Deep sea mining:
Exploring the unknowns

Multi-stakeholder conference – 26th April 2016, Brussels
Discussion paper

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Background and conference objectives

The deep sea occupies 90% of the marine environment and functions as an important regulatory body of the biosphere. These habitats have distinct fauna with widely divergent ecological and life-history characteristics. Most species resident there have low productivity and are extremely vulnerable to human disturbance. The deep sea spans areas both within and beyond national jurisdictions, leading to complex governance frameworks. The unique features of this extreme, enormous, three-dimensional environment create the need for a specialised approach to its management.

Juxtaposed against these reasons for caution, commercial interest in the potential for deep seabed mining is growing rapidly, both within Europe and internationally. In the global quest for raw materials, the deep seabed mining potential currently focuses on polymetallic sulphides, manganese nodules, cobalt-rich ferromanganese crusts, methane hydrates and phosphate (see Annex 1). It requires new technologies and approaches and new scientific knowledge, most of which have yet to be acquired and developed.

Globally, some 1.2 million km^2 of seabed have already been licensed for exploration in the international portion of the seabed, potentially creating the largest mining operation the planet has ever seen and dwarfing anything comparable on land. The area is close to the size of Europe.

Vast expanses of the seabed in the Pacific, Atlantic, and Indian Oceans have been licensed for mining exploration, including waters around Papua New Guinea, Solomon Islands, Fiji, Vanuatu and Tonga.[1].

In total, around 7.5% of the global mid-ocean ridge – some 6,000km (250 times longer than Manhattan) – is now being explored for its mineral wealth.[2]

By 2020, it has been estimated that 5% of the world's minerals, including cobalt, copper and zinc could come from the ocean floors. This could rise to 10% by 2030. Global annual turnover of marine mineral could grow from virtually nothing to €5 billion in the next 10 years and up to €10 billion by 2030.[3]

There is widespread concern about the impact deep sea mining will have on the ecosystems and habitats of the deep and how the practice can be managed. Sites of mining interest often include highly vulnerable marine ecosystems and biodiversity hotspots. Mining poses potentially significant risks both to the sites themselves and into the water column beyond, as indicated by the preliminary results of the EU funded MIDAS research project[4]. These risks include irreversible ecosystem destruction, direct as well as indirect biodiversity loss from plumes and sedimentation, underwater noise and toxic pollution, to name but a few.

Urgent action is therefore needed by independent scientists, policy makers, NGOs and other stakeholders to ensure the protection and preservation of the deep-ocean environment, while enabling the use of its living and non-living resources. The conference organised by the Deep Sea Conservation Coalition (DSCC) and Seas At Risk on 26th April 2016 thus aims to:

- Encourage a dialogue between a wide range of stakeholders, policy makers and scientists around the need for deep-seabed mining, given future demand for raw materials, and
- Update participants on the state of play on the challenges and development of international regulations for deep-seabed mining and its environmental implications.

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[1] http://www.savethehighseas.org/deep-sea-mining/
[2] http://www.bbc.com/news/science-environment-28442640
[3] http://na.unep.net/geas/getUNEPPageWithArticleIDScript.php?article_id=112
[4] MIDAS – Managing Impacts of Deep Sea Resource Exploitation http://www.eu-midas.net/science

Governance

In Areas Beyond National Jurisdiction (ABNJ), deep seabed mining is governed by the International Seabed Authority (ISA). The ISA has 167 members and is the authority responsible for management of mining the international sea floor. It was established under the 1982 UN Convention on the Law of the Sea (UNCLOS) to govern 'the Area', which is to be considered the Common Heritage of Mankind. In the Area, the ISA retains the right to issue exploration and exploitation licenses for mining.

As of July 2015, twenty seven exploration licences have been issued by the ISA for exploration for polymetallic nodules, polymetallic sulphides and cobalt-rich ferromanganese crusts in the deep seabed. Twenty four contracts have been signed thus far - 15 of these contracts are for exploration for polymetallic nodules in the Clarion-Clipperton Fracture Zone (14) and Central Indian Ocean Basin (1); five contracts for exploration for polymetallic sulphides in the South West Indian Ridge, Central Indian Ridge and the Mid-Atlantic Ridge; and four contracts for exploration for cobalt-rich crusts (three in the Western Pacific and one in the South Atlantic).[5] As recently as March 2016, the ISA and the UK Seabed Resources Limited (UKSRL) signed a 15-year contract for exploration for polymetallic nodules in the eastern part of the CCZ.[6] All licenses issued by the ISA are held by governments or state-sponsored companies.

The ISA has not yet issued exploitation licences, but is currently developing a regulatory framework for permitting commercial mining of the seabed.

The ISA has established a strategic environment management plan for the polymetallic nodule province in the Clarion Clipperton Zone (CCZ) in the equatorial eastern Pacific and recognises the value of regional environmental management plans for the preservation and protection of the marine environment The ISA may consider good scientific cases for new strategic management plans for the mid ocean ridges in the North and South Atlantic Oceans and the Indian Ocean in the future, as well as for clusters of seamounts in the Western Pacific which might be exploited for cobalt crusts.

The ISA has also initiated a process to review its own internal working methods, so as to encourage greater stakeholder involvement in the future. A new consultation strategy is to be drafted that will aim to increase much-needed transparency and dialogue.

As to licenses within the national jurisdiction area of individual states' EEZs, a desk study made on behalf of the DG MARE identified 26 projects, most concerning exploration. National governments have until now issued two deep sea marine exploitation (or commercial mining) licenses: one by the government of Papua New Guinea (Solwara 1 project in the Bismarck Sea) and one by the governments of both Saudi Arabia and Sudan (Atlantis II project in the Red Sea). In both projects mining has not yet started. There are as yet no international standards for deep sea mining in these areas and consequently there is a risk that different and stricter standards may in due course apply in the Area than in areas under coastal State's jurisdiction.[7]

Involvement of the EU

The EU has the potential to play a leadership role over the coming years, both as a member of the ISA and due to the fact that there are several European companies and EU Member States spearheading developments. In the Exclusive Economic Zones of European countries, three exploration projects are

[5] https://www.isa.org.jm/deep-seabed-minerals-contractors
[6] https://www.isa.org.jm/news/uksrl-signs-second-exploration-contract-isa
[7] Ecorys (2014), Study to investigate the state of knowledge of deep sea mining

currently under application: one in Italy, one in Norway and one in Portugal. The area around the Azores appears to offer the most probable possibilities for DSM in European waters.[8]

The EU's Blue Growth strategy identified seabed mining as one of five maritime "priority areas" that could boost economic growth and employment. In addition to these economic objectives, deep-sea mining also has links to EU environmental policy, such as the objective of Good Environmental Status under the Marine Strategy Framework Directive[1] and most importantly to international ocean governance, which is currently a priority for the European Commission.

Furthermore, over the last few years the EU has framed several policy documents identifying the need to maintain a secure and sustainable supply of raw materials. The Raw Materials Initiative, which sets out sets an integrated strategy to secure supply of raw materials in the EU, is one example, and recycling and efficiency are also included among its priorities.

Resource efficiency, recycling, eco-design etc. are also addressed through the EU's Circular Economy Strategy, an EU Action Plan for the Circular Economy, with measures covering the whole product lifecycle: from production and consumption to waste management and the market for secondary raw materials. The proposed actions are intended to contribute to "closing the loop" through greater recycling and re-use, and bring benefits for both the environment and the economy.

A study conducted for the European Commission covered the current and latest state of knowledge of deep sea mining, including the geological potential, the relevant technologies, the economic viability, the environmental implications, the legal regime, and an inventory of ongoing exploration and exploitation projects[9]. It pointed to great uncertainties about the environmental risks, and calls into question the socio-economic benefits of the sector.

The European Commission is still considering which policy steps to take next. A public consultation organised by the Commission in 2014 provided a wide variety of views on the different aspects of deep-sea mining, including its necessity, how it should be conducted and its potential impacts. The consultation was however limited in scope and outreach, as alternatives such as increasing recycling were not included as an option for EU action (boosting resource efficiency and recycling are a separate pillar of the Raw Materials Initiative).

In 2015, the European Commission launched a separate public consultation on international ocean governance. A Communication is expected to be published mid-2016; deep seabed mining will likely be an element.

Also in 2015, the European Parliament's Science and Technology Options Assessment service (STOA) formulated a number of policy options and actions to support the EU and its institutions in tackling the key barriers and challenges of deep sea exploration and exploitation, i.e.

- Improve communication and raise awareness on the topic (building confidence/ knowledge);
- Improve the knowledge base and address environmental impacts;
- Support the adoption of a complete legal framework;
- Consider supporting a pilot mining project for mineral resources; and
- Investigate recycling as an alternative to deep sea mining, and to address the societal impacts on local communities.[10]

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[8] Ecorys (2014), Study to investigate the state of knowledge of deep sea mining
[9] Ecorys (2014), Study to investigate the state of knowledge of deep sea mining
https://webgate.ec.europa.eu/maritimeforum/en/node/3732
[10] STOA (2015), Technology options for deep –seabed exploitation – Tackling economic, environmental and societal challenges

EU research

An overview of EU funded research (study made on behalf of the DSCC and available to conference participants) shows that the EU has so far invested some €66 million in research related to deep seabed mining, under the 6th and 7th Framework Programmes and the Horizon 2020 Programme[11]. EU funded research between 2004 and 2014 (closed projects) was predominantly targeted at understanding the deep sea ecosystems, in order to potentially inform EU environmental policies. Although the MIDAS Project is focussed on the potential environmental impacts of deep-sea mining, the other three of the four EU funded research projects currently on-going seem more oriented towards possible solutions to retrieve ore in the seabed, develop new technologies or even to establish the world's first deep-sea mining test facility.

The 4 ongoing research projects are:

- **MIDAS** (project budget: € 12 M/ EU contribution: € 9 M): Managing Impacts of Deep sea resource exploitation: addresses the potential environmental impacts relating to the exploitation of deep-sea mineral and energy resources; specifically polymetallic sulphides, manganese nodules, cobalt-rich ferromanganese crusts, methane hydrates and the potential mining of rare earth elements.
- **Blue Nodules** (project budget/EU contribution 8M€): Breakthrough Solutions for the Sustainable Harvesting and Processing of Deep sea Polymetallic Nodules: aims to address the challenge of creating a viable and sustainable value chain to retrieve polymetallic nodules from the ocean floor. It will develop and test new highly-automated and sustainable technologies for deep-sea mining, with minimal environmental pressures.
- **ROBUST** (project budget/ EU contribution 5.9M€): Robotic subsea exploration technologies: aims at developing sea bed in situ material identification through the fusion of two technologies, namely laser-based in-situ element-analysis capability merged with underwater AUV (Autonomous Underwater Vehicle) technologies for sea bed 3D mapping, in order to have a detailed identification of the raw materials contained in a mining sites and enable targeted mining of only the richest existing resources.
- **BLUE MINING** (project budget 15 M€/ EU contribution 10 M€): Breakthrough Solutions for the Sustainable Exploration and Extraction of Deep-sea Mineral Resources: aims at developing the technical capabilities to adequately and cost-effectively discover, assess and extract deep sea mineral deposits in depths up to 6,000m.

Deep seabed mining is also an issue being considered under the **European Innovation Partnerships (EIPs) on Raw Materials.** The EIP is a stakeholder platform organised by the European Commission, with the overall objective of ensuring the sustainable supply of raw materials to the European economy and bringing together representatives from industry, public services, academia and NGOs.

To achieve the EIP's objectives, a series of joint programmes with several partners (called "Commitments") have been set up, aimed at delivering innovative products, processes, services and bringing wider societal benefits. Most of the EIPs are not funded by the EU, however little information is available about the existing EU contribution. Six commitments are currently related to deep-sea mining: ALBATROSS, Blue Atlantis, ERDEM, SeaFlores, Euroasset and SecPrime.

[11] EU funded deep sea mining projects. Study made on behalf of the DSCC (2016)

The need for deep-seabed mining and the link with a circular economy

Minerals and the metals they contain are an essential component of the modern high-tech world. As global demand for mineral resources increases due to growing consumption patterns, intense demand for valuable metals is expected to push up global prices over the longer term.

Some projections suggest that renewed demand will come from the intensified use of green technologies and electronic devices, particularly lithium and other battery minerals, copper in magnets in electric cars and other applications, wind turbine applications, rare earth minerals in computers, phones and photovoltaic panels and other renewable energy applications. While it is important to stimulate renewable energy implementation in order to combat climate change (which has its own particularly serious implications for the deep sea and the rest of the ocean), there will be choices that can be made between technologies, some of which may require less of the minerals found in the deep sea than others.

Future demand for raw materials must also be assessed in the context of a move to a circular economy, aimed at enhancing design, repair and reuse, and recycling, as well as the development and use of alternative materials (such as graphene to replace copper as a conductor, for example).

A study conducted by the University of Technology, Sydney (soon to be launched) will summarise the key metals needed if global energy were sourced exclusively from renewables by 2050, based on existing and dominant technologies. It will show that a transition towards a 100% renewable energy supply – often referred as the "energy revolution" – can take place without deep-sea mining. Increasing recycling and continued research and development into alternative technologies that reduce or in some cases completely replace the use of metals currently deemed critical to the transition to a renewable energy economy are vitally important complementary strategies.

Calls for precaution

In December 2014, Seas At Risk and the Deep Sea Conservation Coalition (DSCC) hosted a deep sea mining workshop in Brussels, as a first step towards building European NGO dialogue and capacity around these issues. The workshop helped to increase the sense of urgency for coordinated NGO action at international and EU level on this emerging environmental risk. The main conclusions were:

- Intrinsically linked to the exploitation of non-renewable resources as it is, deep seabed mining is very much at odds with the EU strategy for resource efficiency and its aspiration for a circular economy based on renewables.
- Deep seabed mining is a short term solution to expected demand, with potentially very long-term and irreversible environmental impacts , as deep sea ecosystems can take hundreds or thousands of years to recover (if at all) from human disturbance. This poses an important sustainability question. Moreover, we do not yet have the baseline information to determine exactly what the impacts are likely to be and what the 'trade-off' between environmental impacts and mining will be.
- With the many technological and legal constraints, and environmental and wider sustainability impact unknowns, the application of the precautionary principle is more important than ever.
- There are also several concerns with the way in which ISA currently works: transparency in the crucial Legal and Technical Commission is lacking, sharing of environmental data is very limited, and stakeholder involvement is still being developed. There is a need for an Environmental and/or

Scientific Committee, and other reforms need to ensure its effective operation. The current Article 154 review is a good opportunity to address these issues.

- A much wider public debate is necessary to help frame EU policies, including funding, on the issue.

The call for a wide public debate was also requested by 6 European NGOs - Seas At Risk, Oceana, BirdLife, Greenpeace, Client Earth and WWF - in their Blue Manifesto in 2015. The Manifesto urged the Commission to apply the precautionary and polluter pays principles to emerging Blue Growth sectors such as seabed mining, and to pursue a zero-waste circular economy based on renewable resources in order to avoid reliance on deep sea mining.

In 2015, the DSCC (of which SAR is a Steering Group member), issued a position statement stressing the need to fully consider alternatives deep seabed mining, such as a truly circular economy incorporating recycling, more efficient resource usage and reuse. Before any kind of deep seabed mining does occur, there must be a robust set of regulations in place that include:

- Clear conservation and management objectives;
- Transparent and enforceable procedures including access to information, public participation, and review procedures;
- Requirements based on the precautionary and ecosystem approaches and the polluter pays principle;
- Comprehensive baseline information on deep-sea ecosystems potentially impacted by mining;
- Publicly available and comprehensive environmental impact assessments and strategic impact assessments; subject to a robust review process involving independent scientists and stakeholders, and a transparent process to establish a management regime;
- A liability and redress regime;
- Establishment of a network of representative Marine Protected Areas;
- Strategic (regional) environmental management plans at appropriate bioregional scales; and
- An effective monitoring and control regime.

Also in 2015, 11 scientists published a policy paper[12] in Science magazine calling for a temporary halt to new licencing until more can be ascertained about the effects of DSM, while over 700,000 citizens signed a petition urging the ISA to discontinue deep-sea exploration permits and to initiate a moratorium on deep-sea mining until effective regulations are in place.

All this underlines the keen global interest in the deliberations of the ISA, in the involvement and policy initiatives of the EU, as well as in ensuring proper stewardship in the 'common heritage of humankind' that is the deep ocean.

[12] L. M. Wedding et al. (2015), Managing mining of the deep seabed, Science Vol 349

Questions we would like to address in the conference

The need for deep sea mining

1. Given future demand for raw materials: will deep sea mining be essential?

2. How does deep sea mining fit in the EU's aspiration for a circular zero waste economy based on renewables? Can demand for raw materials be managed through the circular economy – i.e. recycling, redesign, repair, reducing planned obsolescence, use of substitute materials.

3. How can we apply the precautionary and polluter pays principles to this new sector?

4. What are the options for future EU policy initiatives?

5. Who would get the benefits and who the impacts - should the sector develop significantly in the near future?

State of play of deep sea mining

1. Does the current international ocean governance framework provide sufficient safeguards?

2. What are the key elements necessary for an environmentally appropriate set of deep-sea mining regulations in light of the current ISA process of drafting exploitation regulations?

3. Can the impacts of deep sea mining be mitigated, and if so how?

4. Where should accountability and liability fall where damage is caused?

5. How can we ensure a network of Marine Protected Areas is established before any form of exploitation takes place?

6. What role does the EU and its member states have within the ISA and which policy initiatives should the EU consider?

7. How effective is stakeholder participation and transparency in the ISA, and how can it be improved?

Annex: Types of mineral of interest to deep sea mining

Source: http://www.savethehighseas.org/deep-sea-mining/

There are currently three types of mineral of interest to prospectors in the deep ocean:

Polymetallic manganese nodules

Manganese nodules are mineral precipitates of manganese and iron oxides. The most commercially interesting ones occur over extensive areas of abyssal plains at depths of 3,500–5,500 meters and grow extremely slowly –5-10 mm every million years. Nodules contain nickel, copper, zinc and cobalt, as well as traces of other metals (notably Rare Earth Elements) that are important to high-tech industries.

Various forms of mineral extraction are being considered for full-scale operations, but many are variants on the hydraulic suction system. Hydraulic suction mining vacuums up the nodules for transfer to the mining vessel and a second pipe may then return sediments, wastes and other effluent to the seabed.

The nodules currently provide a substrate for a variety of suspension feeders and other organisms that are wholly dependent on nodules for their survival. Furthermore, the sediments in and on which the nodules are found host organisms that live on or just below the sediment surface These nodule and sediment communities are known to differ greatly between areas. Areas from which nodules have been removed recover very slowly, if at all, and it is not clear that the original sediment-hosted communities return. The nodule communities cannot return in the absence of their required hard substrata. Little is known about the spatial and temporal requirements for the survival of these communities.[13]

Mining of manganese nodules would occur over large areas and it is possible that all living organisms on the affected seafloor and below the seabed would be destroyed, with adverse impacts spreading to the surrounding areas through sediment plumes. This habitat is poorly adapted to cope with disturbance. Experiments carried out in the Peru basin and the Clarion Clipperton Zone in the Southwest Pacific found that even though mobile species may return after mining disturbance has ended, sessile species do not recover.[14]

Under current mining scenarios, this process represents a major environmental impact.

Cobalt-rich ferromanganese crusts

Cobalt-rich ferromanganese oxides precipitate onto rock surfaces in the deep ocean that are free of sediment (mainly seamounts). Layers build at such a slow rate that it takes one million years for a crust to grow between 1 and 5 mm, less than the thickness of an iPhone. This is one of the slowest natural processes on Earth.

Crusts of economic interest occur at depths of 800–2,500 m on seamounts, mainly in the Pacific Ocean.

[13] 3. http://www.eu-midas.net/science/nodules
[14] Kaneko et al., 1997; ISA, 1999; Thiel et al., 2001; Bluhm, 2001

Technologically, the mining of cobalt crusts is more complex than manganese nodules. Cobalt-rich crust mining involves the removal of the top layer of crust on the summits of a seamount to a depth of 25 cm (or c. 25 million years' worth of growth). This is home to a wide variety of taxa including sessile species, such as corals and sponges, and the other species associated with them.

As yet there is no leading technology for cobalt-rich crust mining, but one method under consideration involves a bottom crawling vehicle, attached to a surface vessel, using articulated cutters to fragment the crusts. Others envisage water-jet stripping, chemical leaching or sonic separation of crusts from rock.[15]

In addition to the destruction of fauna involved in removing the top layer of crust, sediment plumes are likely to affect suspension feeders, such as sponges and corals, downslope of the mine site.

Many seamounts are larger than some mountains on land, with some dwarfing Mount Everest. They alter current flow, which results in eddies and upwelling, which may increase local biological productivity. The seamounts support complex ecosystems from their surface to their base. They are also known to be a stopping point for migratory species, which use them as the equivalent of a motorway rest station.

Any disturbance to such a finely-balanced and slow-growing ecosystem is of concern, but the sheer scale of the mining envisaged could be sufficient to tip entire ecosystems into danger. Many seamounts have already been damaged by bottom trawling and thus have lower resilience and greater need of protection from further damage.

Very few seamounts are alike and all possess considerable heterogeneity, leading to great biological variety. However, seamounts are very poorly sampled and genetic studies of connectivity show a variety of patterns depending on the taxon studied. Recent data have highlighted that the degree of knowledge decreases very markedly with increasing depth. The level of knowledge of seamount ecosystems at depths at which cobalt crusts may be mined is extremely limited.[16]

Polymetallic sulphides

Deep sea hydrothermal vents – now thought to be the cradle for all life on Earth – are found along mid-ocean ridges and back-arc basins and support some of the most unique ecological communities known to science. Called "black-smoker complexes" (although the colour varies with mineral content and can be white or grey or yellow), the vents are outgrowths into the water column of minerals leached from the subsurface reservoirs by super-heated seawater. Venting producing these minerals tend to occur in certain seismically active areas, such as where tectonic plates are converging or diverging.

Certain organisms at vent sites do not derive their energy from light, but rather from sulphide chemicals in hot (350^{o}C) mineralised vent fluids. Many are unlike any other life form on the planet. Most species discovered at vents are new to science, and the vents support communities with extremely high biomass relative to other deep sea habitats.

The first commercial operator to explore for polymetallic sulphide deposits is Nautilus Minerals, which has commenced exploration in the exclusive economic zones (an area surrounding coastal nations, stretching out 200 nautical miles or 370 kilometers) of Papua New Guinea, Fiji and Tonga (covering an area roughly the size of the UK). This has been negotiated outside the auspices of the International Seabed Authority (ISA), directly with the national governments of the respective countries. For this work, Nautilus has developed a huge robotic machine called the "bulk cutter", which weighs 310 tons (the equivalent of over 40 London buses) and is roughly the size of a medium-sized house. Although mining systems are still in

[15] https://www.isa.org.jm/files/documents/EN/Brochures/ENG9.pdf
[16] Ecorys (2014), Study to investigate the state of knowledge of deep sea mining

development, they seem likely to be based around continuous-recovery systems using rotating cutter heads.[17]

Mining of hydrothermal vents would destroy an extensive area of habitat, including thousands of vent chimneys, killing virtually all of the attached organisms. While more sea life is known to be attached to active hydrothermal vents, even the destruction of inactive hydrothermal vents will entail widespread habitat removal and destruction of species. The extent of the impacts to vents and other seafloor habitats mined will inevitably be severe. Mining is also expected to alter venting occurrence and frequency where active hydrothermal vents are being mined or in the vicinity, as well as characteristics of surrounding seafloor areas, affecting ecological communities beyond the mining point. Some of the life forms destroyed may well be endemic, meaning that mining may destroy species before they are even catalogued.

The uniqueness and fragility of this geographically fragmented ecosystem is of interest to scientists, is a potential source of new life-saving medicines, and may hold many secrets about evolution and adaptation of life on Earth.

[17] https://www.isa.org.jm/files/documents/EN/Brochures/ENG8.pdf Back to Text

SEAS AT RISK

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