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## The Current State of Global Activities Related to Deep-sea Mineral Exploration and Mining

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### SUMMARY

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Deep-sea mining is seen as a potential way to provide future secure metal supply to global markets. The current rush to the seafloor in areas beyond national jurisdiction indicates that sound knowledge of the geological characteristics of the various commodities, a realistic resource assessment, and a social and political discussion about the cons and pros of their exploitation that is based on facts, not myths, is required. This contribution provides the most recent information on global deep-sea mineral resources and sets the stage for detailed talks in this session.

## Introduction

Earth provides natural resources such as minerals and metals that are vital for human life. At present almost all of these resources are mined on land with large highgrade deposits becoming more and more difficult to find, driving industry to lower-grade sites where mining has greater environmental impacts, or to greater depth. At the same time, the global demand for metals is suspected to rise further due to steady population growth, expected to reach 9.7 billion by the year 2050 (United Nations 2015), and economic growth of countries such as China and India. The population growth may cause increasing land-use conflicts between the mining industry and the need to feed and house the growing population. In addition to the rising demand for metals, geo-political issues can also limit the availability of metal resources. Possible risks of increasing resource supply shortages for certain metals moved a number of countries to look for ways to ensure secure supplies of these critical metals including mining of marine mineral resources (US Department of Energy 2011; European Commission 2014).

## Recent Trends in Marine Mineral Resources

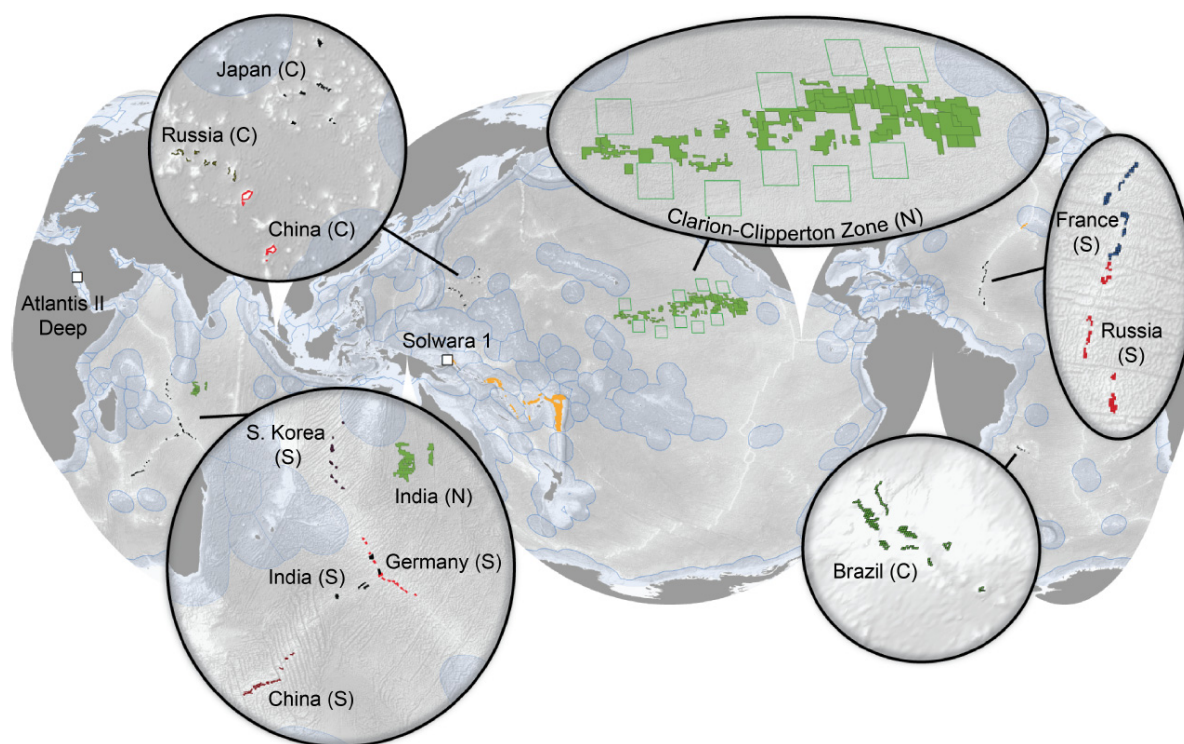
The past few years saw a surge in the interest for deepsea marine mineral resources resulting in increased exploration activities by governments and commercial entities in international waters (the 'Area'). The International Seabed Authority (Jamaica), who is responsible for managing resource-related activities in international waters, so far issued 27 contracts for exploration of deep-sea mineral resources. Of these, 17 are related to manganese nodules, 6 to massive sulfides, and 4 to ferromanganese crusts. For manganese nodules 9 applications covering close to 1.2 million km<sup>2</sup> were approved since 2011. Private companies sponsored by individual states submitted all these applications. On the contrary, government bodies largely drive exploration activity for massive sulfides and ferromanganese crusts. Applications for exploration of massive sulfides (10,000 km<sup>2</sup> each) cover areas in the Atlantic and the Indic and were all approved within the last 4 years. The latest addition to exploration activities in the 'Area' targets ferromanganese crusts. Here, 4 applications totalling 12,000 km<sup>2</sup> were approved within the past 2 years. It should be noted that all contracts are exploration licenses, granted for a period of 15 years, and are subject to relinquishments over time. Regulations for deep-sea mining have not been released, despite the fact that the 6 earliest contracts for manganese nodules will expire in 2016. At this time the contractors have to decide whether they want to start mining or extend the exploration contract for another 5 years if justifications warrant that extension.

While there are only exploration licenses in the 'Area', two deep-sea mining licenses have been issued by national governments, both for massive sulfides within exclusive economic zones (EEZ). The government of Papua New Guinea granted a license to *Nautilus Minerals Inc.* in 2011 (Solwara-1 project in the Bismarck Sea) and the governments of Saudi Arabia and Sudan granted a 30-year mining license to *Diamondfields International* in 2010 for the Atlantis II project in the Red Sea. At both projects mining has not yet started. Whether deep-sea mining will become viable in the future depends to a large extent on the ability to develop mining systems capable of efficient, reliable operation in deep-sea environments. Recently the European Commission started a 10 million € project ('BLUE MINING') to help overcome technological barriers in exploration, resource assessment, and exploitation while at the same time funding the similar-sized 'MIDAS'-project to look at potential impacts of mining activities. There are also some strong national exploration programs, namely by Japan, Korea, and France within the EEZ of countries in the western Pacific. Most Pacific Island States regard deep-sea mining as a potential way to generate revenue and are therefore interested to establish regulations and governance structures for deepsea mining.

At the same time as interest in deep-sea mining is taking off, a number of shallow-water mining applications (for phosphorites and iron sands) have been rejected recently for environmental reasons. This clearly shows that environmental concerns play a critical role in any future deep-sea mining activities and need to be addressed from the very beginning.

## Exploration Constraints

Marine minerals such as manganese nodules, Co-rich ferromanganese crusts, and seafloor massive sulfides are commonly seen as possible future resources that could potentially supply the world with raw materials demanded by a growing world population. At present, a proper assessment of these resources is not possible due to a severe lack of information regarding their size, distribution, and composition. It is clear, however, that manganese nodules and Co-rich ferromanganese crusts are a vast resource and mining them could have a profound impact on global metal markets, whereas the global resource potential of seafloor massive sulfides appears to be small. These three deep-sea mineral commodities are formed by very different geological processes resulting in deposits with distinctly different distribution, tonnage, shape, metal contents, and grades. These geological boundary conditions also determine the size of any future mining operations and the area that will be affected by mining. The sizes of the most favorable areas that need to be explored for a proper global resource assessment are also dependent on the geological environment. The most favorable areas are very large for manganese nodules (38 million km<sup>2</sup>), whereas those for Co-rich crusts (1.7 million km<sup>2</sup>) and massive sulfides near spreading axes (3.2 million km<sup>2</sup>) are much smaller (Petersen et al., 2016). Moreover, different commodities are more abundant in some jurisdictions than in others. While only 19 % of the favorable area for manganese nodules lies within the Exclusive Economic Zone of coastal states or is covered by proposals for the extension of the continental shelf, 42 % of the favorable areas for massive sulfides and 54 % for Co-rich crusts are located in EEZs.



**Figure 1** Locations of global exploration licenses for manganese nodules (N), Co-rich ferromanganese crusts (C) and seafloor massive sulfides (S for licenses within “the Area”, orange for licenses within EEZs). The locations of the only two deep-sea mining licenses (Atlantis II Deep in the Red Sea and Solwara 1 in Papua New Guinea) are indicated by the white squares. The location of the “Areas of Particular Environmental Interest” (size of 400km by 400 km each) in the CCZ is provided as rectangles with a green outline.

## Conclusions

Despite the current decline in metal prices and exploration spending deep-sea mining may have the potential to provide a secure metal supply for the future. Over the past few years the interest in deep-sea minerals has been growing resulting in staking of large areas of the seafloor for exploration purposes not only by government bodies, but also from private companies. At the same time some mineral mining projects in shallow water have been proposed and were rejected for environmental issues. As deep-sea mining is not yet occurring, the process of defining the mining regulations by the ISA provides the opportunity for NGOs and scientists to contribute and shape the regulations before mining actually starts. Comprehensive environmental impact assessment, mitigation strategies, baseline studies, as well as long-term monitoring need to be implemented into the regulations not only in order to do it right, but also to get the social license to mine.

## References

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