub> emissions and sequestered CO<sub>2</sub> release**

- CO<sub>2</sub> emissions from terrestrial mining are 20-74% higher than those from nodule collecting according to life cycle analyses (Benchmark Min Int, 2023) (Paulikas, 2020) (Alvarenga, 2022).
- Life cycle analysis indicates that the amount of sequestered carbon dioxide released in nodule collecting is 94% below that which is released during land-based mining (Paulikas, 2020).

- **Increased threat to Western national security and strategic industries**

- China dominates the world's production & processing of critical minerals and has introduced restrictions on these minerals nine times from 2009-2020 (Coyne, 2024).
- Critical minerals are necessary for developing advanced defense systems and a variety of commercial applications. A moratorium increases our reliance on China's supply chain for these minerals just as it dims western commercial and economic prospects and thus represents a national security threat. It also provides great political and economic power to a country whose goals and values are not aligned with those of the west.

- **Reduction in opportunity for breakthrough medical therapies**

- Investment in nodule exploration had driven increased access to deep-sea biological data, creating the opportunity for medical breakthroughs. Yet, the moratorium impedes this research by cutting off industry funding.
- The moratorium risks the extinction of countless unknown plants and animals in rainforests due to the extremely high biodiversity found there, and therefore represents a far greater threat to the creation of novel therapies than does nodule collecting.

**Figure E Impact Comparison**

	<b>Terrestrial Strip Mining</b>	<b>Nodule Collecting</b>
<i>Location<sup>1</sup></i>	<b>Rainforests &amp; Forests</b>	<b>Abyssal plains</b>
<i>Invasiveness<sup>2</sup></i>	<b>Highly invasive</b>	<b>Non-invasive</b>
<i>Number of Species Present<sup>3</sup></i>	<b>4,350,000</b>	<b>~8,000 (in CCZ)</b>
<i>Biodiversity impact<sup>4</sup></i>	<b>~100% reduction</b>	<b>20% reduction</b>
<i>Biodensity impact<sup>5</sup></i>	<b>~100% reduction</b>	<b>50% reduction</b>
<i>Human Impact<sup>6</sup></i>	<b>Great loss of life, disease</b>	<b>Negligible</b>
<i>Solid Processing Waste<sup>7</sup></i>	<b>Large quantities</b>	<b>Negligible</b>
<i>CO<sub>2</sub> Footprint<sup>8</sup></i>	<b>Very large</b>	<b>Small</b>
<i>% Ecosystem Impacted<sup>9</sup></i>	<b>10% to 33%</b>	<b>0.06% to 0.2%</b>

In the following pages we delve into additional support behind each of the above bullet points. We offer more information, complete with references to a variety of scientific sources, on our website at COMRC.org. COMRC’s website also includes a section on “[Misinformation](#)” where we debunk many of the false claims that WWF and other environmental groups make in their attacks on the industry.

<sup>1</sup> Incremental supplies of nickel, cobalt, copper, manganese, and rare earths often (but not always) originate in tropical rainforest or forest ecosystems

<sup>2</sup> Nodule extraction requires no digging and is thus non-invasive

<sup>3</sup> (Pillay, 2021),(Mora, 2011),(Rabone, 2023)

<sup>4</sup> (O’Malley, Benthic foraminifera as bioindicators for the management of deep-sea mining: A lesson in setting baselines and establishing thresholds, 2023)

<sup>5</sup> (O’Malley, Benthic foraminifera as bioindicators for the management of deep-sea mining: A lesson in setting baselines and establishing thresholds, 2023)

<sup>6</sup> (World Counts, 2024) (Silva-Rego, 2022) (Macklin, 2023)

<sup>7</sup> (Tan, 2023),(Silva, 2023),(Bilgic, 2019),(Sullivan, 2017),(Paulikas, 2020)

<sup>8</sup> (Paulikas, 2020).

<sup>9</sup> Terrestrial mining figures reflect all mining – not just ETMs (Radwin, 2023); Nodules see quantitative analysis under rainforest impacts section

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