Impossible Metals Frequently Asked Questions (FAQ) for website.

v1.5

Please contact our team if you have any questions that aren't covered here or would like to discuss your questions or feedback with Impossible Metals.

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Market for Deep Sea Critical Minerals

Why do we need more critical minerals than what we mine on land today?

As the world works toward achieving net-zero emissions by 2050, transitioning to a low-carbon economy requires massive amounts of critical metals to produce batteries and other clean energy technologies. For example, on average, a conventional gas car contains five times less selected metal mass than that required to build an electric vehicle. Not surprisingly, the demand for nickel, cobalt, copper, and manganese has skyrocketed. Projections from the World Bank are that this demand will increase by 500% by 2050, and its sheer scale raises concerns about these metals' availability and sustainability. Without deep sea minerals, 388 new mines must be built by 2030 to provide the necessary minerals to meet international government mandates for electric vehicles.

Can recycling replace the need for deep sea minerals?

Recycling can be a part of the solution, as metals are highly reusable, but it is insufficient. A new electric vehicle (EV) won't be scrapped for 10 to 15 years. Its battery pack, while no longer able to power a vehicle, can last 15 to 20 years and may find a second life by storing wind or solar energy before being recycled. The International Energy Agency forecasts that the secondary supply of batteries and the reuse of nickel will represent just 3% of total demand in 2030 and 10% in 2040. To help close the demand gap, mining for new metals will still be essential.

Can reducing demand replace the need for metal mining?

Proposals to reduce demand fall into two categories:

The first category is to reduce demand by reducing car dependence in wealthy nations, which sounds doable in theory but can have significant implications for GDP and the economy. For example, in the U.S., that could require the migration of 50% to 75% of the population from rural and low-density communities to medium-density communities to take advantage of cycling, biking, walking, and mass transit. This migration would impact hundreds of millions of Americans and require significant policy, urban, infrastructure, and transportation changes that could take decades to implement and bring their own challenges.

The second proposed solution would limit access to modern technology like air conditioning (AC) and electric vehicles (EVs) in developing countries like India and in Africa. While climate change affects the entire planet, poorer countries are more severely affected, and their need for

AC to reduce heat stroke and improve daily life is already significant. When Harvard China Project researchers modeled future air conditioning demand, they found an enormous gap between current AC capacity (2.8 billion people live in the hottest parts of the world, but only 8% of them have home AC) and the AC capacity needed by 2050 to save lives. In addition, a World Bank study of 20 developing countries found that EVs would be an economic and environmental win for more than half of those countries. While it is essential to dig into how to reduce the overall demand for critical metals to attain net-zero goals, it's clear that the solution needs to be more practical and humane.

Will new battery chemistries eliminate the need for deep sea minerals?

While new battery chemistries are emerging, nickel and cobalt are likely to remain important for longer-range EVs and many non-battery uses.

Nickel and cobalt are used in many but not all battery chemistries. Today, they are mainly used in lithium, nickel, manganese, cobalt oxides (NMC), and lithium nickel, cobalt, aluminum, and oxides (NCA). Lithium iron phosphate batteries (LFP) are popular in China and do not use nickel or cobalt. However, LFP batteries are also significantly heavier, resulting in less range in an EV. Manganese-rich NMC could be a cheap alternative to LFP/LMFP, avoiding dependency on Chinese supply chains without sacrificing range. Cheaper, sustainably mined Cobalt from deep sea minerals would make high-voltage mid-nickel NMC an additional alternative. Nickel and cobalt are also used in many non-battery energy transition applications, including solar, wind, and nuclear power.

External industry analysts, such as Roland Berger, Benchmark Mineral Intelligence, etc., forecast that L(M)FP will account for around 35% of North American EV batteries in 2030. North American EVs will also use nickel-based (NMC) and iron-based (LFP) batteries. LFP is better for small pack sizes and cheaper vehicles, which are very popular in China. NMC has higher energy density and is best for long-range vehicles with bigger pack sizes.

LFP is primarily a Chinese technology today, so North America has no volume manufacturing. If you buy a car with Chinese batteries, you do not qualify for the Inflation Reduction Act (IRA)'s $7,500 tax rebate because they contain materials from a "foreign entity of concern." For example, the lowest-cost Model 3 Teslas, which use LFP batteries currently do not qualify for the credit,but the long-range vehicles do qualify, making them cheaper on an after-tax basis than the LFP-based vehicles and offering almost 100 more miles of range. LFP also has a very low recycling value. NMC has large recycling values; if you factor in the end-of-life recycling value, NMC is cost-competitive.

Finally, while additional battery chemistries are being developed today, some of which will not require nickel and cobalt, they are unlikely to make a significant impact on climate goals in the next one to two decades. It typically takes 20 years after a new battery chemistry is invented before a Western automotive manufacturer deploys it at scale. Western automotive manufacturers need many years of samples from the volume production factory before the battery cells will be qualified.

For more details, see our blog post, "Inconvenient Facts About LFP Batteries."

How long does it take for a land-based mineral deposit to get into production?

According to S&P Global, mining companies take an average of 23 years from discovery to production; in the US, it's 29 years.

Can deep sea minerals be cost-competitive with land-based mining?

Deep sea minerals will significantly lower recovery costs compared to new land-based mines. Given the high ore grade, four metals in one ore, and low infrastructure costs, deep sea minerals extracted from polymetallic nodules will be the lowest cost of all forms of mining. In addition, the ocean seabed is the world's largest source of nickel, cobalt, and manganese, and selective harvesting will have the lowest environmental impact. For more details, see this blog post, "Why Will Deep Sea Mining Be Less Expensive Than Traditional Land-Based Mining?"

Will deep sea minerals replace new land-based mines?

Yes. Existing land-based mines will continue to operate, but new land-based mines will not open after deep sea minerals ramp into production. This is because of the cost advantages of extracting deep sea minerals, the size of the resource, and the lower Environmental, Social, and Governance (ESG) impacts.

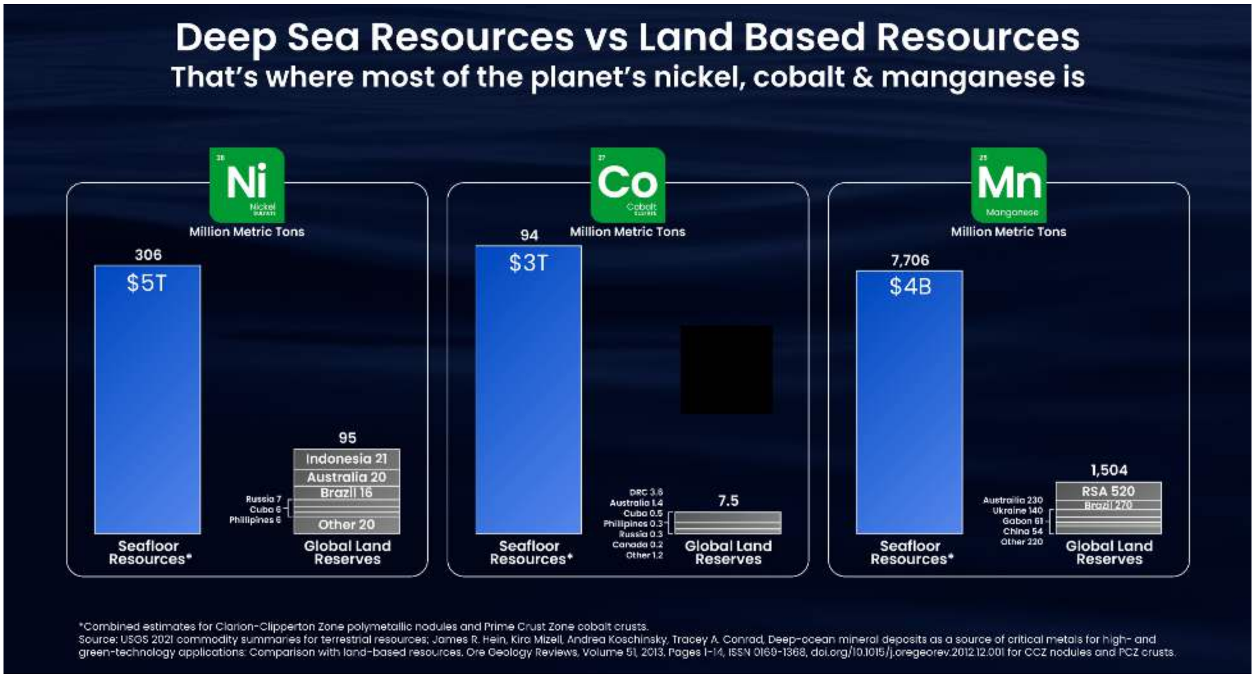
What are the different types of deep sea minerals?

There are four potential sources of deep sea minerals: polymetallic nodules, cobalt-rich ferromanganese crusts, seafloor massive sulfides, and rare earth element muds.

Polymetallic Nodules (PMN) contain nickel, cobalt, copper, and manganese. These potato-sized rocks are found on the abyssal plains lying on the seabed sediment. They do not require cutting, blasting, or tunneling. This is the exclusive focus of Impossible Metals. Cobalt-rich Ferromanganese Crusts (CFC) mainly contain cobalt. They form on sediment-free rock surfaces around oceanic seamounts, ocean plateaus, and other elevated features. Seafloor Massive Sulfides (SMS) mainly contain copper, lead, zinc, and some gold and silver. They appear on and within the seafloor when mineralized water discharges from a hydrothermal vent. The hot, mineral-rich water precipitates and condenses when it meets cold seawater. Most proposed mining is focused on extinct hydrothermal vents. Rare Earth Element Muds (REEM) mainly contain rare earth elements in the seabed sediment.

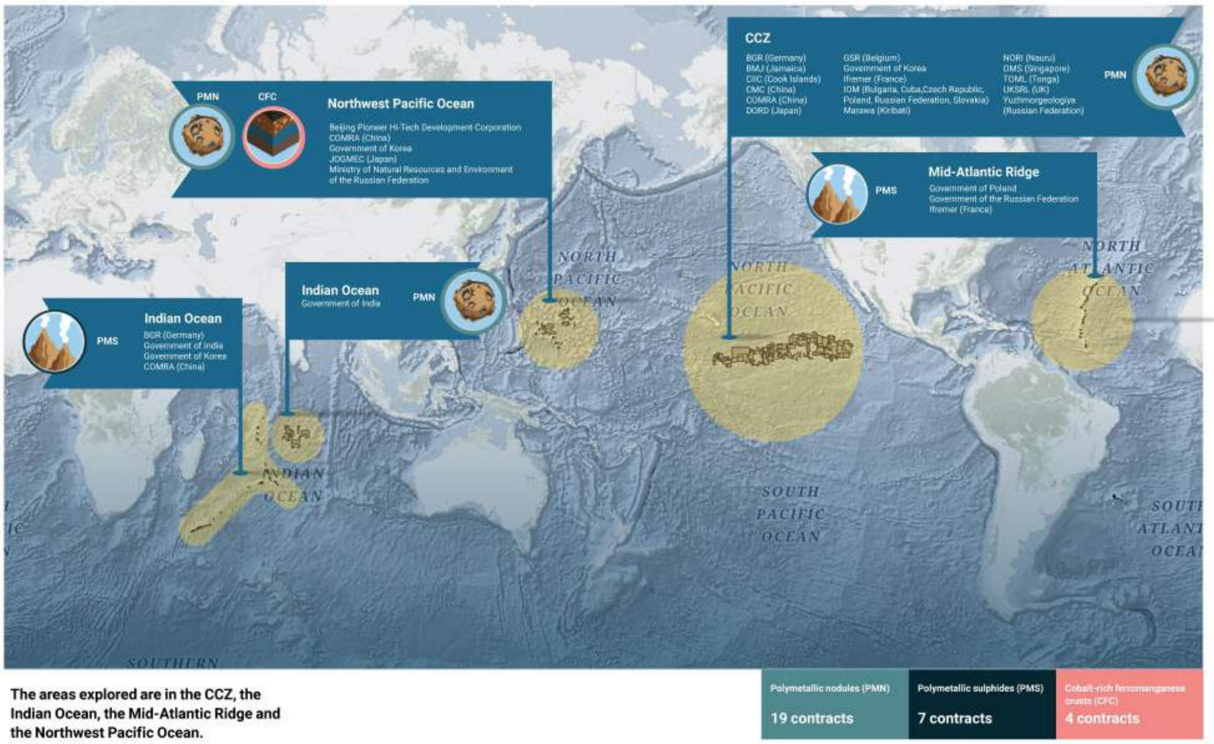
How significant are the reserves for deep sea minerals vs land-based reserves?

71% of our planet's surface area is oceans, and only 29% is land. We have mined on land since the Bronze Age, so the world's oceans contain significantly more nickel, cobalt, and manganese reserves.



Where are deep sea minerals found?

All of the world's oceans contain deep sea minerals. The international seabed area, under ISA jurisdiction, has issued exploration licenses in the Clarion-Clipperton Zone (CCZ), the Indian Ocean, the Mid-Atlantic Ridge, and the Pacific Ocean.



Many countries contain deep sea minerals within their EEZs, such as the Cook Islands, Norway, Japan, Sweden, India, the Kingdom of Saudi Arabia, American Samoa, Papua New Guinea, Chile, the United States, Brazil, and China. See countries developing subsea minerals in their EEZs.

How will polymetallic nodules ore be processed (refined) into pure metals?

Traditional hydrometallurgical and pyrometallurgy processes can be used to refine nodules.

Environmental and Social Responsibility for Deep Sea Mining

What are the environmental concerns related to deep sea mining?

There are a few categories of concerns about the potential impacts of deep sea mining. Impossible Metals' approach from our founding has focused on removing or minimizing these concerns to create the most environmentally responsible form of mining.

1. **Loss of Biodiversity**: Identifying new species during deep sea exploration is common. These creatures may hold unknown discoveries for science or medicine, and there is

concern that deep sea mining could result in their loss before we know they exist. Although “protected areas” (the ISA calls them “areas of particular environmental interest” [APEIs]) are left as non-mining areas, these protected areas are significantly distant from the mining areas, so the biodiversity in these areas differs from the mining areas.

2. **Sediment Disturbance & Pollution**: Deep sea mining may disturb sediment, which can have various impacts, such as:
    a. Disturbance of animals that live in the sediment. These are typically small (or very small) creatures that spend all or part of their lifecycle under the upper layers of the very fine deep sea sediments.
    b. When sediment is disturbed, it sinks to the seafloor, which can smother animals that cannot move out of the way, like deep sea corals.
    c. Increasing toxicity in the water can harm marine organisms and bioaccumulate/magnify. This could impact fish food sources.
    d. Potential for release of stored carbon in sediment.
3. **Noise & Vibration Disturbance**: Equipment used in the ocean may have sounds or vibrations associated with them, from the motors running dynamic positioning (DP) systems to keep ships in place to electromagnetic waves from various monitoring or communication systems. Plenty of sea creatures use particular wavelengths to communicate, like whales. Noise and vibration from deep sea mining have the potential to impact this communication, which could result in changing behaviors or migratory pathways.

4. **Light Disturbance**: The abyssal plains where nodules form are very deep (4-6 km) and, therefore, very dark. There is concern that the introduction of light sources could impact sea creatures.

5. **Loss of Hard Surface**: Polymetallic nodules often represent the only hard surface in these abyssal ecosystems, where the rest of the seafloor is composed of very fine sediment. Some animals attach to the nodules, like deep-sea corals and sponges. Other animals use the nodules to move around, similar to how it takes less energy for a person to walk on a sidewalk than on soft sand.

6. **Emission of Greenhouse Gasses:** Management of emissions will be a key task for the deep sea mining industry. Ship fuel will account for a significant proportion of emissions,

providing energy for ship movement and the variety of tasks the ship will perform. This includes ship dynamic positioning (DP) and the riser system in a traditional architecture.

What is Impossible Metals' plan to protect the marine environment?

Impossible Metals was explicitly founded to address the environmental concerns surrounding deep sea mining of polymetallic nodules, so here's how we address each of the concerns listed in the previous answer:

1. **Loss of Biodiversity**: By avoiding picking up visible life (megafauna) and leaving behind a percentage of nodules, our system minimizes the potential for destruction of animals for their own sake, for the ecosystem, and for any potential human uses.
2. **Sediment Disturbance & Pollution**: Our underwater robots—formally known as Autonomous Underwater Vehicles (AUVs)—have a variety of features that minimize sediment disturbance:
    a. Our AUVs hover over the seafloor so they do not disturb sediment from landing or driving over the seafloor.
    b. The buoyancy engine makes the robot positively buoyant while it hovers over the seafloor, meaning thrusters push upward, not downward into the sediment.
    c. Robotic arms/claws pick up nodules individually, minimizing sediment pickup.
    d. The AUV's move up and down the water column avoiding the need for a riser pump system and its discharge plume.
3. **Noise & Vibration Disturbance**: Our goal is to have a launch and recovery system for the robots that will remove the need for a dynamic positioning system on our ships, including avoiding the need for a second vessel and for ship-to-ship transfers; this will significantly reduce noise and vibration in surface waters. We are committed to understanding and optimizing our robot's electromagnetic wavelengths (communication, monitoring, etc.) for minimal disturbance. Our architecture does not require a riser pump system that uses multiple pumps and generates significant noise.
4. **Light Disturbance**: Our robots use visible light to identify nodules and life (to avoid) with our computer vision system. We are committed to studying the impacts of this light and innovating as needed to minimize it. Lights are turned off for vehicle ascent/descent through the water column.

5. **Loss of Hard Surface**: Selective harvesting allows us to leave behind a percentage and/or pattern of nodules that maintain the ecosystem's hard surface and avoid nodules with attached visible life (megafauna). Our current economic models assume we will leave 20% of nodules behind, but this estimate will be refined through study and discussion with scientists.
6. **Emission of greenhouse gasses:** Our plan for producing responsible metals includes a commitment to net zero. This means we will minimize emissions as much as possible, and use carbon offsets for any remaining impacts. We report annually on our environmental impact. Our selective harvesting system design minimizes emissions in the following ways:
    a. AUVs are electric, and we are investigating renewable energy sources for battery charging
    b. No riser pump, ship-to-ship transfer, or onboard separation of nodules from sediment and water
    c. We are working on a launch and recovery system that does not require our ships to have dynamic positioning.

How will Impossible Metals prove selective harvesting has a lower environmental impact than competing technologies?

The only way we can prove our impact level is to collect nodules from the seafloor, so that is what we will do. We will carry out a test where our robot picks up nodules, typically called "component testing" or "test mining," depending on scope. During this test, there will be a wide range of environmental monitoring to characterize the environmental impact, including sediment monitoring and a photomosaic with detailed imagery before and after the test. Before the test, sediment modeling will be carried out to estimate the sediment disturbance. Impossible Metals is committed to transparency about all modeling and monitoring results.

How does Impossible Metals work with marine scientists?

Impossible Metals started engaging with marine scientists early in our company's history, with initial discussions about selective harvesting in April and May 2022. Since then, we have continued to engage scientists to discuss vehicle testing and monitoring and will continue to carry out this engagement as we develop our technology. Additionally, we will leverage the expertise of marine scientists to monitor the environmental impacts of selective harvesting during testing.

What are the standards that Impossible Metals has committed to following for responsible metals sourcing?

- Protects safety and human rights.
- Are carbon neutral.
- Maximizes the potential for recycling and circularity.
- Eliminates toxic waste.
- Avoids widespread habitat destruction.
- Avoids water scarcity.
- Avoids loss of biodiversity.
- Avoids displacing Indigenous people or communities.

What data has Impossible Metals published?

Impossible Metals has published minutes from multiple scientist roundtable events here. Data and material from the May 2023 Demo Day event is published here. ESG annual reports are here.

What is Impossible Metal's commitment to the UN Sustainable Development Goals (SDGs)?

- SDG Goal 5 – Achieve Gender Equality and Empower All Women and Girls.
- SDG Goal 6 – Clean Water and Sanitation.
- SDG Goal 7 – Affordable and Clean Energy.
- SDG Goal 9 – Innovation, Industry and Infrastructure.
- SDG Goal 12 – Responsible Consumption & Production.
- SDG Goal 13 – Climate Action.
- SDG Goal 14 – Life Below Water.
- SDG Goal 15 – Life on Land.

Do we know enough about the deep ocean to start deep sea mining?

If you were to point to a random point in the deep ocean, we likely would need more information to start mining there. However, the areas proposed for deep sea mining are some of the best-explored areas of abyssal plains in the world. In international waters, at least three years of environmental baseline information must be collected, characterizing biodiversity and the ecosystem, the physical and chemical characteristics of the water and sediment, and their interactions. Some exploration permit holders have been doing baseline studies for over 20 years! For more on this topic, check out our blog, "Data from the Deep Seabed - What Do We Know?**"**

What are the most significant human impacts on ocean life?
Currently, deep sea mining is not occurring. Existing industries that impact ocean life are fishing (particularly bottom trawling), oil and gas, offshore wind, and shipping. Bottom trawling is of particular concern as it scrapes the ocean floor, destroying and disrupting habitats and ecosystems. Bottom trawlers catch 26 percent of the total global marine fisheries catch. Additionally, many industries contribute to the global issue of climate change, which impacts the ocean through warming, deoxygenation, and ocean acidification.

What are the environmental & social impacts of land-based mining for nickel?
Land-based nickel mining has significant environmental impacts, with the severity varying based on the regulatory frameworks in different jurisdictions. Indonesia and the Philippines produced 58.2% of the world's nickel in 2022, largely from deposits located beneath rainforest ecosystems. In addition to environmental destruction, poor social protections put local communities at risk, including Indigenous communities, which have the right to free, prior, informed consent under the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP).
Watch a video about Indonesian nickel mining (BBC News)
Watch a video about Philippines nickel mining (FRANCE 24)

What are the environmental & social impacts of land-based mining for cobalt?
The Democratic Republic of the Congo (DRC) supplies an overwhelming 68% of the world's cobalt and has half of global land reserves, so the significant impacts in the DRC are especially notable. Amnesty International reports that cobalt (and copper) mining in the DRC has led to *"the forced eviction of entire communities and grievous human rights abuses including sexual assault, arson, and beatings."* Additionally, it is well-documented that DRC mines use child labour. The US Department of Labor states that, "*While mining is on the DRC's list of hazardous activities for which children's work is forbidden, the majority of cobalt mining in the DRC is done*

informally, where monitoring and enforcement are poor." These social issues in the DRC are compounded by environmental hazards, such as deforestation, toxic tailings, and soil erosion/degradation that further threaten human health and wellness.
To learn more, check out "Cobalt Red", a book by Siddharth Kara.

What is Impossible Metals' stance on calls for a deep sea mining moratorium, pause or ban?
We want the environmental bar to be set high and for the industry to innovate to reach it. A ban would stop innovation and remove significant funding for scientific research. It is well established that we will need a lot of critical minerals for the energy transition away from fossil fuels (e.g. IEA, World Bank Group). Deep sea mining represents an opportunity for environmentally and socially responsible access to these resources. Consumer demand for responsibly sourced materials is rising, so we should define what that looks like and empower the innovators to do their work. We also feel that a holistic approach to critical minerals is required. A deep sea mining moratorium, pause, or ban would only result in more land-based mining impacts and will make it impossible to achieve Net-Zero by 2050.

NGOs cite that many countries and companies have signed up for a moratorium, pause, or ban. What is Impossible Metals' view on this?
A number of countries are listed as having signed up for a moratorium, pause, or ban. Although these countries may have made public statements, the vast majority have not passed legislation. In fact, these countries have signed UNCLOS, which legally commits them to deep sea mining regulated by the ISA. Some of these countries have sponsored exploration applications. If they legally supported a moratorium, pause, or ban, they would be in violation of their legal obligations and could lose their exploration areas.
A number of companies are listed as having signed up for a moratorium, pause, or ban. The wording says, "Before any potential deep seabed mining occurs, it needs to be clearly demonstrated that such activities can be managed in a way that ensures the effective protection of the marine environment." This is the purpose of the Environmental Impact Assessment (EIA), which must be approved by the regulator before any mining can start. After a regulator approves an exploitation application, the EIA will provide for protecting the marine environment. So, any companies that have signed the moratorium will be free to purchase deep sea minerals.

Deep Sea Mining Regulations

Is deep sea mining happening right now?

The exploration phase of collecting deep sea minerals has begun. So far, no commercial collection has taken place in the deep sea. To date, approximately 40 exploration licenses have been awarded: 31 by the International Seabed Authority (ISA) and the remainder by different governments within their exclusive economic zones (EEZ).

Who regulates deep sea minerals?

Individual countries govern the deep sea minerals within their EEZs. In international waters, deep sea minerals are governed by the United Nations (UN) through the "The United Nations Convention Law Of the Sea (UNCLOS)." 167 countries and the European Union are signatories to UNCLOS. UNCLOS is controlled and enforced by the International Seabed Authority (ISA), an autonomous organization within the United Nations common system. For more details, please see the blog post "Current Status of Deep Sea Mining Regulations."

What is the current status of deep sea mining regulations?

Exploration regulations have been in force for many years. Exploration includes analyzing deposits, testing systems and equipment, and completing environmental baseline, scientific, technical, and economic studies; no commercial activity is permitted under exploration.

Exploitation (commercial mining) regulations have been under development for many years. The ISA has stated that the exploitation regulations will be adopted in 2025. Multiple countries, including the Cook Islands, have awarded exploration licenses within their exclusive economic zones. For more details, please see the blog post "Current Status of Deep Sea Mining Regulations."

When do you expect exploitation contracts to be awarded?

Exploitation regulations are in the final stages of being adopted by multiple regulators. It is anticipated that the earliest date an exploitation contract could be awarded and production mining started is 2027.

What environmental data is required before an exploitation (mining) license can be issued?

Extensive environmental data will be required before exploitation, but the requirements may vary depending on the jurisdiction and the nature of the license area. Countries issuing mineral licenses in their own Exclusive Economic Zones (EEZ) will set their own guidelines. In contrast, all companies with license areas in international waters will be subject to the guidelines set by the ISA under UNCLOS. However, all jurisdictions are expected to request an Environmental Assessment Statement (EAS), which will outline a first level of analysis of the activity's environmental impact. Subsequently, an Environmental Impact Statement (EIS) will likely be required to outline the potential effects on the environment in a detailed, scientific-backed manner. Based on this information, measures will be outlined to address the impact and for continued monitoring/reporting.

Why has the United States not ratified UNCLOS?

167 countries plus the European Union have ratified UNCLOS. This represents 7.5 billion people (93%) of the world's population. In the United States, there has been vigorous debate over the treaty's ratification, with criticism coming mainly from political conservatives that raised concerns on the Convention's impact on U.S. sovereignty. See more details in the 60 minutes TV program from March 2024.

Will there be a royalty for deep sea mining?

Yes. All mining typically has a royalty, paid for access to the resource. The ISA Finance Committee is working on equitable finance sharing from deep seabed mining. This is likely to result in a royalty. See the blog post "For All Mankind: How Deep Sea Minerals Could Pay Children in Africa to Go to School Instead of Mining" for more information.

Impossible Metals Technology

How is Impossible Metals technology different from others?

Impossible Metals leverages advanced autonomous robotics and AI technology to conduct underwater mining with minimal environmental impact. Unlike traditional methods that rely on destructive dredging, our robots—formally known as Autonomous Underwater Vehicles (AUVs)—selectively harvest critical minerals while preserving marine ecosystems. Our technology ensures sustainability and efficiency, setting a new standard for responsible underwater mining. A list of deep sea dredging tractors + Eureka II AUV is here.

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What technical risks does Impossible Metals still have to mitigate?

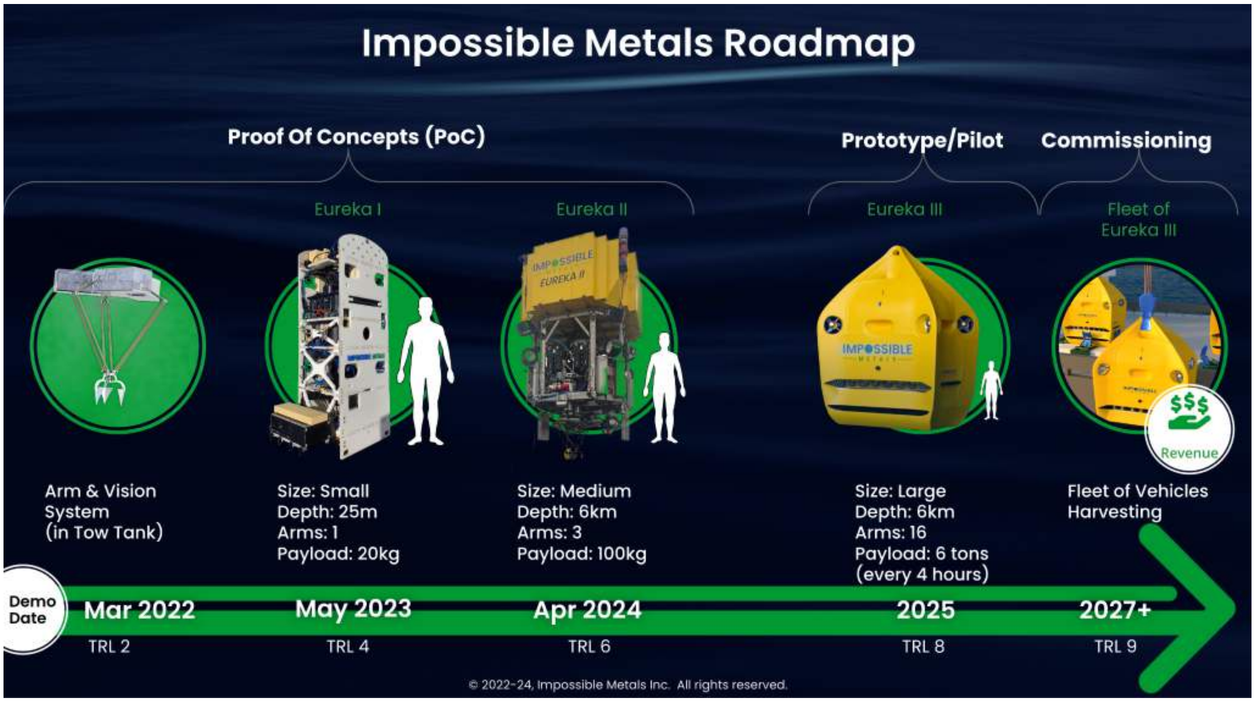
Our primary technical risks include ensuring the durability and resilience of our robots in harsh underwater conditions, refining our AI algorithms for optimal target identification and resource recovery, and maintaining reliable communication systems between our robots and surface operations. We are actively working on mitigating these risks through rigorous testing, continuous improvement, and strategic partnerships with leading technology providers.

What technical risks do competing dredging tractor and riser systems still have to mitigate?

A number of companies have conducted dredging tractor and riser system deep sea trials; however, the ship-to-ship transfer of the nodules has not been tested. The ship-to-ship transfer of the nodules in the ocean is complex and will likely require very specialized transport ships, including dynamic positioning (DP) and dewatering technology. This article includes more details on this topic.

When will your technology be ready for commercial mining operations?

Our technology will be ready for commercial mining operations by 2027. As of mid-2024, we are in the final stages of testing and validation, ensuring our systems meet all regulatory and environmental standards. We also engage with potential customers to align our development with market needs and expectations. We are currently designing Eureka III, the full-size production system.



How does the cost of Impossible Metals technology compare to dredging technology?

We expect Impossible Metals' approach to be the lowest cost method for deep sea mining. A fleet of robots has three primary economic benefits compared to dredge and riser-based systems.

The first is the improved economics for a fully operating system. This is achieved through reduced capital expenses (CapEx) by not requiring a dedicated surface production vessel with dynamic positioning for supporting equipment like a riser system. With the Impossible Metals approach, the transport ships pull the robots from the water without needing dynamic positioning surface vessels or ship-to-ship ore transfer. We need one ship instead of two.

The second benefit is the ability to scale the system with the incremental addition of CapEx. A small-scale operation can become operational with a relatively modest initial capital investment. As additional capital is invested, the fleet of robots and, thus, the material throughput can be scaled.

The third economic benefit is the lack of single points of failure. While there are increased points of failure with the fleet of robots, there are no single points of failure, ensuring that the selective harvesting architecture remains operational through these failures.

How do you scale to high rates of production?

Each Eureka IV, our planned production scale AUV, will be able to deliver 25 metric tons of nodules to the transport ship in under four hours. The same vehicle can be reused six times in 24 hours to deliver 150 metric tons to the transport ship. One hundred Eureka IV operating in parallel would harvest 15,000 tons per day. There is no fundamental limit on how many AUVs and transport ships are deployed. We anticipate a volume production per location of around 6 million tons of nodules a year.

How reliable will your technology be?

Reliability is a cornerstone of our technology development. Our robots are designed with multiple fail-safes, redundancy systems, and real-time monitoring capabilities to ensure consistent performance in various underwater conditions. We conduct extensive testing under simulated and real-world conditions to validate the reliability and durability of our systems.

How do you deal with the complexity of your technology?

We address the complexity of our technology through a modular design approach, enabling easy maintenance and upgrades. Our interdisciplinary team of experts continuously collaborates to integrate cutting-edge robotics, AI, and marine engineering advancements.

How is the robot (AUV) controlled?

A mission plan is uploaded to each robot before deployment. The robot is fully autonomous and completes the mission plan based on sensors and programming. The robot's progress is monitored through an acoustic modem (USBL) that tracks the robot's position and provides low bandwidth status information. The fleet management software on the surface will automatically send essential speed and course adjustment information to the robots in the water to support synchronization of the robotic vehicle launch and recovery. Additionally, the operator on the surface vessel can provide override commands when required.

Why is your robot (AUV) untethered?

To allow many robots to operate in parallel, we need to eliminate the need to manage a tether (cable). Each robot is lithium-ion battery-powered.

Won't local sediment disturbance obscure the vision system from identifying nodules and life on the nodules?
The design of the robotic arms, the claw, the arm's movement, and the claw's position on the nodule are optimized to minimize local sediment disturbance. Even so, some local sediment disturbance can occur when the nodule is picked. The cameras identify the location of the nodule in front of the vehicle. The nodule's location is tracked relative to the robot through precise tracking of the vehicle position. Even with the nodule out of sight from the camera, because the robot's position is precisely tracked, the nodule's location is understood, enabling the arm to pick it. With the nodule under the vehicle, the arm picks it, and any disturbed sediment is well behind the camera. Additionally, the vehicle will travel primarily into any current that exists. Between the vehicle motion and the surrounding currents, any sediment distributed under the vehicle will remain behind the vehicle.

How can you scale to millions of tons of nodules?
Each Eureka IV robot has approximately 60 arms with a 25-metric-ton payload. The Eureka IV can be reused every 4 hours. So, in 24 hours, 6 missions can be completed, delivering 6 * 25 = 150 metric tons per 24 hours. A fleet of 128 Eureka IV robots can deliver 19,200 metric tons per 24 hours using 4 vessels, which translates to 6 million metric tons per year, assuming ~312 production days a year. (Assuming around 53 days a year when a weather hold is in operation.)

Impossible Metals Company

When was Impossible Metals incorporated?

Impossible Metals was incorporated in 2020 as a Delaware B Corporation, which is a public benefits corporation (“B Corp”).

What is Impossible Metals' public benefit?

The corporation's specific public benefit purpose is to deliver responsibly mined and processed battery metals to the market in a manner that promotes sustainability, transparency, and accountability and to render a public benefit by accelerating the world's transition to sustainable energy to mitigate the climate crisis.

What is Impossible Metals’ vision?

Accelerating clean energy by delivering the most sustainable critical metals.

What is Impossible Metals’ Mission?

To harvest and process critical metals from the seabed, while protecting the environment.

What are Impossible Metals’ Core Values?

1. Planet comes first: environment and people before profit.
2. We are determined, striving to make the impossible possible.
3. We encourage, share and respect all perspectives.
4. We move fast, separating what must be done now from what can be improved later.
5. We embrace and learn from every success and failure.
6. We act as owners, managing resources responsibility and efficiently.

How much seed funding has Impossible Metals raised to date?

Over $12M. We closed our seed round in May 2022 of $10M and pre-seed round of $2M in September 2021.

Who are Impossible Metals’ investors?

Chalet, Y Combinator, Justin Hamilton, and many smaller funds and individuals.

Where is Impossible Metals based?

San Jose, CA, USA, and Collingwood, ON, Canada

Who is the leadership and board member of Impossible Metals?

See the leadership team here.

See the board members here.

What is Impossible Metals' business model?

Impossible Metals intends to partner with companies that hold deep-sea mineral exploration areas, leverage third parties to process (refine) the metals, and sell the resulting offtake. In the longer term, Impossible Metals intends to apply for its own exploration areas.

What is the total available market (TAM) for Impossible Metals?

Polymetallic nodules contain four metals (nickel, cobalt, copper, manganese). The TAM for the four metals in 2030 is estimated to be $559B per year.

What happened to the mineral processing team?

In April 2024, this team was spun out into a new company called Viridian Biometals. Impossible Metals maintains a minority holding in Viridian Biometals.

Deep Sea Mining Glossary

Abyssal plains = Is an underwater plain on the deep ocean floor, usually found at depths between 3,000 and 6,000 meters.
AUV (Autonomous underwater vehicle) = AUVs are robot submarines that can explore the ocean without a pilot or tether.
Biodiversity = biological diversity among and within plant and animal species in an environment.
CCZ (Clarion-Clipperton Zone) = A large area in the Pacific Ocean from Hawaii to Mexico.

Critical Minerals = Copper, nickel, and cobalt are essential components in many of today's rapidly growing clean energy applications.

DP (Dynamic Positioning) = is a computer-controlled system to automatically maintain a vessel's position and heading by using its own propellers and thrusters.

DSM (Deep Sea Minerals) = The minerals found on the deep seabed.

EEZ (exclusive economic zone) = an area of the ocean, generally extending 200 nautical miles beyond a nation's territorial sea, within which a coastal nation has jurisdiction over both living and nonliving resources.

EIS (Environmental Impact Statement) = is a tool for decision-making. It describes the positive and negative environmental effects of a proposed action.

Eureka I, II, III = Underwater robots (AUVs') designed by Impossible metals for selective harvesting of polymetallic nodules from the ocean floor.

EV (electric vehicle) = is a vehicle that uses one or more electric motors for propulsion.

ISA (International Seabed Authority) = is an autonomous international organization that organizes and controls all mineral-resources-related activities in the Area for the benefit of humankind.

Megafauna = animals of a given area that can be seen with the unaided eye.

UNCLOS (United Nations Convention on the Law of the Sea) = established a comprehensive international legal framework to govern activities related to the global oceans.
USBL (ultra-short baseline) = method of underwater acoustic positioning as GPS does not work underwater.
TAM (Total addressable market) = a metric that estimates the maximum revenue potential for a product or service if it were to capture 100% of a market.