CSPR Briefing

Deep Sea Mining

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**Introduction: What is deep sea mining and why is it topical?**

This brief is based on a literature review conducted by Axel Hallgren at Linköping University that maps ongoing deep sea mining (DSM) research, scientific debates and controversies and synthesizes major narratives in the field. The brief will first contextualize DSM, pinpoint a few significant challenges, and continue with a short description of the targeted mineral resources. The discussion that follows hone in on a few governance challenges that emanate from the aspirations to achieve an equitable distribution of mining revenues and the lack of scientific knowledge, and the inherently unmanageable task to draft a legitimate regulatory system for the governance of the global and currently uncharted deep sea bed in merely a few years. The brief rounds off by highlighting a few avenues for topical social scientific research.

As modern growth-oriented society depends on an increasing flow of resources, minerals and metals, and land-based mining industries are facing declining concentrations of high-grade ores, more distant and remote areas are now also considered for exploration and eventual extraction. Following decades of technological innovation, price volatility, growing asymmetry in control over rare earth minerals, and increasing demand of metals, the highly contested and unconventional method of deep seabed mining (DSM) has recently become a political reality, with geopolitical consequences.

A few projects on shallow seabeds within national jurisdictions already exist, but DSM on a commercial-scale at depths of more than 600 meters is currently not practiced. Nonetheless, the UN body responsible for regulating the deep sea bed resources beyond national jurisdictions - the International Seabed Authority, ISA - had awarded 29 exploration contracts in 22 different countries before December 2018. However, subsequent exploitation cannot take place until ISA’s drafting of the “Mining Code” is completed. The Mining Code, currently in the making, will regulate prospecting, exploration and exploitation. The code has to interpret and align with the aspirations expressed by the UN General Assembly in 1966, namely that the exploitation of the deep ocean should benefit all humankind and be a means to address inequality gaps across nations.

In addition to the regulatory challenges, DSM mining is controversial because it poses risks of irreversible damage to marine ecosystems and biodiversity. It may also interfere with fishing and other economic activities, and, as the deep sea is virtually uncharted territory, there are many unknown risks still to be revealed. On the other hand, vast resources of e.g. cobalt, nickel, and other rare earth metals lie beneath the seabed, and some actors argue that they may displace environmentally
and socially contested on-shore mining (Kochinsky et al., 2018). There are several intriguing trade-offs that are difficult to reconcile currently being mapped; interpreted and negotiated both in scientific and political spheres. Following a brief technical description, we will highlight some of the concerns that attract most attention in the scientific literature on DSM.
Technical description

The three main types of mineral resources targeted for future exploration are the seafloor massive sulfides (SMS), ferromanganese crusts (also cobalt-rich crusts) and polymetallic nodules. These resources are all located in sensitive marine environments and an eventual extraction would face significant technical challenges that would need resource-specific and carefully tailored environmental regulation.

Ferromanganese nodules
Ferromanganese nodules, also referred to as polymetallic nodules, are best described as potato-sized rocks found on the abyssal plains approximately 3000-6000 meters below sea level. The nodules found on the plains differ in both size and vary in ore-grades; some are as small as pebbles, while others can be half a meter in diameter (Miller et al., 2018). Exactly how they are formed is still under scientific debate. Enticing to miners, many nodules contain high grades of manganese minerals, nickel, cobalt, copper, zinc, and traces of other attractive metals such as lithium. The nodules provide the nearby benthic life with a heterogeneous environment and hard substrate – a limited habitat in the deep sea that otherwise mostly consists of sediment (Simon-Lledó et al., 2019). The global areas of most interest for nodule extraction lie within the Clarion Clipperton Fracture Zone (CCZ) in the north-central equatorial Pacific Ocean, the Peru and Penrhyn Basin of the South Pacific and the northern parts of the Indian Ocean. Calculations roughly estimate that the CCZ could hold over 21 billion tons of nodules, which collectively would contain 6000 million tons of manganese, 270 million tons of nickel and 44 million tons of cobalt (Miller et al. 2018). The extraction is planned to be managed remotely, controlling nodule harvesters that plow or scrape the seabed and sediment. Nodules and the sediment in which they lie will be pumped up to the surface, sorted and sediment-water returned into the ocean on-site (Levin et al., 2016).

Seafloor massive sulfides
Seafloor massive sulfides (SMS) are deposits found in tandem with so-called active or inactive hydrothermal vents (Levin et al., 2016). Hydrothermal vents are small unique parts of the deep sea found along the ocean floor ridges. These vents (also called black smokers) are best described as small underwater volcanoes. The vent areas contain rich concentrations of sulfides as well as other metals and minerals such as copper, zinc, gold, barium, and silver. The vents are generally located at depths between 1000-4000 meters, where no light penetrates, and life is dependent on chemically produced energy. Active vents are filled with benthic life formed from microbes that produce food through chemosynthesis.
When tectonic plates pull apart, cold water seeps into the cracks. This cold water is then rapidly heated by the magma beneath and, after reacting with the metals and elements in the Earth’s crust, spat back out, creating turbulence mixing with the cold deep sea water. The minerals spat out in the hot water look like dark snow, which mixes with the colder environment creating hydrothermal mineralization and forming chimneys. What is of real interest for the mining industry is what lies beneath these chimneys (Levin et al., 2016; Miller et al., 2018). The most famous area found covered with large black and white smokers is dubbed the Lost City Vent Field located around the Mid Atlantic Ridge. To date, there are approximately 400 known active vent fields around the globe. Being able to distinguish between the active or inactive vents becomes important when considering the environmental impacts and management related to mining. These sites carry different communities and need to be assessed accordingly. What may seem like an inactive vent could potentially mask venting activity underneath. The active vents host unique ecosystems and endemic species that rely on the 400 C fluids that stream out, mineralize, and precipitate as they mix with the cold deep ocean water (Van Dover et al., 2018).

**Cobalt-Rich Crusts**
Cobalt-rich crusts (CRC) - also referred to as ferromanganese crusts or polymetallic crusts - are found on the seamounts rising 1000 meters or more above the seafloor. The crust layer of these mounts contain iron, manganese, and trace metals such as copper, cobalt, and nickel. The thickest parts of the crust are estimated to be around 25 cm and occur on top of the mountain summits or flanks. Seamounts, or knolls, can be found in all oceans but the area of highest industrial interest lies in the Pacific Ocean, with more than 55 000 mounts and smaller knolls. The international areas around the central equator or within the EEZs of Pacific island states such as Kiribati, French Polynesia, Tuvalu, and the Samoa Islands are highlighted in the literature as hotspots for potential CRC exploitation. CRCs may pose a more challenging mining procedure than the above as 1) the entire crust has to be removed from rock substrate and 2) the steep and rugged landscapes where machinery has to operate make the technological obstacles more difficult to overcome (Miller et al., 2018; Levin et al., 2016).
Governance challenges

Deep sea mining is first and foremost regulated by the United Nations Law of the Sea Convention (UNCLOS), which was signed in 1982 and entered into force in 1994. UNCLOS’ legal framework regulates the sea beyond a coastal state’s national jurisdiction. A coastal state’s territorial water stretches 12 nautical miles from the coast and includes both sub-soil and air. The exclusive economic zone (EEZ) extends a further 200 nautical miles. Within the EEZ, a state has the exclusive authority to exploit and regulate resources. The ISA are responsible for controlling, regulating and managing activities that affect the seabed beyond a nation’s EEZ. Established in 1994, the ISA is an autonomous intergovernmental body put together by 167 member states, plus the EU.

The minerals found on the deep seabed in international waters (the so-called Area), have been set aside as the ‘Common Heritage of Mankind’ – a common good. The ISA has been awarded the responsibility to govern these resources on behalf of the global population. Not only is the ISA controlling the exploration and potential future exploitation, but they are also in charge of making sure that the DSM-regime becomes a space of equal participation, guided by transparency and fairness. Profits derived from the seabed are intended to be shared equally across all countries (Kochinsky et al., 2018). Feichtner (2019) argues that there is a contradictory aspect to how the ISA has laid out the foundations for a system that is supposed to be equitable and even, while it hands out permits to exclusively exploit and appropriate certain areas of the sea for economic gain by only a few actors. Developing countries, far from being capable of setting up their own mining operations, are instead supposed to engage in DSM by becoming sponsoring states of corporations (Kim, 2017). Examples of this are seen in the Clarion Clipperton Zone where the Small Island states of Tonga and Nauru have entered into contracts with the ISA and Tonga Offshore Mining Limited, a joint subsidiary of Nautilus Minerals (ISA, 2019).

Another issue is that compensation is often riddled with problems of transparency and corruption. One could ask if the premise itself is rather naïve, since laws on how money allocated by governments is to be redistributed are often lacking (Kochinsky et al., 2018). Another critique of the current DSM-regime is directed towards the ISA and how they have mismanaged their responsibilities. Boetius & Haecke (2018) ask for more transparency concerning the decision-making processes for issuing contracts. The major lack of in-depth knowledge of how deep sea ecosystems function, their life, and interactions, make many natural scientists argue for a firm precautionary principle that would prohibit DSM exploitation at this stage (e.g. Cuvelier et al., 2018). In sharp contrast, more optimistic voices argue that DSM in
its current phase creates a unique opportunity for scientists to help the industry set the best possible environmental mining practices from the outset (Cuvelier et al., 2018).

So far, only two Canadian owned companies - Nautilus Minerals, and Diamond Fields International - have gained exploitation licenses within national jurisdiction (Miller et al. 2018; Fukushima & Nishijima 2017). Nautilus’ Solwara 1 project, which is the most developed and most closely monitored of the two, was granted exploitation status in 2011 and covered an area of 59 km² in the Bismarck Sea off the coast of Papua New Guinea. Nautilus aims to extract mainly high-grade copper and gold from the seafloor massive sulfide deposits found in hydrothermal vents. In 2008, the company estimated that about 1.3 million tons of material could be harvested each year from the mining site (Miller et al. 2018). However, the pioneering DSM Solwara 1 project has been ridden by controversies, technical backlashes, and financial cutbacks. Several independent experts and NGOs have criticized how the environmental impact assessment (EIA) was carried out, and the way in which a ‘social license’ to mine was constructed. The company tried to reassure local stakeholders that there would be no adverse effects from the mining – something highly debated especially in terms of the vast uncertainties on the externalities caused to the marine ecosystems and surroundings (Filer & Gabriel 2017). Nautilus applied a similar approach to how a mining company would operate in a conventional terrestrial setting, which usually focuses on the collection of sufficient environmental data that helps to produce the EIA and subsequent management strategies. Although their plan contains mitigation of potential harm to benthic marine life, recolonization of the mined area and relocation of fauna, it still remains unclear how, and if these strategies would be carried out. Nautilus did not publish their EIA until after the environmental permit was handed out, which minimized input from outside actors and undermined its legitimacy. Later, an independent review of Nautilus’ EIA came to the conclusion that the risks of the Solwara 1 mining were well underplayed and the data collected insufficient.

In sum, challenges arise from DSM’s unprecedented character and uncertainties of its temporal and spatial environmental impacts. Jones et al (2019) write that these challenges could be addressed through further collection of scientific information, following a precautionary approach and making sure that management regulations are adaptive and not static. The ISA has already created tools for regional and local management in the CCZ, but the enormous knowledge gaps regarding deep sea ecosystems remain a serious issue in terms of creating policies, management plans and laws that are legitimate, feasible and safe (Folkersen et al., 2019).

Even if there are benefits of DSM compared to mining operations on land, the large unknowns pose major concerns on at least three fronts according to Folkersen et al. (2019): Firstly, it is down in the deep sea that the basis for all marine life and the marine ecosystem is formed, and so, mining could risk impacting what are already
suffering global fish stocks. Secondly, the ocean is highly interconnected with biogeochemical cycles on land. Altering those might decrease the ocean’s ability to help us regulate carbon and climate – affecting human life. For example, it is very uncertain what impact DSM may have on productive ecosystems formed around hydrothermal vents. Thirdly, DSM may compete with and extinguish more valuable bio-genetic resources, crucial for future generations. Several scientists are therefore arguing that it is neither safe for the environment, nor for current or future generations to start mining based on current knowledge (Kim, 2017; Boetius & Haecke 2018; Vanreusel et al., 2016). Opponents of DSM maintain that the only way for the ISA to live up to its commitments from UNCLOS Article 145. Protection of the marine environment, and Article 194. Measures to prevent, reduce and control pollution of the marine environment (Van Dover et al., 2018) is to call for a long-term moratorium on mining deep sea resources.
Avenues for further research

In line with the discussions above we want to suggest seven topical areas for further research:

1. The current law-making process in the ISA have been criticized for their one-dimensional focus on economic growth and for downplaying social justice. Since it is stated in the Law of the Sea that the ISA should safeguard and protect deep sea resources for the common heritage of mankind, it is of importance to understand how public interest is interpreted by the ISA. Are societal benefits from the potential economic gains underpinning DSM adequately outlined by the ISA? How do the benefits of mankind and potential redistribution of wealth weigh against environmental protection and on what basis?

2. Influencing regulations and policymakers at this fluid stage of DSM is critical, there is a need to investigate new ways of economic valuations that appreciate the social benefits, e.g., which resource is likely to generate the highest social benefits on various time-scales. How are social benefits currently assessed and incorporated into the valuation of DSM activities?

3. Forthcoming studies need to pay close attention to how deep sea ecology interacts with the proposed mining sites. Environmental management plans need to be scrutinized by the academic community with a focus on accountability, environmental protection, social justice, and geopolitics underpinned by ecological responses to mining. This is why the ongoing Nautilius project can set relevant precedents for future considerations (Filer & Gabriel 2019). How can Nautilius’ project in Papua New Guinea inform regulation and management of DSM, what can be learnt about the ways in which a ‘social license’ is obtained?

4. Insufficient capacity and a lack of legitimacy in the ISA may jeopardize the quality and acceptance of environmental impact assessments. More research on how power is devolved from the ISA down to a potential independent inspectorate is needed. How could such an agency exist within the ISA to ensure both development and environmental protection of deep sea resources (Durden et al. 2018)? What are the perceptions of DSM in the public sphere? What is the level of awareness, and what stakeholders are relevant to explore?

5. Also, the making of ISA’s mining code presents an opportunity for researchers to question how a political economy of a resource is constructed before exploitation has begun (Feichter 2019; Sparenberg 2019). The pro-
mining argument that DSM would be able to remedy previous colonial exploitation leading to global inequality (by distributing mining profits), while at the same time satisfy a large scale commercial industry is contested. What are the understandings of this equity premise in developing countries? Additionally, is redistribution only considered to be monetary or will cultural and social values also be taken into consideration? What critique of the Mining Code is forwarded by the scientific communities?

6. Kim (2017) argues that ‘deep seabed mining could reinforce unsustainable patterns of production and consumption, divest from recycling, and further exacerbate inequality in both spatial and temporal dimensions. On the other hand, some argue that humanity needs more minerals for (green) infrastructure. (Beaulieu et al. 2017). DSM also intersects with several of the UN’s Sustainable Development Goals including Goal 9 on ‘equitable access to all,’ Goal 10 to ‘reduce inequality’ and Goal 14 to ‘conserve and sustainably use the ocean and its resources.’ What are the implications of DSM for sustainable development and the weighing between economic gains versus environmental protection across time and space?

7. Another instrumental aspect of the future for DSM is how the ISA will relate their regulations to other multilateral environmental agreements, especially the upcoming treaty for biodiversity beyond national jurisdiction (BBNJ) under UNCLOS that will impact the regulation of the resources and areas in the high seas. It is most pressing to develop and review the currently suggested guidelines and regulations put forward by the ISA. Can lessons be drawn from other offshore industries and how can they be incorporated to inform clear and robust protocols for DSM (Jones et al. 2019)?
References


