

DEEP SEA MINING ISN'T WORTH THE RISK

HIGH COSTS, FINANCIAL DEVELOPMENTS SINCE
2021, AND EXTERNALITIES STAND TO DIMINISH
THEORETICAL RETURNS ON INVESTMENT

This report critiques the business rationale for Deep Seabed Mining (DSM) activities and addresses some of the reasons investors – both in fixed assets and public or private equity – may want to exercise caution when considering DSM.

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EXECUTIVE SUMMARY

Deep seabed mining (DSM) is a prospective commercial industry aimed at extracting mineral deposits from the ocean floor, targeting the four minerals that dominate their composition: manganese, copper, cobalt, and nickel.

While no DSM yet exists (except for scientific exploration), potential miners continue to actively seek capital. Despite interest in launching this new industry, DSM is an unproven industrial endeavor fraught with technical, financial, and regulatory uncertainty, lacking in social license (e.g., Indigenous opposition, human rights concerns), and carrying significant potential financial and legal liabilities for both public and private investors.

This report critically examines the business case for DSM, highlighting a suite of risks compounded by numerous unknown factors.

1

Unrealistically optimistic financial models ignore major technical difficulties in extraction (at unprecedented depths below the surface), a volatile metals market, and substantial negative changes in key economic assumptions since 2021.

- Demand fluctuations may affect the industry's ability to sell DSM products, as business models rely on expected growth in demand for EV minerals. A report commissioned by the International Seabed Authority (ISA) found that there is high uncertainty around prices for commercial metals once contractors begin production, leading to the possibility that relatively high-cost minerals from the seabed are not competitive, and thus generate little or no profit. **In fact, metals prices have not risen in tandem with EV production: between 2016 and 2023 EV production is up 2,000% and cobalt prices are down 10%.**
- Routine due diligence on the operational or processing aspects of proposed DSM may prove difficult, as much remains undefined or speculative.
- In Fall 2022, the first DSM collection trial in international waters, done at a very small scale, had significant technological hitches.
- There would be a large up front operational cost associated with DSM, on par with highly industrial extractive industries including oil and gas. It is unreasonable to assume DSM projects would fare better than standard industrial projects, two-thirds of which go over budget by an average of 50%.

2

Seabed minerals are not, as mining companies quip, “a battery in a rock.” Polymetallic nodules contain only four minerals that are potentially economically attractive: nickel, cobalt, manganese, and copper. DSM proponents speak of supplying cobalt and nickel to the electric vehicle (EV) industry, an industry that is rapidly moving away from cobalt and from nickel toward new battery chemistries such as lithium iron phosphate (LFP).

Relicanthus daphneae, an anemone-like organism in the CCZ, stuck on top of the stalk of a dead sea sponge. Its tentacles can extend several feet long. *Credit: Diva Amon and Craig Smith/University of Hawai'i*

3

Innovation design for the energy transition, including batteries, is moving away from minerals found on the seabed, particularly cobalt. In tandem with the growing circular economy, this will likely render DSM unnecessary.

- New chemistries for electric vehicle batteries and reducing dependence on lithium-ion batteries for non-moveable uses could **reduce the demand for cobalt, nickel, and manganese** by 40-50% between 2022 and 2050.
- Currently, just 8.6% of the world's materials are part of a circular economy, but **by 2050, researchers predict 45–52% of cobalt, 22–27% of lithium, and 40–46% of nickel could be supplied from recycled materials.**

4 Potential Costs and “Long Tail” Liabilities are exacerbated by known and unknown threats present in all aspects of DSM, making return on investment uncertain. These threats take the form of:

- An **unfinished regulatory scheme** that – in its draft form – is rife with high costs and extreme liabilities and is overseen by a problematic regulator.
 - A peer reviewed paper published in January 2024 found that 30 major issues in the ISA regulations remain outstanding and that the ISA internal target date to complete the regulations in 2025 is unrealistic.
 - It is notable that both at the ISA and under state jurisdictions, financial guarantees for restoration obligations will be required before mining begins – a significant up-front expenditure.
- **Reputational concerns** associated with companies that would engage in, or support, DSM may jeopardize investment.
- While damage to the ocean and its ecosystems is guaranteed, **who will pay that damage and how much it will cost** is undefined.
 - A 2023 report estimated “the total biosphere impacted by nodule mining in abyssal plains in international waters alone would be up to 25–75 million km³, more than the volume of all freshwater in the world, including ice and snow.”
 - A study published in May 2023 analyzed more than 100,000 records of animals in the Clarion Clipperton Zone (CCZ), (the primary target of DSM at the time of this report writing), and found over 90% of species from the records were unknown to science.
- **Lack of social license** (Indigenous opposition, human rights concerns), misleading comparisons to terrestrial mining and overstated Environmental, Social, and Governance (ESG) claims.
 - Environmentalists, scientists, cultural leaders, and individuals are showing their support for the value of the deep sea before an unproven extractive industry begins commercial production of a nonrenewable resource.

5 Front runner company The Metals Company (TMC) has not addressed risk or actual damages from environmental spills nor protests (with their attendant costs and liabilities), giving potential investors and decision-makers an incomplete picture.

- Originally, when TMC was first listed on the U.S. stock exchange, civil society argued that its prospectus **did not sufficiently disclose risks**; the Securities Exchange Commission agreed, and required TMC to file an update.

6 International pressure is building to halt DSM: the decision-making body of the International Seabed Authority has said there should be no DSM without regulations; major companies, Indigenous people, civil society, and scientists are calling for a moratorium; and banks, financial institutions, and insurers are rejecting investment in DSM.

- **24 countries have called for a ban**, moratorium, or precautionary pause.
- **39 companies have signed onto a business statement indicating their commitment to not invest in DSM**, allow for mined minerals to enter their supply chains, and to not source minerals from the deep sea. These companies include Google, Samsung, Philips, BMW, Rivian, Volkswagen, and Salesforce. Their signature commits them to support a moratorium, not source minerals from the deep seabed, exclude those minerals from their supply chains, and not finance DSM activities.

Operational challenges in the deep sea, such as extremely high pressure (4,000+ pounds per square inch), freezing temperatures, corrosive seawater, a high particulate environment, and limited light jeopardize the efficiency and efficacy of equipment, thus hindering the viability of this commercially untested industry. *The high operational, processing, and establishment costs inherent in DSM greatly threaten any potential profits across the industry, with no way to capture the risk.*

The high operational, processing, and establishment costs inherent in DSM greatly threaten any potential profits across the industry, with no way to capture the risk.

Meanwhile, innovation in design is leading industry toward rapidly emerging alternatives to minerals found on the seabed. Battery innovation is transitioning away from cobalt and nickel towards safer, more efficient, and recyclable chemistries, reducing reliance on new extractive methods. Investment in the circular economy is reducing dependence on new extractive methods and industries in favor of recycling and reuse of the materials already in the supply chain.

The potential impacts of DSM on fragile ocean ecosystems and human rights cannot be overlooked. DSM carries the risk of irreparable damage to ocean ecosystems and violations of human rights and Indigenous Peoples' rights, exposing investors to significant liabilities and reputational risks.

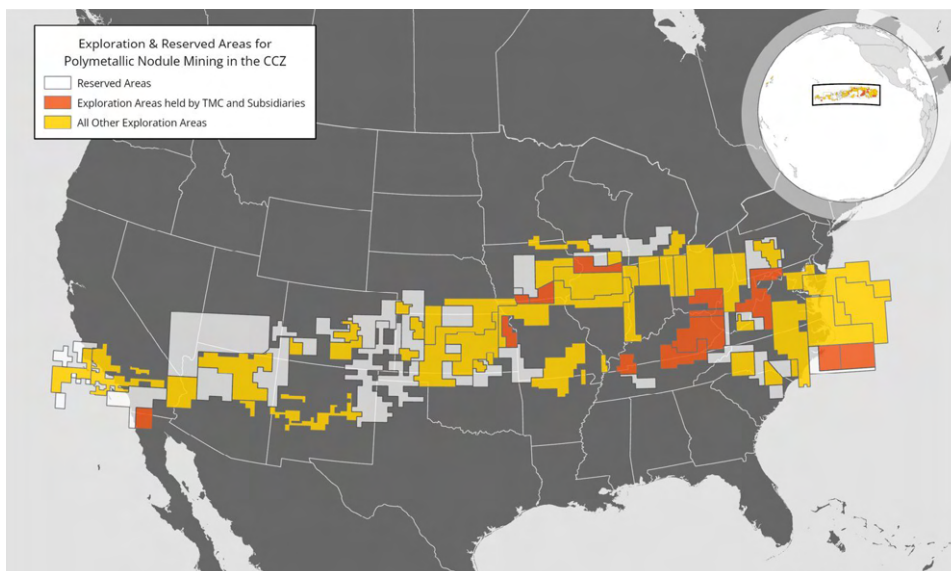
Despite a handful of vocal proponents, including early-stage private sector companies and a handful of countries, opposition to DSM is mounting. Major corporations like Google, Samsung, Phillips, Volvo, BMW, and Salesforce have already committed not to use DSM-sourced minerals, and – since June 2022 – 24 countries have called for a moratorium on DSM. Established mining companies, financial institutions, and even a major insurer have also taken positions against DSM.

In light of these considerations, investors—whether in fixed assets or public/private equity—should **exercise extreme caution when evaluating potential investments in DSM.**

BACKGROUND

Deep Seabed Mining (DSM) is a potential commercial industry with a goal to mine mineral deposits from the ocean floor, in the hopes of extracting metals such as manganese, copper, cobalt, and nickel.

Some quantities of these mineral deposits have been found in three habitats located on the seafloor: the abyssal plains, seamounts, and hydrothermal vents.¹



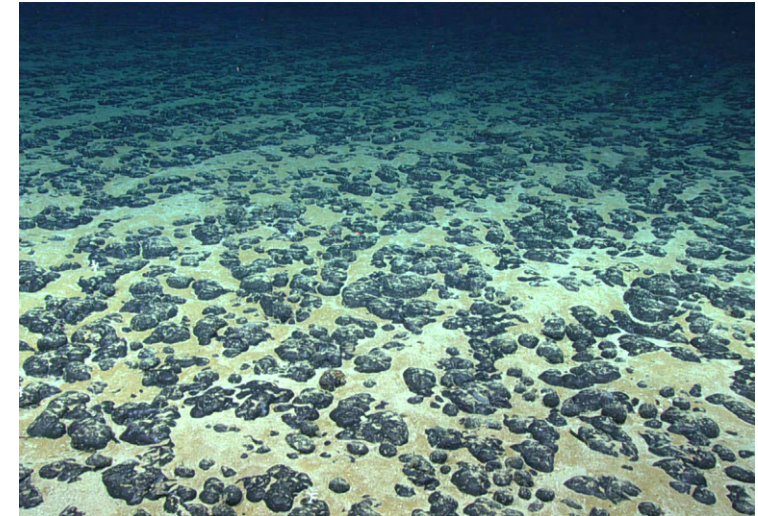
The Clarion Clipperton Zone (CCZ) overlaid over a map of the United States. Credit: Oceans North.

Abyssal plains are vast expanses of benthic (bottom dwelling) fauna habitat where biological debris fallen from above provides the primary source of energy for deep ocean animals.³ This deep seabed is also covered in sediment and mineral deposits, called **polymetallic nodules**.

International attention is currently focused on the Clarion Clipperton Zone (CCZ): a region of abyssal plains as wide as the continental United States, located in international waters (beyond the jurisdiction of any single nation) and spanning from the west coast of Mexico to the middle of the Pacific Ocean, just south of the Hawaiian Islands.²

This report mainly contemplates potential nodule mining in the CCZ, as that is the primary target of DSM as of this writing. Current proposed methods of mining for nodules include the deployment of a **mining vehicle**,⁴ an **industrial machine resembling a three-story tall bulldozer, to the seafloor**. Once on the seabed, the vehicle crawls along on tank-like tracks, aiming to suck up the top four inches of the seabed before sending the sediment, rocks, crushed animals, and nodules up to a ship waiting on the surface.⁵ On the ship, the minerals are sorted and the remaining wastewater slurry, a mix of fragmented heavy metals, sediment, water, and processing agents, is returned to the ocean via a discharge plume.⁶

The most direct analogue to operations on land is **strip mining**; DSM is, in almost all respects, strip mining of the seafloor.



Manganese nodules covering the seafloor of the Blake Plateau during Dive 07 of the 2019 Southeastern U.S. Deep-sea Exploration. Credit: the NOAA Office of Ocean Exploration and Research, 2019 Southeastern U.S. Deep-sea Exploration. <https://oceanexplorer.noaa.gov/oceanos/explorations/ex1907/logs/nov7/nov7.html>

DSM has the potential to occur within the jurisdiction of individual nations or in the high seas beyond any national jurisdiction (also called the Area); there are different permitting and regulatory regimes depending on where it is located. All potential DSM in the Area is governed by the International Seabed Authority (ISA). Negotiations toward regulations for commercial exploitation of the seafloor in the Area ("exploitation regulations") are ongoing at the time of writing. Recent years have seen an attempt, spearheaded by a single private sector startup,⁷ to drive an accelerated push toward DSM, resulting in the subsequent expansion of business, financial sector, government, and civil society voices coming together to call for a pause or ban on DSM.⁸

Opposition to DSM is growing, with the likes of Google, Samsung, Phillips, Volvo, BMW, and Salesforce signing a Business Statement committing not to use DSM-sourced minerals.⁹ The most vocal proponents of DSM include early stage private sector companies focused solely on DSM.¹⁰ However, these pure-play companies do not generate any revenue.¹¹ Countries that vocally support DSM, or that may allow the activity to occur in their national waters are few and include a Pacific nation, the Republic of Nauru, which is the international sponsor for a would-be mining company and the Cook Islands, another Pacific nation that has granted licenses for exploration in its own waters.¹² Immediate domestic, pan-European, and global criticism was directed at Norway when the country announced in January 2024 that it would open its waters to DSM exploration.¹³ **There has been a notable lack of interest by established mining companies**, and Rio Tinto, the world's second-largest metals and mining corporation, took a position against DSM in late 2023.¹⁴

As DSM companies actively seek funding, both public and private financial institutions as well as major insurer (and re-insurer) Swiss Re have committed not to support DSM.¹⁵ On a global level, the United Nations Environment Program Finance Initiative has strongly recommended against investment in DSM in their brief, "Harmful Marine Extractives".¹⁶

This report critiques the business rationale for DSM and addresses some of the reasons investors – both in fixed assets and public or private equity – may want to exercise extreme caution when considering DSM.

PART 1: TECHNICAL HURDLES, MARKET VOLATILITY, AND MACROECONOMIC TRENDS MAKE THE ECONOMIC VIABILITY OF DSM UNCERTAIN

DSM Presents Extensive, and Expensive, Technical Challenges at Unprecedented Depths

DSM technology is highly complicated and widely untested at commercial scale, causing uncertainty around the feasibility of extracting and processing seabed minerals at a cost-efficient commercial scale. Far from shore, DSM projects would be operating at unprecedented depths. Areas of interest in the CCZ are over 1,000 km, or over 600 miles, south of Hawaii and over 2,000 km, or over 1,200 miles, from Mexico.¹⁷ Distance from shore is likely to heighten operational costs (including re-provisioning, re-staffing, getting product to processing and customer base and more).

Step 1: Testing Mining and Mining

Before even test mining could occur, a prospective miner must complete the capital intensive exploration stage. In international waters, this is required by existing international regulation. Following this stage, a prospective miner would need to apply for a separate permit to commercially extract minerals. To date, no exploration activities have led to commercial mining, either in the Area or in national waters.

Were mining to occur, the deep sea is fraught with unique operational challenges, including high pressure, freezing temperatures, corrosive seawater, high turbidity, and low light.¹⁸ (Turbidity is the amount of particulate matter in the water, and as is relevant because high turbidity increases the chance that particles would get into the machinery and cause it to break.) Specific and expensive machines are required to operate in such harsh conditions. Current proposed technology includes unmanned Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUVs) operating at depths 4,000-5,000 meters, or over 2 miles, below the surface of the ocean and over 2,000 km, or 1,200 miles from land in the CCZ.¹⁹ Both technologies experience limitations underwater and generate underwater light and noise pollution.²⁰ Limitations range from the inability to transmit information wirelessly underwater to limited spatial awareness and issues with depth perception.²¹ **With less than 25% of the seafloor mapped,²² these problems raise concerns about the ability of underwater technology to identify and avoid the over 3 million shipwrecks,²³ cultural artifacts, and natural environmental habitats like whale falls located on the seabed floor.²⁴**

The operational intensity of DSM is predicted to be on par with highly industrial extractive industries including oil and gas, which are notoriously capital intensive.²⁵ 64% of hydrocarbon megaprojects face higher costs than originally predicted,²⁶ with the average overrun cost for oil and gas projects extending 51% more than the expected budget.²⁷ **It is unreasonable to assume DSM projects would fare better than standard industrial projects.** DSM would be an industrial endeavor never seen before: commercial attempts to mine the deep sea would rely on equipment that has not been tested at full scale and, in some cases, has not yet even been manufactured.²⁸ The equipment and technology that prospective miner The Metals Company (TMC) intends to use “has not been fully proven in [...] subsea conditions and for this specific material and application.”²⁹ **Extraction of nodules would require a completely different production method from oil and gas production,** which relies on the release of pressure to raise oil and gas to the surface. **DSM for nodules would require lifting a highly abrasive and rocky substrate against gravity** using mining machines that must travel over large areas.

Potential areas of impact for sediment plumes, noise, and nodule mining machinery on the deep seabed floor. Organisms and plumes are not drawn to scale. *Image credit: Amanda Dillon (graphic artist), image published in Drazen et. al, Midwater ecosystems must be considered when evaluating environmental risks of deep-sea mining; <https://www.pnas.org/doi/10.1073/>*

This harsh operating environment may lead to technical failures, halting production and quickly becoming expensive and time consuming to fix. Two machine trials done to date at very small scale have had significant technological hitches, with the break of the umbilical (the cable that links the surface and the seafloor) of Patania II, a machine belonging to Belgian DSM company GSR³⁰ and uncontrollable spills over a period of several hours from TMC's nodule cleaning spinner.³¹ (The unit at the international regulator of DSM, the International Seabed Authority, that investigated the report found TMC's subsidiary did not follow its own risk management procedures.³²)

In November 2023, protesters obstructed TMC's latest expedition, costing TMC an estimated \$1 million daily.³³ TMC sued the protestors, and the court supported the protestor's right to protest, declining to sanction them (although the protestors were ordered to leave TMC's ship itself, the court declined to order them to maintain 500 meters of distance, as requested by the company).³⁴ Protest at sea has been on the rise and – whether or not protests are found to be lawful – enforcement and remedies are not well defined.³⁵ Neither the potential for environmental spills nor protests (with their attendant costs and liabilities) or potential for environmental or other litigation, once there is credible risk of damages or actual damages, appear to be factored into TMC's financial projections.

Step 2: Bringing Materials to Shore and Further Transport



After mining, the remaining nodules (a rocky material) would be placed on barges and transported to shore (which will be thousands of miles away in many cases). Once ashore, the nodules would have to be trucked or trained to a processing facility.

The nodules themselves have been found to be radioactive,³⁶ increasing the likelihood of community, state, or national opposition to landing (bringing to shore) and transiting the materials.³⁷

This is especially true if fish are exposed in the ports, and communities along the transit routes.

Processing is also uncertain and untested end to end, although it will likely be done using processing techniques similar to those used in land-based mining. One may presume that like land-based mining, processing of DSM ore will produce significant volume of tailings (leftover waste). The polymetallic nature of the nodules may require more intensive processing, causing more voluminous, or more toxic, waste streams. Tailings or other wastes would require management post-processing (presenting another set of environmental and social risks and economic costs, which are similarly unaccounted for in financial projections). TMC claims it will reduce waste streams, but has also disclosed that one material resulting from its planned processing is a manganese silicate which “does not yet have recognition in the marketplace” and “may require additional approvals for export and import.”³⁸ **At the time of writing, routine due diligence on the operational or processing aspects of proposed DSM may prove difficult, as much remains undefined or speculative. Investors should carefully trace and manage resulting potential costs, and potential liabilities.**

Volatile Metal Prices Threaten Market Stability

Metal prices have fluctuated over the last decade, in part because of battery innovation. One of the key assumptions of the business case for DSM is that metals prices will stay where they are if not rapidly accelerate with the massive increase in demand for EVs. However, as demand for EV metals has increased, new supplies have come online, new technologies have made extraction more efficient (terrestrially), and battery substitutes have been commercialized.

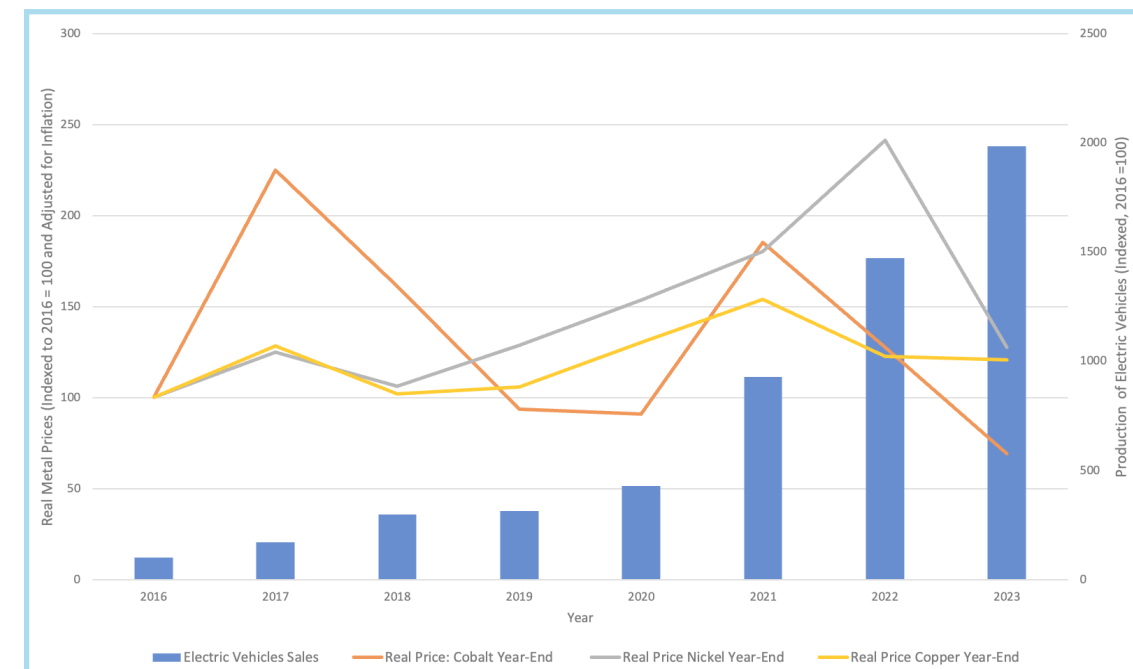


Figure 1: Electric vehicle production compared to the prices of cobalt, nickel, and copper 2016-2023 (adjusted for inflation). Credit: Victor Vescovo. Sources: *Commodity Prices from TradingEconomics.com*, Inflation Adjustment using US CPI found at Investopedia.

Between 2016 and 2023 EV production has increased 20x (up 2,000%) but in the same time frame, real nickel prices are up just 28%, and real copper prices are up just 21%.³⁹ More surprisingly, between 2016 and 2023, real cobalt prices are down 10%, despite EV production being up 2,000%.⁴⁰

The volatility of metal prices can be seen in as little as one year. Between July 2022 and July 2023, cobalt,⁴¹ nickel,⁴² and copper⁴³ decreased in value on the London Metals Exchange. In the two years between March 2021 and July 2023 the price of these metals fluctuated with little consistency in value. In March 2021, The Metals Company, Inc. (TMC) presented first investment summary.⁴⁴ **As of writing, since March 2021, both cobalt and nickel are down – cobalt has fallen consistently, and a February 2024 Bloomberg article alleged that “the nickel industry has imploded.”**⁴⁵

Mining company disclosures indicate that demand fluctuations may affect the industry’s ability to sell DSM products, as business models rely on expected growth in demand for EV minerals.⁴⁶ A 2020 study commissioned by the ISA found that there is high uncertainty around prices for commercial metals once contractors begin production, leading to the possibility that relatively high cost minerals from the seabed are not competitive, and thus generate little or no profit.⁴⁷ The high cost of DSM mining operations and production may make the industry uncompetitive on price, directly threatening profitability.

“A decrease in prices for one or more of the four affected metals [copper, nickel, cobalt, and manganese], caused by any reason, automatically reduces the market value of polymetallic nodules as raw materials for the extraction of these metals. This decline may result in some or even all seabed mining projects becoming subeconomic or unprofitable. This transformation is possible both before and during seabed mining.” – ISA Metals Study, p. 10⁴⁸



Recent Years' Macro-Economic Trends Negatively Affect DSM Economic Feasibility

Since 2021, inflation has caused increases in direct costs, including labor, and cost of initial, or capital equipment across all sectors. Direct costs have increased steeply since March 2021⁴⁹ and the expected cost of initial, or capital equipment has increased by at least +18%.⁵⁰ The rental cost of drill ships, similar to Allseas' vessel "Hidden Gem," which has been used by The Metals Company, has increased over 200% since 2021.⁵¹

Further, interests rates on speculative debt have doubled since March 2021.⁵² This is exacerbated by a lower appetite in the debt markets for high-risk technology products backed by special purposes acquisitions company (SPAC) vehicles.⁵³

CASE STUDY: The Metals Company's Problematic Financial Models, Projections, and Underestimation of Operating Costs

In 2021, The Metals Company, Inc. (TMC) was founded via a merger of DeepGreen Metals Inc. and the Sustainable Opportunities Acquisition Corporation (SOAC), a SPAC, joining the U.S. stock market as a publicly traded company. TMC serves as a useful case study in DSM finance due to the company's public trading on the Nasdaq, requiring it to make public financial disclosures to the United States Securities and Exchange Commission.

This report does not presume to evaluate TMC's claims, but rather to identify potential issues that investors – both in fixed assets or public/private equity – may choose to further evaluate.

TMC's Development Plan is Based on A Very Aggressive Delivery Rate

TMC's March 2021 investor presentation posits a delivery rate of 12.2 million tons of wet material each year.⁵⁴ This would require a truly massive operation:⁵⁵ 12.2 million tons a year is 33,000 tons a day, or 1,392 tons an hour, assuming operations continued 365 days a year, 24 hours a day. For reference, in Fall 2022, TMC brought up 3,000 tons of nodules (of the 4,500 tons it collected) during a two-month long collector test.⁵⁶ For scale, a large tractor trailer (such as those found on the back of shipping trucks) holds 40 tons,⁵⁷ so TMC is positing bringing up 34 tractor trailers worth of nodule material each hour without interruption every year.

Victor Vescovo, an industrial private equity investor and deep ocean explorer, has noted his great surprise that technical challenges associated with DSM have not received more attention because, in the deep ocean: "Everything breaks. Everything is difficult..." "You're talking about sustained heavy mining operations in depths that exceed the depth of the Titanic."⁵⁸ Vescovo has also said that TMC's cost projections fail to account for the realities of work in the deep ocean, which "[is] an incredibly hostile environment [which] rips up anything mechanical or electrical almost like it has a will to do so."⁵⁹ TMC's planned delivery rate may be further complicated by the company's disclosure that "much of the commercial-scale equipment, particularly as it pertains to subsea engineering and recovery systems, has yet to have completion of engineering, and has not been constructed and fully tested, and may not be suitable or may prove unreliable, and may not be delivered to [the company] on a timely basis, thereby delaying [its] contemplated timetable."⁶⁰



TMC Has Not Finalized Processing

The Metals Company (TMC), which posits itself as the most advanced company in DSM, has disclosed to the U.S. Securities and Exchange Commission (SEC) that it has yet to finalize minerals processing contracts, and there is “no certainty” around the caliber of the metals it will end up with.⁶¹

TMC notes that “there is a risk that such processing and refining may not be economically viable and/or that the nodules will contain elements or compounds that would render them unsuitable for selected processing and refining ...”⁶² TMC had previously pursued a collaboration MoU with Epsilon Carbon Pvt, LTD. to build a processing plant in India, but that work paused due to capital concerns.⁶³ It has now finalized an MoU for processing with Pacific Metals Co, Ltd. (PAMCO) of Japan to begin a feasibility study and estimate costs. Under the MOU, TMC guarantees to provide PAMCO in Japan with the first 1.3 million wet tons of polymetallic nodules that it could produce each year.⁶⁴

TMC may not have adequately disclosed the effects of changing Macro Economic Trends

TMC’s NPV models have not, apparently, been updated to account for the increased discount rate mandated by the very rapid recent rise in interest rates. When TMC’s NPV model was created in March 2021, TMC used a discount rate of 9%.⁶⁵ 9% is an extremely optimistic discount rate as technically or financially riskier assets in a similar class typically utilize significantly higher discount rates, such as 15% or even higher (startups often use 30 – 60%).⁶⁶ TMC’s original 9% rate has been presumed to be based on the CCC Moody’s credit rating trading rate of 7.34% at the time with an additional +1.66% (very low) risk premium. As interest rates rose steeply in late 2023, at the time of writing such CCC bonds are trading at 14.84% - more than double the rate in March 2021 when TMC was going public.⁶⁷ Even adding the exact same optimistic 1.66% risk premium to mirror how TMC appears to have arrived at its original 9% discount rate in 2021, the new discount rate for TMC’s financial model should be 16.5%. **Using this market-adjusted discount rate would bring the total project NPV down from \$6.8 billion in TMC’s published financial model to \$1.8 billion, a 73% reduction based only on a change in the discount rate (and not even reflective of either decreased metal prices or increased costs since 2021).**

TMC Shareholder Communications Remain Highly Optimistic While the Company Reports Lower Project Revenue to Regulators

TMC has presented information to investors that over the life of its core project (the NORI-D project) the company would generate \$95 billion in total revenue.⁶⁸ However, its November 9, 2023 SEC filing states that the company sold 2% of its future revenue stream to a third party.⁶⁹ This TMC filing states that the “fair value” of a 2% gross overriding royalty on revenue from the “NORI project area in the CCZ” is \$14 million.⁷⁰ Thus, the total (100%) fair value of TMC’s expected revenue for the company’s NORI project area based on this 10Q disclosure is \$700 million, as 2% of \$700 million is \$14 million (through a calculation of dividing \$14 million by 2%). If the referenced “NORI project area in the CCZ” refers to NORI-D, it **raises the question of whether TMC is inflating the expected value of the NORI-D project when talking to investors in less regulated spaces, but not in its SEC disclosures.** That is, in TMC’s November 2023 10Q filing the company implicitly values the NORI-D project as \$700 million. In TMC’s investor December 2023 presentation, it showed the value of the company as \$8.6 billion, the NPV of its CCZ mining operation over the entire life of the project, based on changing metals prices.⁷¹

Civil society organizations noticed that TMC’s initially filed S-1 prospectus downplayed major risks and glossed over the difficulties and unknowns surrounding DSM.⁷² The SEC agreed with the critique, and required TMC to file an updated S-1.⁷³ **Potential investors may want to carefully compare TMC’s investor materials to its SEC filings.**

A Volatile Stock Price



TMC’s stock price fell steeply upon going public because much of the original potential investment failed to materialize.

The private placement, private investment in public equity (PIPE) investors reneged, and many SOAC shareholders redeemed their warrants.⁷⁴

Figure 2: The Metals Company NASDAQ stock price between 2020 and 2024. Stocks that remain under \$1 for 30 days receive a delisting notice from the NASDAQ. Source: NASDAQ \$TMC historical stock data.

Since then, **TMC has struggled repeatedly to maintain a stock price above \$1 and thus to stay listed on the NASDAQ.** On December 5, 2022, TMC received a notice of delisting from the U.S. stock market because it traded under \$1 for more than 30 days. After recovering briefly, TMC received a second delisting notice in April 2023 and a third in October 2023.⁷⁵ On all three occasions, capital infusions from existing or new shareholders appear to have propped up the stock price to once again trade over \$1 per share, in effect, “re-setting the clock” on delisting procedures each time it got above \$1.

Banks, Financial Institutions, and Insurers are Rejecting Investment in DSM

Many investors and financial institutions around the world are explicitly excluding DSM from their definition of a sustainable investment that meets Environmental, Social, and Governance (ESG) standards.

Banks that have pledged to avoid DSM financing include Lloyds, NatWest, Standard Chartered, ABN Amro, Credit Suisse, and BBVA.⁷⁶ ABN Amro pledged to avoid DSM after it experienced major losses following the Nautilus Minerals bankruptcy.⁷⁷ The European Investment Bank excludes DSM as “[p]rojects unacceptable in climate and environmental terms.”⁷⁸ Note that at the time of writing, TMC is the only publicly traded DSM license holder, and one of a handful of publicly traded companies in the DSM space, including logistics.⁷⁹ The lack of publicly traded DSM companies precludes opportunities to diversify in the sector.

Banks are also beginning to evaluate pre-existing commitments that implicitly prohibit financing for DSM projects. For example, the Equator Principles require all projects to comply with guidance around Free, Prior, and Informed Consent (FPIC) from Indigenous Peoples.⁸⁰ As conversations about cultural relationships to the deep ocean and underwater cultural heritage in jeopardy from DSM intensify, these commitments are being evaluated more closely.

Insurer Swiss Re has updated its ESG Risk Framework such that now their mining policy, which also includes reinsurance, excludes DSM.⁸¹ Swiss Re is one of a small number of reinsurers who effectively provide financial cover for high value/risk insurance.

In 2022, the United Nations Environment Programme Finance Initiative (UNEP FI) released a report designed for banks, insurers, and investors on the financial, biological, and other risks of DSM.⁸² The report concludes that there is no foreseeable way that financing DSM can be viewed as consistent with established principles of sustainable finance due to the significant reputational, regulatory, and operational risks associated with plans to mine deep seabed minerals. A partnership between UNEP and the global financial sector, the UNEP FI aims to mobilize private sector finance for sustainable development, working with more than 450 banks, insurers, and investors and is supported by over 100 institutions.

In September 2023, the International Capital Market Association, a trade association for those who participate in capital markets, released a guidance report on financing bonds for a sustainable blue economy, explicitly excluding non-renewable energy sources including oil and gas, and DSM.⁸³

The United Nations Conference on Trade and Development (UNCTAD), an international trade organization, has excluded DSM from its sustainable ocean economy classification scheme, due to its high risk to the environment.⁸⁴

The High-Level Panel for a Sustainable Blue Economy further supports this reasoning.⁸⁵



PART 2: DEEP SEABED MINING IS NOT NEEDED FOR THE ENERGY TRANSITION; BATTERY INNOVATION IS ELIMINATING THE BUSINESS RATIONALE FOR DSM

Breakthrough Battery Innovation is Moving the Market Away from Minerals Found on the Seabed

Seabed minerals are not, as mining companies quip, “a battery in a rock.”

Polymetallic nodules contain only four potentially economically attractive minerals: nickel, cobalt, manganese, and copper. Specifically, DSM proponents speak of supplying cobalt and nickel to the electric vehicle industry, but the industry is rapidly moving away from expensive and socially-challenged cobalt and nickel toward less-expensive new battery chemistries such as **lithium iron phosphate (LFP)**. “Supply concerns are particularly high for lithium; however, lithium is not currently targeted by the DSM industry and, at trace levels, is not viable for extraction from polymetallic nodules – the focus of the majority of current DSM ventures.”⁸⁶ A January 2024 report found that “[l]ithium-iron-phosphate (LFP) batteries that require neither nickel nor cobalt – two of the main minerals targeted by the DSM industry – already account for around one-third of the share of the global passenger electric vehicle market.”⁸⁷ LFP batteries are lower in capability than those that use cobalt and nickel, but the cost, performance and availability advantages of LFP are great enough to result in widespread adoption.⁸⁸ Furthermore, significant research continues into how to make LFP batteries even more capable, thus eroding the advantages of cobalt-nickel batteries even further.⁸⁹



Key Investments Place New Nickel- and Cobalt-free Batteries on the Market

Companies are investing heavily in alternatives to traditional nickel- and cobalt-based batteries.

For example, Clarios, a global leader in battery technology, has paired up with Natron Energy Inc. to mass produce sodium-ion batteries which do not contain minerals like cobalt, nickel, or copper.⁹⁰ Electric vehicle producers are also utilizing new technologies to decrease their need for deep seabed minerals. Tesla is building half of its new EVs with LFP batteries.⁹¹ Similarly, the world's number two electric carmaker, BYD, announced plans to move to LFP batteries and away from nickel-, cobalt-, and manganese based batteries.⁹²

Other auto industry giants are moving towards LFP batteries. Ford, for example, is investing \$3.5 billion dollars in a brand new LFP plant in Michigan,⁹³ showing that the company is doubling down on these alternative chemistries. American Battery Factory, a company that exclusively makes LFPs, is opening the first LFP Gigafactory in Tucson, AZ, with plans to create a network of such factories.⁹⁴ Toyota is also investing in new battery technology, including LFPs.⁹⁵ This interest in LFPs is driven by many factors in addition to reducing use of cobalt or nickel. LFPs are known to be safer and less likely to combust, more efficient, more easily recyclable, cheaper, and have a longer lifespan than Lithium ion batteries.⁹⁶

U.S. Based company Solid Power received Department of Energy (DOE) funding to continue development of its nickel and cobalt free solid-state batteries.⁹⁷ Silia Nanotechnologies is pursuing lithium silicon batteries that are cobalt, nickel, and copper free,⁹⁸ with lithium sulfur batteries also in development.⁹⁹ Hydrogen fuel cell technology has advanced to allow electric vehicles to run on zero-carbon energy. SAIC Motors¹⁰⁰ produced the first high-end hydrogen cell based EVs in 2020, and in June 2022, UK-based company Tevva launched the first hydrogen cell powered electric truck (hydrogen power can be mineral intensive, but is less dependent on the minerals that could be found on the seabed).¹⁰¹ Interest in hydrogen fuel cell technology is growing and moving farther from non-renewable mineral and metal based technologies.

A Fast Growing Circular Economy May Render DSM Unnecessary

The circular economy is increasingly the subject of serious interest by investors and entrepreneurs.

The revenue potential for an EV circular economy is estimated to reach \$10 billion in 2030¹⁰² and “can play a significant role in reducing demand for critical minerals.”¹⁰³ Volkswagen, General Motors, BYD, Hyundai Motor, Jaguar Land Rover, BMW and Mercedes-Benz are among the auto manufacturers developing and/or advocating for a circular economy.¹⁰⁴ The World Economic Forum anticipates the consumer electronics market to reach \$1.7 trillion by 2024.¹⁰⁵ A circular economy for electronics may successfully tap into that market. For example, recycling materials from smartphones alone is expected to generate a value of \$11.5 billion.¹⁰⁶ Apple has invested in a materials recovery lab, and the new iPhone 15 Pro and Pro Max use 100% recycled cobalt in the batteries.¹⁰⁸



Infrastructure for the EV and electronics circular economies have seen attention and improvement in the past few years. Tesla Co-founder JB Straubel's Redwood Materials company plans to build an EV battery recycling and materials plant in Nevada.¹⁰⁹ Solvay, a chemical company, and Veolia, a utilities business, joined forces to develop a circular economy consortium for LFP battery metals, aiming to aid in the development of a recycling value chain.¹¹⁰ “Swedish battery manufacturer Northvolt, backed by Goldman Sachs, Volkswagen and others, announced in 2021 that it produced the first-ever lithium-ion battery cell with 100% recycled nickel, manganese, and cobalt.”¹¹¹

According to a recent study, mineral demand can be reduced by 58% by 2050 through new technology, circular economy practices and recycling.¹¹² Currently, just 8.6% of the world's materials are part of a circular economy, but by 2050, researchers predict 45–52% of cobalt, 22–27% of lithium, and 40–46% of nickel could be supplied from recycled materials.¹¹³ A 2020 study commissioned by the ISA found that use of secondary or recycled cobalt, copper, nickel, and manganese will grow as part of the general trend to recycle minerals.¹¹⁴ Even TMC states that it will mine until it has enough metals for the circular economy to make mining unnecessary.¹¹⁵ If true, that assertion further complicates any investment analysis.

Auto and battery makers have been identified as a new type of buyer on the metals market, seen as innovative, sensitive to prices, and risk averse.¹¹⁶ By the time seabed minerals could come to market, batteries may require none of them, significantly shrinking the market, and the potential returns for investors.

A November 2022 study found that new chemistries for electric vehicle batteries and reducing dependence on lithium-ion batteries for non-moveable uses could reduce the demand for cobalt, nickel, and manganese by 40-50% between 2022 and 2050.¹¹⁷ A study commissioned by the ISA itself found that the market consumption of cobalt could decrease with new changes in the chemical composition of batteries to replace or reduce cobalt.¹¹⁸ **The European Academies Science Advisory Council found that seabed minerals could not supply any gap in nickel or cobalt demand in the short term because of the need to set up processing chains.**¹¹⁹ A recent December 2023 report determined that, “[t]he financial viability of DSM - already questionable based on high costs, technological challenges and regulatory hurdles - has been further undermined by these new batteries that don't use Deep Sea Metals.”¹²⁰

PART 3:

DSM IS RIFE WITH UNCERTAINTIES WHICH POSE POTENTIAL COSTS AND LIABILITIES

Environmental Costs: DSM Will Damage The Ocean and Its Ecosystems; Who Will Pay? and How Much Will It Cost?

The liability regime for who would be responsible, and who would pay, for the destruction of ocean biodiversity, including important marine genetic resources, or causing negative effects to earth's ability to regulate its climate, is a new and ill-defined frontier. There are three ways that investors could be affected:

- **Intricate environmental study and reporting regimes** (DSM-specific in national waters, at the ISA, or via in investors' own commitments, whether under the Equator Principles, the Task Force on Climate Related Financial Disclosures, or the Task Force on Nature Related Financial Disclosures). Investors should query whether enough is known about DSM and the potential impacts thereof to even properly evaluate or report in compliance with those or other frameworks.
- **Requirements to pay for purported damage under international regimes:** in addition to the ISA's own draft requirements, the new treaty on Biodiversity Beyond National Jurisdiction is beginning to define a regulatory regime around marine genetic resources,¹²¹ and there are legal cases pending that will define how those who have made the climate worse must remunerate the most affected.¹²² It has been argued to the U.S. Securities Exchange Commission that DSM is a climate amplification risk: an unproven industry marketed as a climate solution that could accelerate or intensify changes to our climate.¹²³
- **Direct demands for payment by injured third parties,** whether fisheries, eco-tourism (including marine mammal watching), or adjacent coastal nations whose waters are polluted.

A 2022 report estimated "the total biosphere impacted by nodule mining in abyssal plains in international waters alone would be up to 25–75 million km³, more than the volume of all freshwater in the world, including ice and snow."¹²⁴ The sheer scale of the areas involved is an important difference from land-based mining, or oil and gas. (The same report estimates that "mining minerals critical for the energy transition on land impacts biodiversity across 1–10 million km³."¹²⁵)

Research on the impacts of DSM has increased rapidly over the last few years.

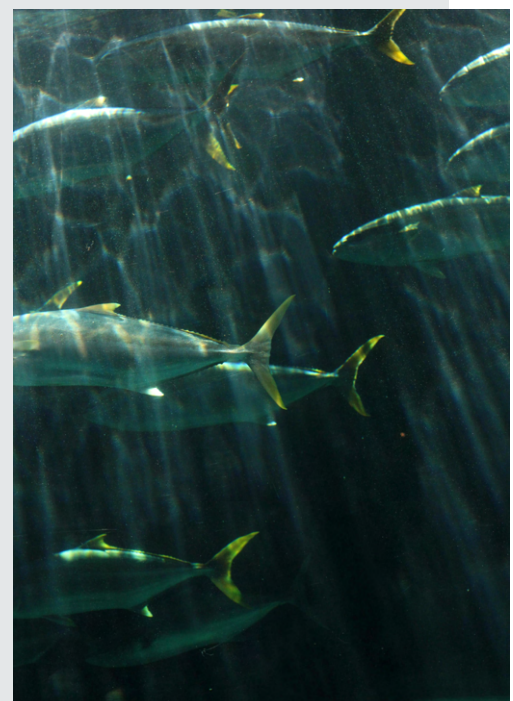
Scientists confirm that DSM will have devastatingly wide impacts on microorganisms, fisheries, food chains, cultural traditions, and more by impacting the seafloor and water column. A study published in May 2023 analyzed more than 100,000 records of animals in the CCZ and found over 90% of species from the records were unknown to science.¹²⁶

The movement of a mining machine directly disturbs the deep seabed, potentially upsetting the ocean carbon cycle and presenting a climate amplification risk. **Studies indicate that even after small-scale experimental DSM, carbon cycling has not recovered after 26 years.**¹²⁷ The deep ocean is a major active sink and reservoir of heat and carbon dioxide,¹²⁸ and DSM may cause impacts to the carbon cycle, affecting the way in which the ocean mitigates warming global temperatures.^{129, 130} A 2023 report found that "[t]here is also a risk that deep sea mining could transform the Clarion-Clipperton Zone from a carbon sink to a carbon source by disturbing carbon contained in sediments... blocking sunlight and reducing photosynthesis... [and by removing nodules] effectively permanently remove the carbon sequestration services associated with [the animals that live on them]."¹³¹

Plumes from DSM could travel hundreds or thousands of kilometers and affect the entire midwater food web, up to commercially important fish, including tuna.¹³² Noise from DSM would affect many animals that use sonar for communication,¹³³ including whales,¹³⁴ which provide significant tourism revenue.¹³⁵ Deep water corals are also at risk,¹³⁶ as are marine genetic resources.¹³⁷ Nodules themselves provide habitat for unique animals in the deep ocean.¹³⁸

Many gaps exist in the current understanding of the deep sea.¹³⁹ Scientists are working to develop global knowledge of the systems and marine life, but there are still questions about exactly what can be found in the deep sea, everything it is doing to support the planet and its systems, or the full range of effects that would occur if it was disturbed. It is becoming increasingly clear that the deep ocean plays a key role in climate regulation, and is part of our global circulation system.¹⁴⁰

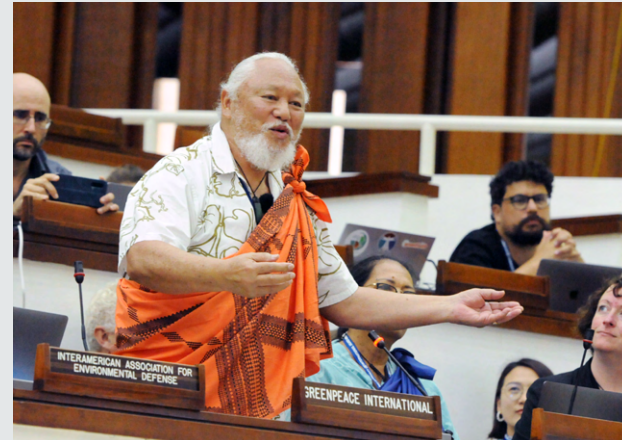
The deep ocean is also closely connected to the rest of the water column, and affects animals through the ocean, including commercially important fish. Fisheries interests are paying attention; the Inter American Tropical Tuna Commission began to consider DSM in 2023.¹⁴¹ The possibility of DSM releasing large concentrations of heavy metals that may increase bioaccumulation of toxins in economically-important species has led seafood market groups to issue a statement calling for a precautionary pause on DSM until there is a clear understanding of the impacts the industry may have on the marine environment, its living resources, and those dependent on them.¹⁴² Signatories include seafood wholesalers, sustainable seafood NGOs, and large industry groups such as the Global Tuna Alliance.¹⁴³



No Social License – Indigenous Opposition, Human Rights Concerns

Despite the remoteness of the proposed DSM locations, there is still **significant risk of infringement of human rights**, including potential effects on human health and livelihoods from DSM-caused pollution, as well as failure to respect Indigenous rights.

These pose massive investment risks as a DSM company could be sued or publicly discredited for abuses, affecting stock prices. Future disruptions from protests, including protests at-sea, remain a key risk. Significant public opposition and potential human rights abuses by DSM companies could prevent projects being permitted, mire DSM projects in complex litigation, and/or lead to legal actions claiming financial damages.



Solomon "Uncle Sol" Kaho'ohalahala, Maunalei Ahupua'a/Maui Nui Makai Network offers a Hawaiian oli, or chant, at the International Seabed Authority meetings. Image credit: IISD/ENB | Diego Noguera.

Indigenous people and local communities from around the world are speaking out against DSM in efforts to protect their cultural heritage and ties to the ocean for current and future generations.¹⁴⁴ Pacific Indigenous leaders have raised concerns about the potential for DSM to disturb deep ocean ecosystems and sever their relationship with deep sea corals and marine species.¹⁴⁵ With 80% of the seabed unmapped, DSM is a threat to this relationship as well as a wide variety of other underwater cultural heritage including human remains and sunken vessels.¹⁴⁶ (Many of those vessels, if disturbed, could also release harmful chemical pollutants, unexploded munitions, or heavy fuel oil.¹⁴⁷) **Underwater cultural heritage is protected by two treaties and has become a recurrent topic of conversation at the ISA meetings.**¹⁴⁸

The ISA has been criticized for its lack of opportunities for public participation.¹⁴⁹ The proposed DSM regulations do not take into account the need for Indigenous people and local communities to have **Free, Prior, and Informed Consent (FPIC)**, further reducing the agency of Indigenous people and local communities and increasing the liability for any negative impacts from mining.¹⁵⁰ Indigenous communities are clear that DSM is diametrically opposed to what they see as needed protection and stewardship of the ocean. As of September 2023, Indigenous leaders from 49 countries and 71 indigenous groups had called for a ban on DSM.¹⁵¹ Any DSM project would cause reputational risk to investors choosing to ignore the will, and rights, of Indigenous communities around the world. Ignoring FPIC is increasingly resulting in financial impacts to companies.¹⁵²

Under the United Nations Convention on the Law of the Sea (UNCLOS), the ISA has been tasked to ensure equitable distribution of benefits from DSM to all of humankind and particularly developing countries, but a recent study looking at various financial scenarios found that DSM would not be enough to meaningfully affect any nation's economy.¹⁵³

DSM is increasingly discussed in the context of human rights, specifically regarding intergenerational equity and the rights of children. The United Nations High Commissioner for Human Rights published a briefing paper urging caution on DSM, as, "[u]ltimately, all life on earth is dependent upon healthy ocean ecosystems."¹⁵⁴

These social factors have led scholars of a 2023 article to find that "DSM currently lacks social legitimacy. Without legitimacy, investors and consumers might reject seabed minerals and their use."¹⁵⁵



International Pressure is Building to Halt DSM

Between June 2022 and November 2023, 24 countries have announced positions in opposition to DSM.¹⁵⁶ France is calling for a ban, while others are calling for a moratorium or precautionary pause. Notably, countries where DSM exploration has occurred and where investors were previously excited about DSM, such as Fiji and Vanuatu, now support a moratorium.¹⁵⁷ Political decisions outside of any company's influence add another level of uncertainty to DSM investments.

Pressure for a moratorium extends beyond governments, with a growing civil society and Indigenous presence at the ISA and at conferences around the world.¹⁵⁸ **Environmentalists, scientists, cultural leaders, and individuals are showing their support for valuing the deep sea before an unproven extractive industry begins commercial production of a nonrenewable resource.**

The private sector has also joined the conversation. Financial institutions and energy, car, and technology companies are also speaking up against DSM, with **39 companies signing onto a business statement indicating their commitment to not invest in DSM, allow for mined minerals to enter their supply chains, and to not source minerals from the deep sea.**¹⁵⁹ **These companies include Google, Samsung, Philips, BMW, Rivian, Volkswagen, and Salesforce.**¹⁶⁰ Each company's signature commits it to support a moratorium, not source minerals from the deep seabed, exclude those minerals from its supply chains, and not finance DSM activities.¹⁶¹

Two high profile backers of DSM, Maersk and Lockheed Martin, pulled support for DSM in 2023.¹⁶² Rio Tinto, the world's second largest metals and mining corporation, released a position statement in November 2023 stating "We believe that not enough is known about the impacts of deep-sea mining, and that it should not take place unless comprehensive scientific research refutes currently held evidence that it will create significant environmental and socio-economic implications."¹⁶³

In 2024, Norway opened its waters for DSM exploration (exploitation has not been authorized). This was done by Norway's Ministry of Petroleum, against the advice of its own Ministry of Environment, and immediately garnered intense criticism from neighboring nations and the European Parliament as well as calls for Norway to step down as a leader of the High Level Ocean Panel on a Sustainable Ocean Economy.¹⁶⁴



No Mining Without Regulations

Regulations for DSM exploitation in international waters do not currently exist.

The current ISA draft of mining exploitation regulations is filled with unconfirmed, proposed text and incomplete addenda, with the phrase “nothing is agreed until everything is agreed” echoing in the negotiating room. Key parts of the text have not been drafted or discussed, including those relevant to financial and liability concerns. Adoption of the DSM draft exploitation regulations requires consensus in the executive body of the ISA; that consensus does not currently exist.¹⁶⁵ Many, if not all – financial and liability questions remain unresolved with many relevant provisions of the draft exploitation regulations still under negotiation.¹⁶⁶

Many countries have said they will not approve a plan of work to mine without finishing DSM exploitation regulations¹⁶⁷ and the ISA Council, the body responsible for the decision, has taken two resolutions by consensus stating that no plans of work should be approved in the absence of regulations.¹⁶⁸ The regulations are currently far from completion, with divergent views on fundamental concepts blocking consensus on key issues.¹⁶⁹ A peer reviewed paper published in January 2024 found that 30 major issues in the ISA regulations remain outstanding and that the ISA internal target date to complete the regulations in 2025 is unrealistic.¹⁷⁰

Costs and Risk Inherent in the Draft International

30 major outstanding issues in the ISA regulations remain outstanding because of one or more of the following factors: the need for further discussion, a divergence of views, and/or the issue requires external information or input. However, the regulations in their draft form are instructive in that they require significant upfront costs or pose serious risk to investors.

Draft measures in the current version of the exploitation regulations that would cause significant **upfront costs** to investors include:

- Extensive, lengthy, costly environmental baseline data collection.
- Requirement to build and test mining system before mining license can be secured.
- Significant upfront financial guarantees/ bonds.
- Payments into ‘liability gap’ compensation fund.¹⁷²
- Mandatory insurance requirements¹⁷³ (this insurance is not yet on the market, and Swiss Re has committed not to insure or re-insure DSM).
- Long post-mining monitoring obligations e.g., in perpetuity.¹⁷⁴

Draft measures in the current version of the exploitation regulations that would cause significant **risk** to investors include:

- Severe regulatory response to unexpected environmental impacts (e.g., mining suspensions, license revocation).
- Strict liability (‘no fault’) regimes.
- Member States and ISA requiring indemnification from the contractor for any damages occurring.¹⁷⁵

Current draft regulations for DSM indicate that any company engaging in DSM at a commercial scale will be expected to return the ocean to a healthy status after closing operations, requiring restoration and rehabilitation of the marine environment.¹⁷⁶ **It is notable that both at the ISA and under state jurisdictions, financial guarantees for restoration obligations will be required before mining begins – a significant up-front expenditure.** Restoration of the environment is expected to astronomically increase the closing costs of DSM projects.¹⁷⁷ Importantly, scientists believe restoration of the deep ocean is completely impossible because of the much-longer than human timescales on which it operates, and the attendant slow recovery.¹⁷⁸

Nonetheless, restoration is required by the draft regulations, and a recent study found that restoring only 10% of the 500,000 km² that may ultimately be mined in the Pacific would cost US \$50 billion, using conservative estimates.¹⁷⁹

The high cost of restoration will decrease the expected revenue of any DSM projects, and cause lower investment returns.

Aspects of the DSM Regulatory Regime Within and Outside the ISA Remain Unsettled

The DSM space is full of unknowns, many of which have the potential for significant negative effects on investment.

In one example, **contractors with the ISA will be required to pay some form of royalty, but neither the structure nor the amount of this royalty have been decided.**¹⁸⁰ The ISA Secretariat commissioned financial modeling which was undertaken by the Massachusetts Institute of Technology.¹⁸¹ The resulting models have been criticized for not addressing key issues, namely: the taxation of transfer of rights, additional royalty instead of Sponsoring State income tax, fiscal stability, valuation of manganese, and royalty rates¹⁸² by various countries, including the African Group (all African Country members of the ISA, acting as a collective negotiating group).¹⁸³ The discussion of the royalty regimes and benefit sharing is far from complete and heavily dependent on geopolitics; there is little consensus.¹⁸⁴ The use of a different proposed model may change the money available to Sponsoring States and to corporations. **Specifically, the royalty rates under discussion vary from 2.5 – 30%, a difference which could greatly affect the feasibility of a project (and whether and if it will produce returns for investors).**¹⁸⁵ To push a project forward in the absence of a fixed royalty rate may be to create existential project risk.

The ISA regulatory regime requires compensation for adversely affected land-based mining countries.¹⁸⁶ This element of the regime has not been developed by the ISA yet, so it's unclear what amounts will be required, how it will be quantified, and - crucially for investors - to what extent that may involve costs that are passed on to the mining companies themselves.¹⁸⁷

Enforcement and compliance have been the subject of much discussion at recent ISA meetings; "at the November 2023 meeting it was noted by two member States that the ISA does not have a compliance strategy, nor standard operating procedures for ISA inspections and enforcement function."¹⁸⁸ 2023 reporting by The Outlaw Ocean Project exposed massive human rights abuses and fraud in global seafood chains, in part due to an inability to monitor and enforce the ocean far from the coast and beyond national jurisdiction.¹⁸⁹ The nascent nature of the regulatory regime for DSM, combined with the complicated multi-jurisdictional legal framework and weak institutional accountability at the ISA, and the complex company structures evolving for DSM actors, may give rise to concern of DSM similarly being used as a safe haven beyond the orbit of our terrestrial enforcement systems. Investors should carefully consider such potential issues, and their attendant liabilities.

There exist unclear and overlapping jurisdictions between flag states, the ISA, states that sponsor DSM, and adjacent coastal states; "There are international treaties setting out certain responsibilities for sponsoring States, flag States and port States; but how these jurisdictions interact with each other and with the ISA's RRP is not always clear."¹⁹⁰ This could lead to conflict, litigation, or the requirement to comply with multiple regulatory regimes. The application of treaty protections for foreign investors in ISA-focused projects is unclear.¹⁹¹ It is possible that no foreign investor treaties or tribunals apply to ISA decision-making, removing a safety net that investors are often accustomed to.



ISA Concerns: Institutional Issues, Transparency, Accountability, Trust & Confidence

It is also unclear to what extent the ISA's existing exploration regulations are being followed.

For example, at the November 2022 ISA meeting, questions were raised regarding a required payment of a financial guarantee to the ISA by exploration contractors "prior to the commencement of testing of collecting systems."¹⁹² Despite the fact that TMC was, during that meeting, testing a collector system in the CCZ, it was unclear whether TMC had provided the financial guarantee required under the exploration regulations.

Uncertainty within the work of the international regulatory body charged to govern the seabed floor, as well as behavior by the Secretary General of the ISA, who has been characterized as a problematic ally of mining companies,¹⁹³ further exacerbates the financial risks and liability concerns associated with DSM.

The ISA Secretariat has also come under scrutiny for a host of internal practices from bullying to excessive spending in multiple major newspapers, including the Los Angeles Times¹⁹⁴ and the New York Times.¹⁹⁵ ISA Secretary General Michael Lodge is reported to have given confidential information, available only to developing nations, regarding the areas with the highest nodule concentration directly to TMC.¹⁹⁶

Diplomats have accused ISA Secretary General Michael Lodge of a bias toward mining, and the German government sent him a letter, later covered in the media, stating that "it is not the task of the Secretariat to interfere in the decision-making of the [other parts of the ISA]" and stating that the German government is "seriously concerned" that the ISA Secretary General has used his platform to express his personal views on interpretation of the agreements that govern DSM in the Area.¹⁹⁷ Following recent protests against TMC by Greenpeace International, the ISA Secretary General wrote a letter demanding an end to the protest and encouraging the Kingdom of the Netherlands, the flag state of the Greenpeace vessel, to take action against the protestors.¹⁹⁸ A Dutch court later noted that the ISA Secretary General does not appear to be authorized to order Greenpeace to stand down.¹⁹⁹

Reputational Concerns Associated with Front Running DSM Companies Jeopardize Investment

In addition to direct financial risk to potential investors, the history of current players seeking to take the lead on DSM raises flags that investors evaluating DSM may want to consider.

TMC is currently embroiled in four separate litigation matters, including an ongoing class action lawsuit against TMC alleging that TMC and/or its personnel made false or misleading statements, and a 2023 lawsuit alleging breach of good faith.²⁰⁰ The short seller Bonitas Research believes that: "TMC siphoned US\$ 43 million in cash and stock to undisclosed insiders by overpaying for [subsidiary Tonga Offshore Mining Limited (TOML) after...] the TOML license was shopped around to ~300 prospective investors [and] no interest was found for the TOML license from independent parties."²⁰¹ If true, this could raise liabilities, further endangering TMC's solvency and reputation. **The SEC itself is concerned: TMC reports that it "has received letters from the SEC notifying us of an investigation and requesting the voluntary production of documents and information regarding the Company's March 31, 2020 acquisition of Tonga Offshore Mining Limited from Deep Sea Mining Finance Ltd. and the business combination, completed September 9, 2021, between DeepGreen Metals Inc. and Sustainable Opportunities Acquisition Corporation that led to the Company's formation."**²⁰² As of November 2023, TMC reports that it is "continuing to cooperate with the investigation and respond voluntarily to the SEC's requests" related to this investigation.²⁰³

TMC is associated with other entities that raise serious reputational concerns. The organizational chart for various prospective DSM companies including TMC, DeepGreen Metals Inc., TOML, Deep Sea Mining Finance Ltd. (DSMF), and Nautilus Minerals Inc. overlaps with many of the same individuals.²⁰⁴ The funding behind these entities is also intertwined. While this overlap is not inherently problematic, two major shareholders, allegedly each with 50% ownership of DSMF (the current holders of Nautilus Minerals' licenses post-bankruptcy),²⁰⁵ are Russian company Metalloinvest and Omani company MB Holding group. Metalloinvest is controlled by Alisher Usmanov, who has been sanctioned in the UK,²⁰⁶ Europe,²⁰⁷ and the United States²⁰⁸ due to close personal and financial relationships with Vladimir Putin and Dmitry Medvedev, the Deputy Chairman of the Security Council of Russia and former President and Prime Minister of Russia.²⁰⁹ MB Holding Group and its founder and Chairman Dr. Mohammed al Barwani have been implicated in the 1MDB scandal.²¹⁰ DSMF insiders have also been alleged to be connected with the Panama Papers, money laundering, and insider trading.²¹¹

In 2019, Nautilus Minerals filed for insolvency, leading to the collapse of its Solwara 1 project in Papua New Guinea due in part to community opposition, sparking the first calls for a DSM moratorium.²¹² The failure of the project caused large losses for investors; the Papua New Guinea government lost \$375 million kina, or more than \$100 million USD.²¹³ The Campaign for Accountability also alleges that TMC CEO Gerard Barron was "shareholder and director of an environmental remediation company, Windward Prospects Limited ("Windward"), that was created for the sole purpose of restoring a polluted river in Wisconsin and went bankrupt on his watch," having contributed "\$7.9 million into [TMC precursor] DeepGreen."²¹⁴



Despite the growing momentum for a moratorium and expanding legal scholarship supporting it,²¹⁵ TMC continually assures investors that regulatory approval for DSM is forthcoming. As recently as April 2023, CEO Gerard Barron has said that there is no legal basis for a moratorium.²¹⁶

The ISA's decision-making body stated that no mining should take place in the absence of regulations in two separate resolutions agreed by consensus in July 2023.²¹⁷ Despite the resolutions, TMC's Chief Financial Officer stated in October 2023 that "[w]hether [the International Seabed Authority] has finalized what the legal framework for deep-sea mining will look like or not, we'll file our permit application and force them to process it."²¹⁸ Given that recent conversations at the ISA have been largely focused on how to prevent mining without regulations, not whether to do so, any company attempting to "force" the ISA Member States to process its application to mine in the absence of regulations would likely be disappointed.

Undermining its image as a company whose CEO is "on a mission to help wean humanity off fossil fuels,"²¹⁹ according to the company's November 9, 2023 SEC 10Q filing, TMC has sold 2% of its future revenues of its core assets (the NORI-D project), which was developed using shareholder funds, in exchange for \$5 million dollars in cash and 35% of ownership in a company that deals in natural gas exploration and royalties, including in Colombia.²²⁰ Following this transaction, **TMC has now indirectly bought into a company whose majority of revenue appears to be projected to come from significant investments in natural gas.**²²¹ This company is called Low Carbon Royalties, a Canadian company that finances energy technologies and whose current portfolio only includes investments in TMC's NORI-D DSM project and two natural gas fields in Colombia.²²²

ESG Claims May Be Subject to Oversight

Irreparable environmental damage, no social license, and concerning governance indicate that investing in an industry like DSM does not align with an ESG portfolio, especially as ESG investment rules both in the United States and Europe become increasingly strict and oversight increases.²²³

Even companies with proven teams and good governance can misstep in a changing ESG landscape; investors should carefully consider the governance track record of any company before investing.

On human time scales, seabed minerals are a finite, nonrenewable resource which take millions of years to form; their extraction is not sustainable. Extracting such nonrenewable mineral resources to support the 'green transition' is contradictory, and risks destroying the inherent environmental and social value of the deep sea and its ecosystems as they currently function. DSM will not advance ESG goals or solve climate change. Instead, the European Academies Science Advisory Council (EASAC) found that "the pressure for mining is driven by industry and economic interests rather than demands from the transition to a green economy. For instance, venture businesses seek new business opportunities; some nation states may seek new sources of revenue or markets to replace declining industries based on fossil fuels; technology developers may seek new markets and sources of public funding for assets and expertise in danger of becoming stranded as their fossil-fuel-driven business declines."²²⁴



Comparisons to Terrestrial Mining are Misleading

There is no consensus that DSM would be less harmful or have a lower impact, including to biodiversity or to the climate, than terrestrial mining.

A December 2023 report found that "the results of the three current studies comparing the cradle-to-gate (nodule-to-commodity) climate impact of deep sea and terrestrial mining vary hugely, estimating that polymetallic nodules could have a higher or lower climate impact than land ores."²²⁵ The report noted that two of the three studies were funded and supported by DSM companies.²²⁶

The EASAC evaluated claims that DSM is the "lesser of two evils when compared with terrestrial mining" and found those claims misleading: "We discuss the validity of such claims and find them misleading, and note also that deep-sea mining lacks the mitigation and remedial measures available to terrestrial mining."²²⁷



There is also little indication that DSM would replace terrestrial mining and there is much evidence that it would not.²²⁸ A study commissioned by the ISA found that DSM will not cause overproduction of minerals globally.²²⁹ Rather, mining both the deep sea and on land could drive down mineral prices, reducing neither's destructive practices and lowering prices.²³⁰ Victor Vescovo has also stated that **even assuming the peak level of production in TMC's published investment materials, the minerals the company claims that it would bring from the seafloor would not put a dent in global supply:** according to 2022 world production rates for nickel, TMC would provide less than 4.2% of global nickel production.²³¹ This percentage will go down even further as additional nickel mines are slated to open in Indonesia, Australia, Canada, Brazil and even Minnesota in the United States.²³² In 2031, TMC's maximum production rate year, according to its March 2021 forecast, will be 119,000 tons. World production in 2030 is projected to be 5,090,000 tons (and, thus, in 2031 will be at least that number).²³⁴ Therefore, TMC would produce only 2.34% of world's production in 2031. **Investors should further investigate claims that DSM could measurably impact the production of nickel (or other metals) on the world stage.**

Even well-established terrestrial mining may be characterized as a high risk and complicated investment, without the attendant physical, market, and risk uncertainties associated with DSM.²³⁵ Terrestrial mining, for all its problems, is heavily regulated, and investors have been doing extensive work in the first part of the 21st century to try and improve the environmental and safety standards thereof (for example the Principles for Responsible Investment,²³⁶ the Global Tailings Review,²³⁷ and Mining 2030,²³⁸ among others). Investment in DSM has the potential to undercut and set-back such efforts. A decline in prices may reduce safety and environmental management standards in land-based mining, along with the income and livelihoods of some of the poorest people in the world, further exacerbating the known problems with terrestrial mining.²³⁹ The World Economic Forum found that DSM "will not necessarily lead to mine closures or to planned new mines being abandoned. Nor would it selectively eliminate land-mining operations with the lowest environmental or social performance since pressure on land-based mines would correlate to their production costs rather than their sustainability attributes."²⁴⁰



THE FINAL WORD: DEEP SEABED MINING IS NOT WORTH THE FINANCIAL RISK

DSM is a risky investment from all angles.

Between unknowns for market demand due to electric battery innovation, significant cost increases since 2021 to execute DSM, competition with well-established terrestrial mining economics, metal price volatility and legal liabilities associated with inflicting and restoring environmental damage to the seafloor, the DSM landscape is rife with serious questions and substantial risk. Investors interested in DSM have the potential to damage their own reputation by investing in an unproven industry, against a mounting opposition from large financial institutions, to secure hypothetical profits that are extremely questionable. The international DSM regulatory regime is unfinished but, in draft, the regulations impose steep costs and severe liability risks. 24 countries have called for a moratorium or precautionary pause. International companies are pledging to not use minerals and not invest in companies that use the minerals in their supply chain. Civil society, scientists, media, NGOs, and Indigenous people and local communities are further calling out the guaranteed environmental destruction and accompanying liabilities posed DSM.

DSM is an unproven industrial endeavor fraught with technical, financial, and regulatory uncertainty, lacking in social license and carrying significant potential financial and legal liabilities for both public and private investors.

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