Deep-Sea Minerals: What Manufacturers and Markets Need to Know

BRIEFING PAPER

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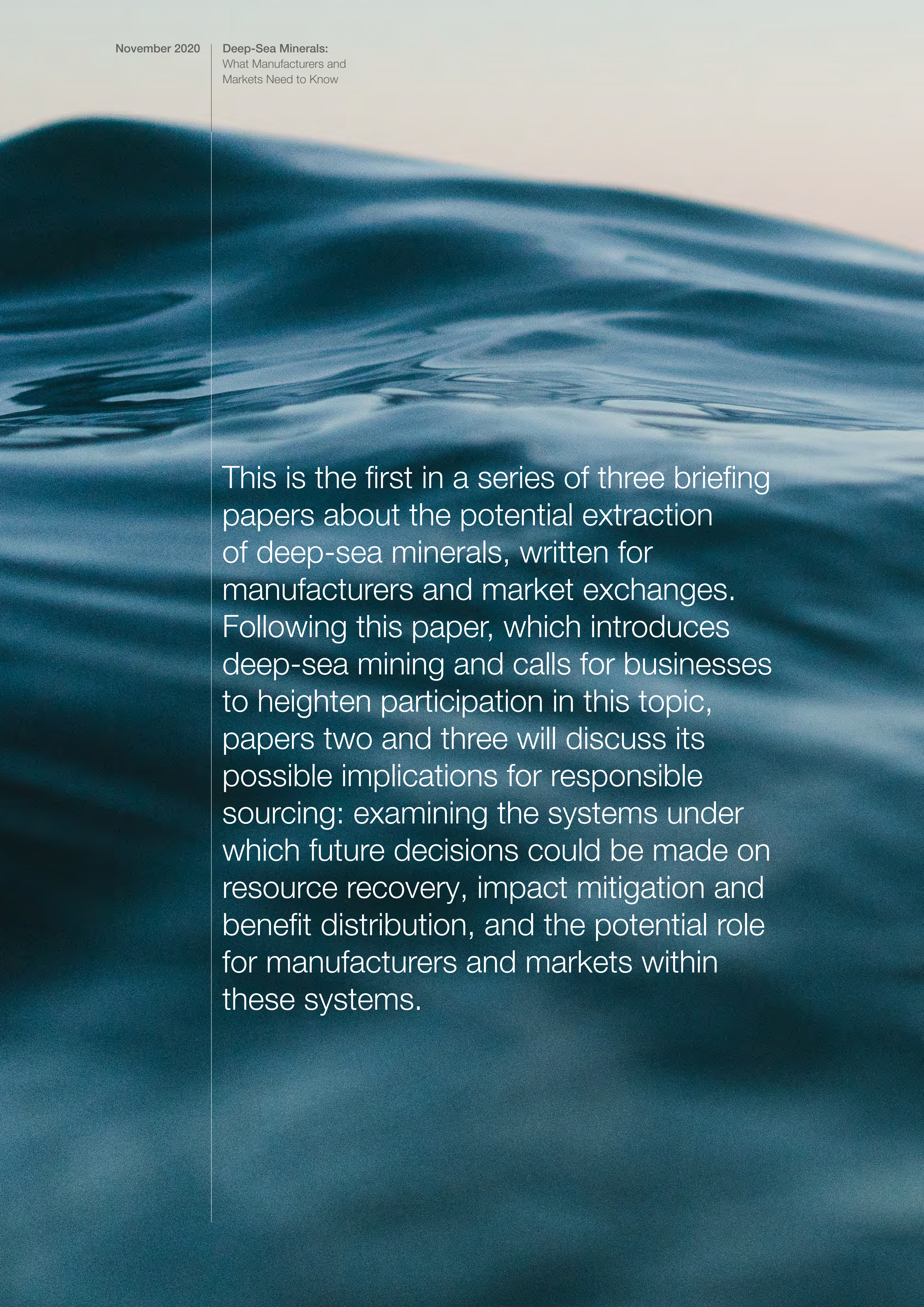


This is the first in a series of three briefing papers about the potential extraction of deep-sea minerals, written for manufacturers and market exchanges. Following this paper, which introduces deep-sea mining and calls for businesses to heighten participation in this topic, papers two and three will discuss its possible implications for responsible sourcing: examining the systems under which future decisions could be made on resource recovery, impact mitigation and benefit distribution, and the potential role for manufacturers and markets within these systems.

1 A call for engagement

Manufacturers have much to lose if they pass up the current opportunity for engagement.

A novel source of minerals may soon become available to global markets. New resource-exploitation industries require new frameworks for governance and these frameworks are taking shape for deep-sea minerals.

In 1982, the United Nations designated the International Seabed Area and its resources the common heritage of mankind.[1] In 2021, the International Seabed Authority could finalize regulations for the exploitation of the deep-sea minerals that can be found there.[2] In parallel, some countries are developing regulatory frameworks for the exploitation of deep-sea minerals in their coastal exclusive economic zones. By 2030, these minerals could be inside consumer products and used within industrial processes.

The special status of minerals from the International Seabed Area (as the common heritage of mankind), the novel environmental challenges of deep-sea mineral extraction, combined with the world's pressing need for mineral resources, make the responsible sourcing of deep-sea minerals a complex proposition.

Recent events have demonstrated customer-facing companies' increased risk of stakeholder dissatisfaction when the materials in their supply chains are associated with negative environmental and social issues. The supply of cobalt from the Democratic Republic of Congo[3] and palm oil from Indonesia[4] and elsewhere, serve as good examples of this phenomenon.

Some stakeholders have already voiced deep concerns about the potential for environmental and social harm from deep-sea mineral mining. If mining goes ahead then possible future risk exposure for manufacturers could potentially be mitigated through effective governance systems, to manage stakeholders' environmental and social concerns.

To be effective, systems for decision-making over natural resource exploitation should be participatory. History demonstrates the consequences when this is not the case. Consider the much-criticized 20th century focus on large dam construction. The seminal report by the World Commission on Dams, *Dams and Development: A New Framework for Decision-Making* (2000), identified five core values for improved decision-making processes related to water and energy development to avoid a repetition of past negative outcomes: equity, efficiency, participatory decision-making, sustainability and accountability.[5] Governance shortfalls in infrastructure development may offer lessons for deep-sea mining.

Manufacturers and the metal markets that supply them, have a brief window of opportunity to influence future decision-making processes for deep-sea mining. By participating now, they can promote strong social and environmental safeguards and avoid much potential negative publicity from stakeholders in ten years' time, if deep-sea mined metals associated with unsustainable and irresponsible production had, by then, entered their products.

2 Deep-sea minerals

What are they and what is new about them?

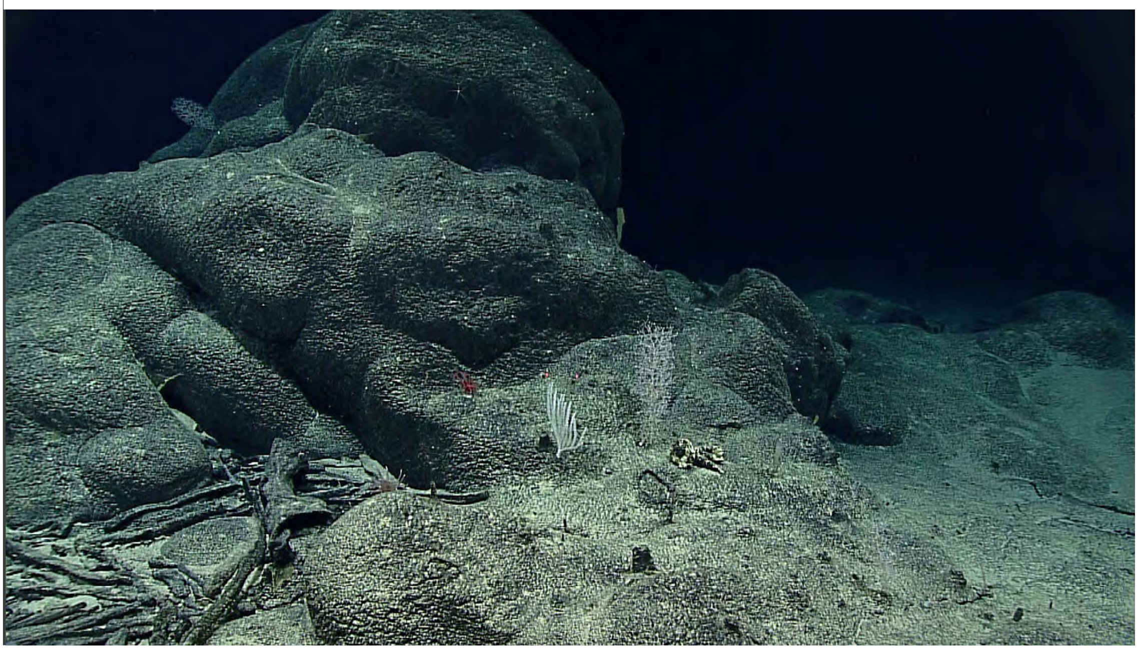
Deep-sea minerals occur on the seabed, at depths below 200 metres.[6] Locations of major known deposits are shown in Figure 4.

Commercial extraction at these depths has not yet begun, but relevant technologies have already been trialled. A forecasted surge in demand for the types of minerals that lie on the seabed (shown in Figure 6) has strengthened the business case for their extraction.[7]

Many of the environmental effects of deep-sea mining will be unlike those on land. Deep-sea operations will not have tailings like conventional mining, for example, but they will create “plumes” of displaced sediment that can spread beyond the area in which operations take place.

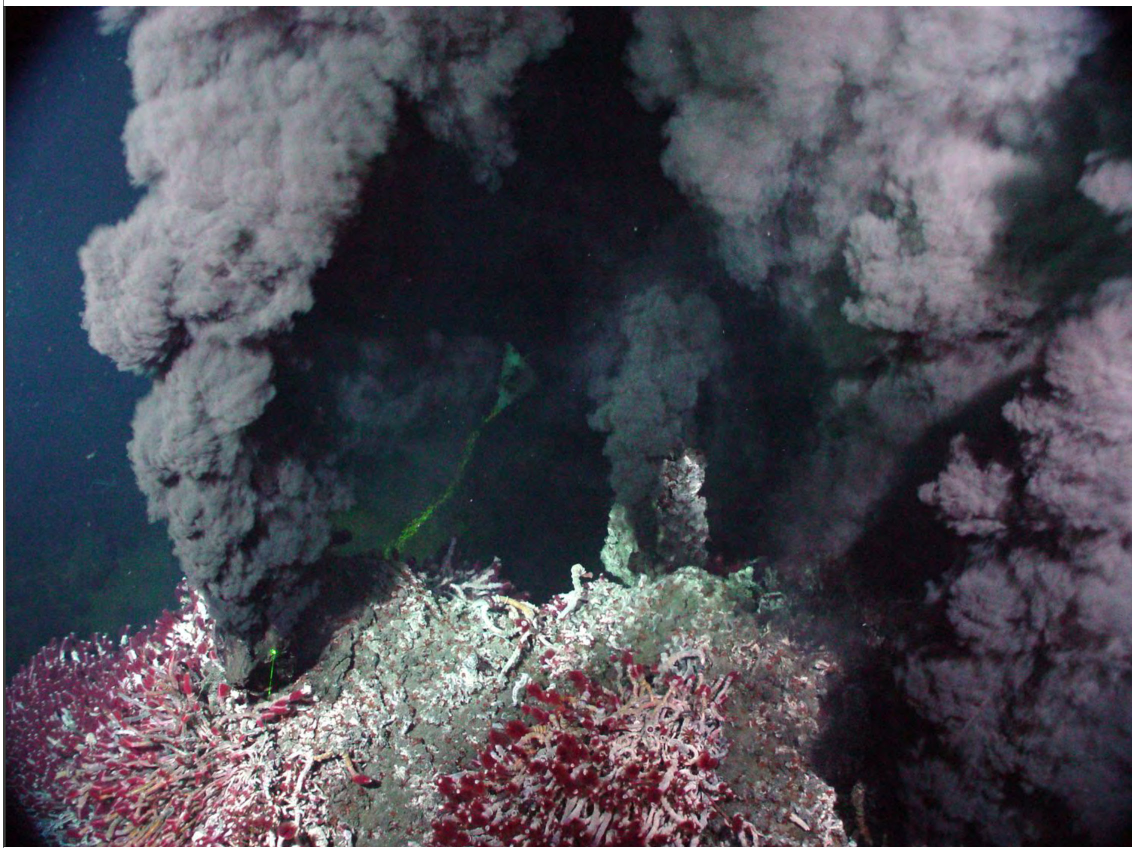
Deposits of deep-sea minerals can be broken down into three categories: cobalt-rich crusts, seabed massive sulphides and polymetallic nodules.

FIGURE 1 **Crusts at Fryer Guyot in the Mariana Region. Image courtesy of the NOAA Office of Ocean Exploration and Research, 2016 Deepwater Exploration of the Marianas.**



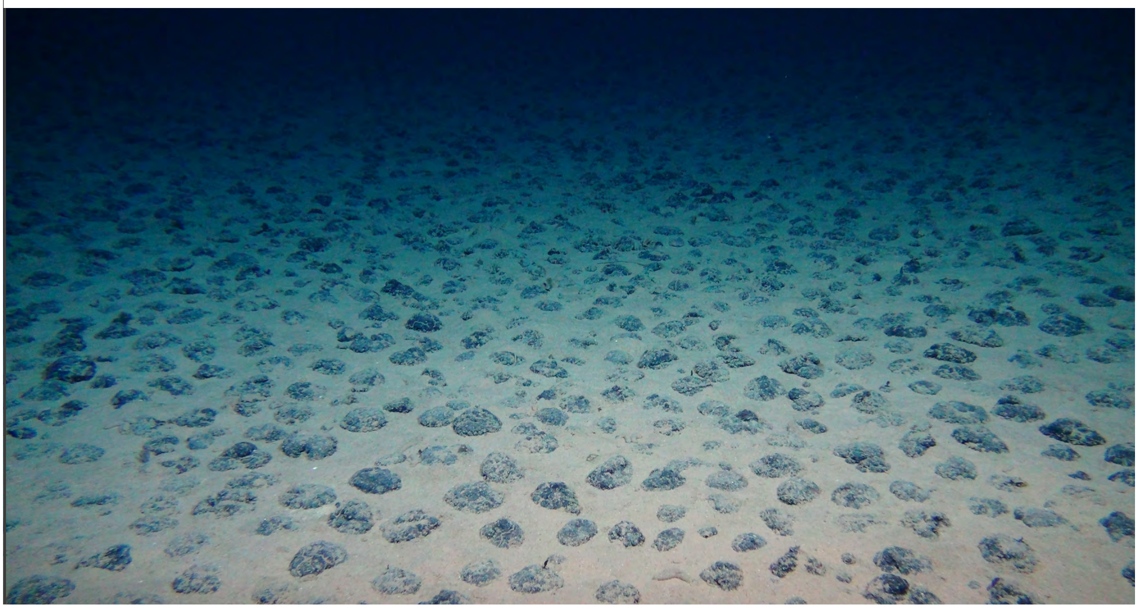
Cobalt-rich crusts: Cobalt-rich crusts can form as a thin surface layer of up to 25cm on the tops and sides of undersea mountains known as seamounts. Extraction would entail grinding from the underlying rock using undersea machinery.[8]

FIGURE 2 **Hydrothermal vent demonstrating ejection of material that can form sulphide deposits, with Riftia tubeworms visible. Tempus Fugit Vent Field near Galapagos Islands. Image courtesy of NOAA Okeanos Explorer Program, Galapagos Rift Expedition 2011.**



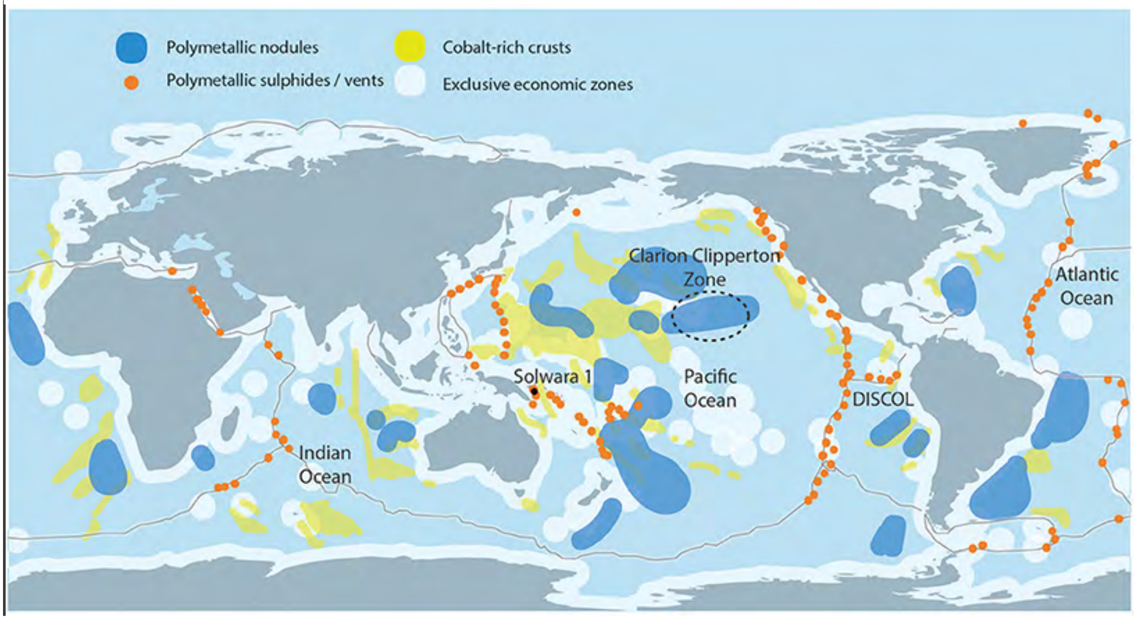
Seabed massive sulphides: Sulphide deposits occur when water rich in dissolved metals is ejected from below the seabed through hydrothermal vents. Over time, metal-containing solids can build up in beds tens of metres thick. Extraction of minerals from these deposits would involve cutting them from the seabed and creating a slurry of broken material to be pumped to the surface.[9,10]

FIGURE 3 **Polymetallic nodules (Clarion Clipperton Zone). Credit: GEOMAR, ROV Kiel 6000.**



Polymetallic nodules: Polymetallic nodules (approximately the size of a potato) can be found on the seabed in some areas of the deep-ocean. They form gradually over millions of years. Extraction entails pumping the nodules, which are unattached to the seabed, into a ship above without crushing.[11]

FIGURE 4 **World map of seafloor mineral occurrences. Sources: Miller et al. 2018; Hein et al. 2013.**



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Decision-making is imminent

It will determine if and how deep-sea minerals will be extracted.

The development of national and international regulatory frameworks under which deep-sea mining could take place is proceeding rapidly and exploration projects are under way.

The International Seabed Authority (ISA) has issued 30 exploration contracts for deep-sea minerals, comprising: 18 for polymetallic nodules, 7 for seabed massive sulphides and 5 for cobalt-rich crusts. These contracts are held by 20 countries, which sponsor seabed exploration contractor companies.[12]

Meanwhile, some countries are eyeing exploitation in their exclusive economic zones, where they can proceed independently. Japan successfully trialled sulphides mining in 2017[13] and crusts mining in 2020,[14] and the Cook Islands launched a licensing process for polymetallic nodule exploration in October 2020.[15]

The ISA has drafted mineral exploitation regulations for the international seabed,[16] which will be discussed and may be finalized at its 2021 assembly.[17] Countries including Japan and the Cook Islands are developing national mining regulations for their own seabed minerals.

The social and environmental components of these regulations will play roles in shaping how deep-sea mineral usage is viewed by society. This, in turn, will have significant impacts on manufacturers and markets.

4 Change is around the corner

New material sources bring new risks and opportunities for manufacturers.

FIGURE 5 **Test-mining equipment at sea. Image courtesy of Global Sea Mineral Resources NV.**

Recent history demonstrates civil society's growing ethical scrutiny of manufacturers' sourcing choices.

For example, five major technology companies were collectively sued in the US in 2019, in a class action lawsuit brought by the families of 14 children allegedly killed or maimed while mining cobalt that would eventually be used in these companies' products. The continuing action claims that the companies knew that child labour was taking place and did not do enough to counter it.[18]

Civil society scrutiny is not limited to mining. Four large consumer goods companies are the subject of a long-running campaign by Greenpeace and other environmental groups, over their use of Indonesian palm oil that originates at sites allegedly associated with large-scale deforestation.[19] Similar controversies exist in many other supply chains too.

Any new material source that is brought to market can bring with it novel ethical issues. As such, manufacturers may forestall significant future challenges to their stakeholder relations by engaging proactively now to support effective environmental and social governance systems for deep-sea mineral extraction in the future.

New mineral sources can also bring opportunities for manufacturers. BMW, GEM Co, Samsung SDI, SK Innovation and Tesla have each signed direct supply deals with the cobalt giant Glencore in recent years, indicating these companies' increased attention on supply security, as metal demand surges.[20]

Figure 6 illustrates the wide range of mineral demands that deep-sea mining could contribute to satisfying, and this offers stability and profitability for manufacturers in a challenging future metal market. It also has, however, the potential to incur significant reputational risks if its environmental, social and economic impacts are not effectively managed.

FIGURE 6 | **Uses and sources of minerals found in the deep-sea. Source: The High Level Panel for a Sustainable Ocean Economy.**

Metal	Uses	Estimated mineral quantities in the Clarion-Clipperton Zone (a major potential source of polymetallic nodules in the Central Pacific) (% of land-based reserves)	Estimated mineral quantities in the prime crust zone (a cobalt-rich crust area in the Central Pacific)* (% of land-based reserves)	Estimated mineral quantities in global seabed massive sulphides** (% of land-based reserves)
Copper (Cu)	Used in electricity production and distribution – wires, telecommunication cables, circuit boards. Non-corrosive Cu-Ni alloys are used for ship hulls	23–30%	0.70%	2%
Cobalt (Co)	Used to produce high-temperature super alloys (for aircraft gas turbo-engines, rechargeable lithium-ion batteries)	340–600%	380%	N/A
Zinc (Zn)	Used to galvanize steel or iron to prevent rusting, in the production of brass and bronze, paint, dietary supplements	N/A	N/A	21%
Manganese (Mn)	Used in construction for sulphur fixing, deoxidizing, alloying properties	114%	33%	N/A
Silver (Ag)	Used in mobile phones, personal computers, batteries. Also in mirrors, jewellery, cutlery and for antibiotic properties	N/A	N/A	N/A
Gold (Au)	Used in jewellery, electrical products (metal-gold alloys)	N/A	N/A	0.002%
Lithium (Li)	High-performance alloys for aircraft; electrical, optical, magnetic and catalytic applications for hybrid and electric cars	25%	0.18%	N/A
Nickel (Ni)	Stainless steel (automobiles, construction), weapons, armour	180–340%	21%	N/A

* Based on 7,533,000 thousand tonnes in the Prime Crust Zone.

** Based on 600,000 thousand tonnes in the neovolcanic zone with grades determined as averages of analysis of surface samples.

5 Environmental considerations

The potential extraction of deep-sea minerals is a new frontier.

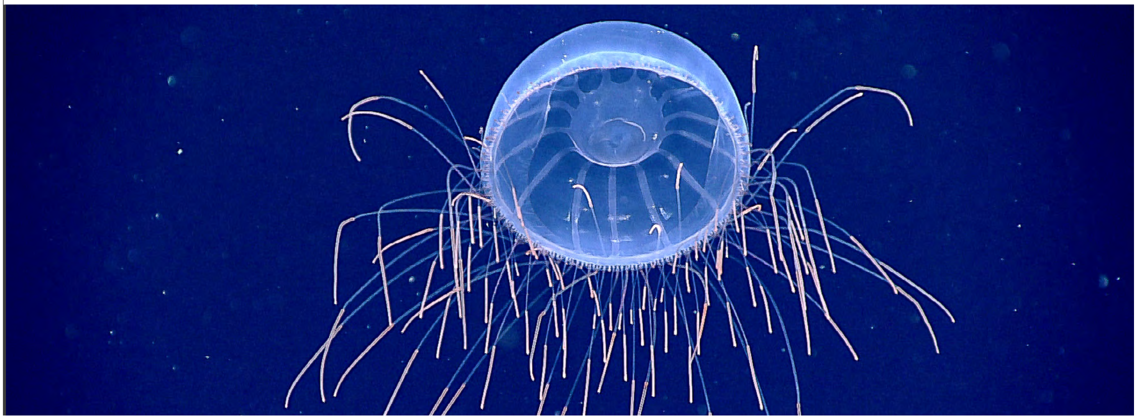
Deep-sea mining presents unique and novel environmental challenges, which must be carefully managed. Potential negative impacts must be weighed alongside a complex set of other anticipated gains and losses.

Although the effects on marine life of sediment plumes, anthropogenic light, noise and electromagnetic disturbance from mineral mining are still being researched, scientists have suggested they could be severe and felt far from mining sites.[21,22] Organism behaviour, growth, reproduction and mortality could all be negatively impacted.[23] Any future extinctions could mean the loss of unique natural wonders and of deep-sea genetic material, which experts believe could one day be used to create new antibiotics, anti-cancer drugs and nutritional supplements.[24] The Deep Sea Conservation Coalition, an alliance of more than 80 international organizations, has called for a moratorium on deep-sea mining until a set of conditions is met, such as comprehensive understanding and protection of deep-sea biodiversity.[25]

Alongside the potential negative environmental impacts of mining, the availability of deep-sea minerals has the potential to lead to indirect environmental benefits.

New mineral deposits are constantly being sought, including in pristine geographies in Greenland,[26] Alaska,[27] the Amazon Rainforest[28] and elsewhere. The availability of deep-sea minerals could remove some of the impetus to mine these areas.

FIGURE 7 **A deep-sea hydromedusa. Image courtesy of NOAA.**



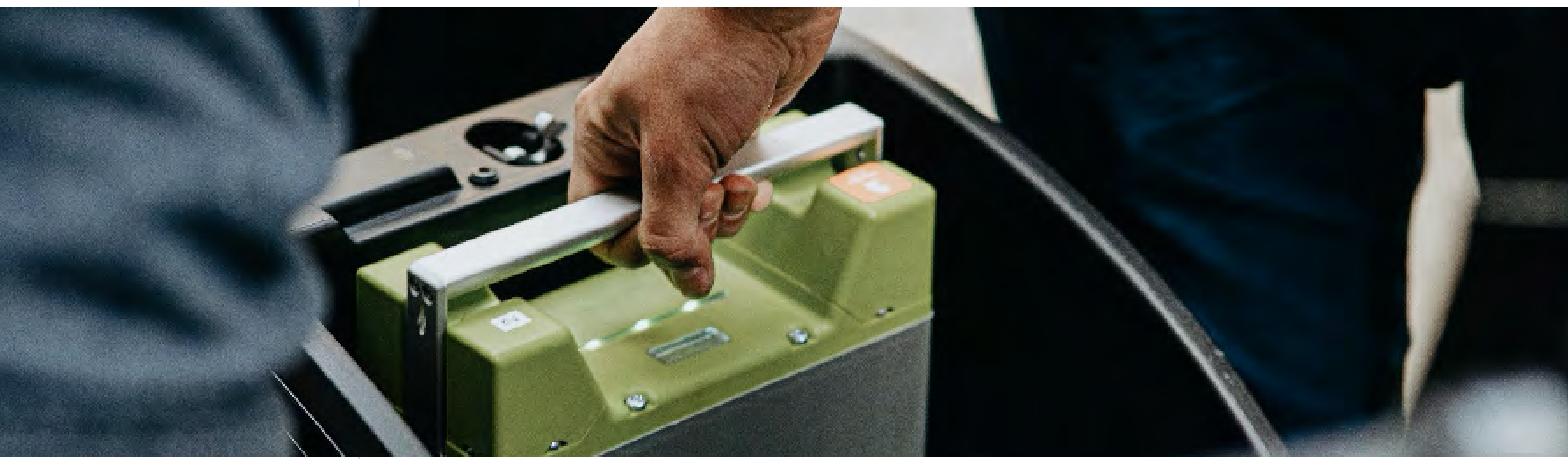
Supply of minerals, including cobalt, is currently a key bottleneck in lithium-ion battery production. This, in turn, constrains the manufacture of electric vehicles and other technologies that aim to aid the global green transition.[29] By increasing the availability of cobalt and other minerals, deep-sea mining has the potential to reduce cost and boost the production of green technologies, perhaps ultimately helping to curb the negative environmental and biodiversity effects of climate change.

According to one scientific paper, deep-sea mining could also help the environment by providing minerals with a lower carbon footprint than those mined on land. The study uses a Life Cycle Analysis methodology to calculate that if nodule mining were used to supply minerals for a billion electric cars, it could save 11.5 Gt of CO_2 emissions in total.[30] By way of comparison, global annual greenhouse gas emissions were 53.5 Gt of CO_2-equivalent in 2012 (the latest annual figures available from the World Bank[31]).

6 Economic and social considerations

Effects associated with deep-sea mineral extraction could be felt by many.

FIGURE 8 **A cobalt-containing lithium ion battery for an electric scooter. Image courtesy of: Kumpan Electric on Unsplash.**



Commencing deep-sea mining could have complex economic and social implications, at a local level and globally. Like deep-sea mining's potential environmental impacts, its economic and social effects could be positive and negative, and their management will require effective, well-balanced decision-making.

Global natural resource consumption in 2019 was 3.4 times what it was in 1970, according to the UN International Resource Panel. The trend is correlated to a doubling in global population and 1.7 time increase in material demand per capita. The vast majority of global resources are currently consumed in high-income and upper-middle income countries.[32]

Extrapolating this trend, a future rise in living standards in lower-middle and low-income countries, where 3.6 billion people currently reside,[33] could mean a significant increase in demand for minerals. This demand should be met, where possible, through improved industrial efficiency and a transition to a more circular economy, but would also require sources of mined minerals for many years to come.[34]

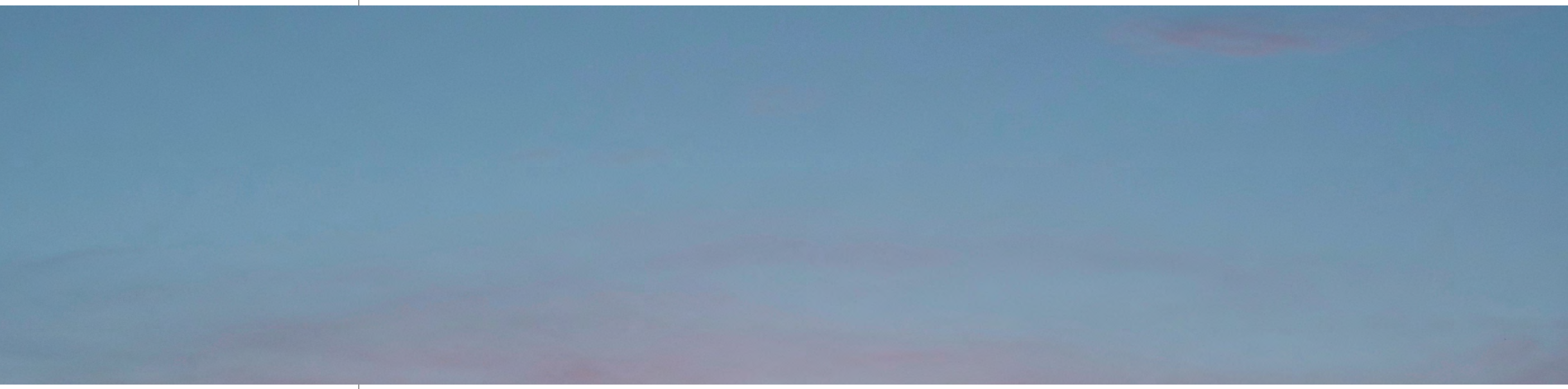
At a local level, deep-sea mining revenues have the potential for economic transformation in island nations that have significant deposits within their exclusive economic zones. Many such islands are isolated from global markets, are vulnerable to climate change and have few other options to diversify their economies.[35]

Conversely, deep-sea mining could also have negative social and economic impacts. Although more research is needed, some scientists warn that sediment plumes could cause reduced fish catches and contribute to metal contamination in marine food chains,[36] potentially affecting the livelihoods of fishing communities. The sea can also have enormous cultural and spiritual significance for some groups, such as coastal communities of Papua New Guinea,[37] and this could be eroded by deep-sea mining.

The presence of undersea resources can be a factor in disputes between countries over territorial waters. For example, in the South China Sea, observers believe that the likely presence of oil and gas reserves is increasing international tensions over contested waters, which could potentially escalate into armed conflict.[38] Deep-sea minerals have already been identified in one disputed exclusive economic zone[39] and more could follow. In future, disputes over access to these resources too could inflame international tensions.

7 A brief window for action

The time for manufacturers and markets to get involved is now.



Minerals from the deep-sea could enter manufacturers' supply chains within a decade. Systems for governing the environmental and social aspects of mineral extraction will be decided on much sooner than that.

Manufacturers and the market exchanges that supply them, have influence over their supply chains and are well placed to balance complex commercial, environmental and social considerations for the materials they purchase. They have done so for many years, for land-based minerals and other resources.

These manufacturers and markets have a short window of opportunity to contribute to the construction of well-designed environmental and social systems. Their participation in this process will help to safeguard their future stakeholder relations, and will promote decision-making that serves humankind and planet Earth effectively.

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Endnotes

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