Review Article

Potential risks of developing countries in the process of exploration and extraction of deep-sea mineral resources

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Abstract: Deep sea mining involves the extraction of minerals from the ocean floor. As deep sea mining is a relatively new practice, there is still much to be learned about the technology and the potential risks associated with it by the developing countries. Developing states must ensure that proper safety measures are in place to prevent accidents and minimize the risk of environmental damage. While the potential benefits of deep sea mining are significant, it is essential to ensure that the process is carried out responsibly and sustainably to protect both the environment and local communities. Developing countries face numerous challenges when it comes to actively participating in deep-sea exploration. Some of these challenges include a lack of adequate resources, limited technological capabilities, and limited access to funding. Additionally, developing countries often lack the necessary legal frameworks and regulatory systems to effectively regulate deep-sea exploration, licensing and extraction activities, especially within the continental shelves and the Exclusive Economic Zones (EEZ). These challenges can make it difficult for developing countries to fully participate in this important area of scientific research for a sustainable blue economy. This paper suggests an effective partnership between oceanographic research institutes from developing countries with research institutes from countries like France, Germany, UK, Belgium, Netherlands, China and International seabed Authority (ISA) in deep sea marine scientific research. The paper identifies the need for a joint collaboration for the purpose of acquiring reliable data on the seabed topography, location, shape, coverage, and abundance of deep-sea mineral resources in the continental shelves, exclusive economic zones of developing countries, and area beyond the national jurisdiction. There is also a need to develop legal framework on deep sea policy for sustainable actualization of developing nations' blue economy.

Keywords: deep sea mining; potential risks; limited technology; developing countries; blue economy

1. Introduction

Deep sea mining (DSM) is the process of retrieving mineral deposits from an area more than 200 metres below sea level referred to as the deep-sea floor. It covers more than 60% of the planet and harbours a rich marine biodiversity that are still relatively unknown to science. It also accommodates unique geological features, such as mountain ranges, plateaus, volcanic peaks, canyons, vast abyssal plains and the Mariana Trench, which is the greatest depth registered in the ocean[1].

The main objective of the DSM code is regulating the exploitation and development of mineral resources, which are the "common heritage of mankind[2]. Thirty exploration permits, covering 1.3 million km^2 of "the area" had been issued by the Authority in the form of contracts, which indicated the specific rights and obligations to the establishments undertaking those activities[3].

Signing a contract for exploration license by companies or establishments within the area beyond national jurisdiction requires the support of International seabed Authority (ISA) member of which the company is a national (article 4, of Annex III to the Convention). The supporting country will therefore acts in the role of "sponsoring state". The sponsoring state takes all required steps and ensured adequate agreements with the

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contractual terms, rules and obligations from the convention. Among these obligations is the protection of the human life and marine environments and ecosystems[4]. Inability to abide by these obligations is an indication that the sponsoring states are liable for any damage that may happened due to lack of adherence to the stipulations. As at the time of writing this article there are no commercial mining processes in the 'Area', despite the fact that deep sea minerals have been highlighted to be a potential contribution to the blue economy since over sixty years ago (precisely 1960). The deep sea mining took several years to develop based on limited technology, dilemma from the cost-benefit and the risk from the high cost of investments, and the environmental impact of deep sea mining to the chemosynthetic communities[5]. Moreover, the developing countries are lagging behind in the exploration of deep sea minerals within their respective exclusive economic zones and the Area beyond National Jurisdiction, based on lack of funding and adequate technology.

This article aims to identify the potential risks faced by developing countries in the process of exploration and extraction of deep-sea mineral resources, and the possible solutions to abating these risks.

2. Risks for developing states of sponsoring Deep Sea Mining

A developing country is a sovereign state with a less developed industrial base and a low Human Development Index (HDI) relative to other countries. These have been grouped into least developed countries and landlocked developing countries[6] .

Each group is composed of: Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Djibouti, Ethiopia, Guinea, Guinea-Bissau, Haiti, Kiribati, Lao People's Democratic Republic, Lesotho, Eritrea, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Nigeria, Congo, Rwanda, Gambia, Sao Tome and Principe, Senegal, Sierra Leone, Solomon Islands, Somalia, South Sudan, Sudan, South Africa, Timor-Leste, Togo, Uganda, United Republic of Tanzania, Yemen, Tuvalu and Zambia.

Mining the deep seabed for minerals in different habitats, such as the abyssal plains-hosted polymetallic nodules (PMN), hydrothermal vents-triggered seafloor massive sulfides (SMS), and seamounts-hosted cobalt rich crust (CRC), has been planned[7] Active interest in DSM from various governments and companies within the Area beyond national jurisdictions, continental shelves and exclusive economic zones (EEZ) increased in 1970[8].

Small Island Developing States (SIDS) share related challenges and sustainable developmental needs. These include small but growing populations, limited resources, remoteness, susceptibility to natural disasters, vulnerability to external shocks, excessive dependence on international trade, and fragile environments[9] Among the Small Island Developing States within the Atlantic, Indian Ocean and South China Sea are: Bahrain, Cape Verde, Sao Tome and Principe, Mauritius, Seychelle and Singapore. Within the Carribbean are: Belize, Dominican Republic, Cuba, Brabados, Guyana, Haiti, Jamaica, Trindad and Tobago. Whereas, the Pacific SIDS are: Kribati, Fiji, Tonga, Tuvalu and Nauru.

The developing states which covers least developing countries (LDCs), landlocked developing countries (LLDCs) and Small Island developing states (SIDS) faces a lot of challenges and risk in the sponsoring of deep sea mining.

3. Applied methodology on exploration and exploitation of deep sea minerals and the knowledge gap

Deep-sea extends from the tail end of the continental shelf, at over 200 m depth. The deep-sea resources, can be described as the raw materials resources that are rich in critical metals (Ag, Au, Zn, Sb, Se, Co, Te, Nd, Cu, Mn, Pt, Li, Ni and rare earth metals (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu), Sc, and Y). These deep sea resources are majorly polymetallic sulfides, polymetallic nodules and Cobalt rich crust[5]. Other resources are the biological and genetic resources that are essential for cosmetic, biotechnology and pharmaceutical industry with various applications in medicine and chemical industries. The critical and rare earth metals are essential for hybrid automobiles and electric vehicles (EVs), powered batteries, solar panels, mobile phones and laptops, high tech industries, renewable energy; and their ability to enhance zero-carbon circular economy. They are useful raw materials that can be used to decarbonize the transportation sector, thereby, triggering equitable global and clean-energy manufacturing industries and enhance the blue economy.

The first stage of exploration is the reconnaissance surveying, this is conducted to locate deep sea minerals, it involves sampling and assessment of deep sea mineral resources[10]. The second stage includes planning and evaluation of mineral resources[5].

The former requires the use of echo sounders, side scan sonar systems, seabed acoustic survey, optical survey, underwater video and camera (UVC) on deep-tow system, multi-beam echo sounding or swath bathymetry device, grabs and corers such as Freefell grab, TV grabs, push cores, piston corer, box corer, gravity corers and dredge sampling. Others are the remotely operated vehicle (ROV), and autonomous underwater vehicle (AUV). These equipment can give a reliable information on the seabed topographic map, water depth, location, shape, coverage, and abundance of deep-sea mineral resources[11]. The latter includes the feasibility studies on the possible extraction of the deep sea mineral resources.

There are four essential components to a deep sea exploitation, (i) Extraction process (ii) Lifting process (iii) surface platform and (iv), a disposal process[12] This stage includes the excavation and transportation of deep sea mineral deposits and its processes. Other includes processes of deep- sea mineral’s distributions and sales, economic and profit sharing, site closure and remediation processes.

The major knowledge gap of developing nations includes access to the above exploration and exploitation technologies that can enable her to estimate the actual concentrations and size of the mineral resources within their respective EEZ, and the Area beyond National Jurisdiction. The uncertainty in the estimation of the resource concentrations and the lack of financial and technical capacity will distract investors in deep sea mineral resources.

Other challenges of developing nations is in the form of the high expenditures to conduct research cruises, and the inability to acquire fast and efficient technology such as the aforementioned autonomous underwater vehicle. AUV is an unmanned, underwater vehicle that conducts its operation with little or no human supervision[11]. It has the ability to carry small equipment such as acoustic, optical, physical and chemical sensors for marine seabed resources and scientific surveys[13]. This is why developing countries has to partner with developed countries in the seabed exploration and mineral extraction research to map the seafloor or characterize the physical, chemical, or biological properties of the water-column within its Exclusive Economic zones and continental shelves. Some of this AUV can go as far as 6000 meters and are owned majorly by research institutes such as Woods Hole Oceanographic Institution and Monterey Bay Aquarium Research Institute USA (Sentry and REMUS 6000), China Ocean Mineral Resources R&D Association (Qianlong-1), National Oceanographic Center UK (Autosub 6000) and GEOMAR Helmholtz Centre for Ocean Research Kiel in Germany (ABYSS)[14].

There is a need for partnership between Oceanographic research institutes from developing countries especially Africa with research institutes from developed countries like France, Germany, UK, Belgium and Netherlands, in deep-sea marine research and joint collaborations in our Exclusive Economic zones. There is also a need to develop our legal framework on deep sea policy. Partnership with the International Seabed Authority (ISA) is another essential needs, because ISA has recently flagged a project termed 'AREA 2030' in collaboration with the International Hydrographic Organization (IHO) on high-resolution mapping of the international seabed area (the Area) by the year 2030.

The joint Sino-Nigerian scientific oceanographic cruise between the Nigerian Institute for Oceanography and marine research (NIOMR) and the Chinese institute of oceanography into the Atlantic Ocean in August, 2012, 'using Dayang Yi Hao' Oceanographic vessels enabled a thorough oceanographic survey, chemical compositions of the waters and sediments of the Nigeria continental waters to be understood. It opened more opportunities for Nigeria and China to work together in scientific research particularly, physical, chemical and geological oceanography.

Other notable benefit of the joint oceanographic cruise includes the observed micro-nodules (**Figure 1**) recovered from some sediment cores collected from the slope of the Eastern Equatorial Atlantic (EEA) offshore, Nigeria at water depth of approximately 3000 m)[15].

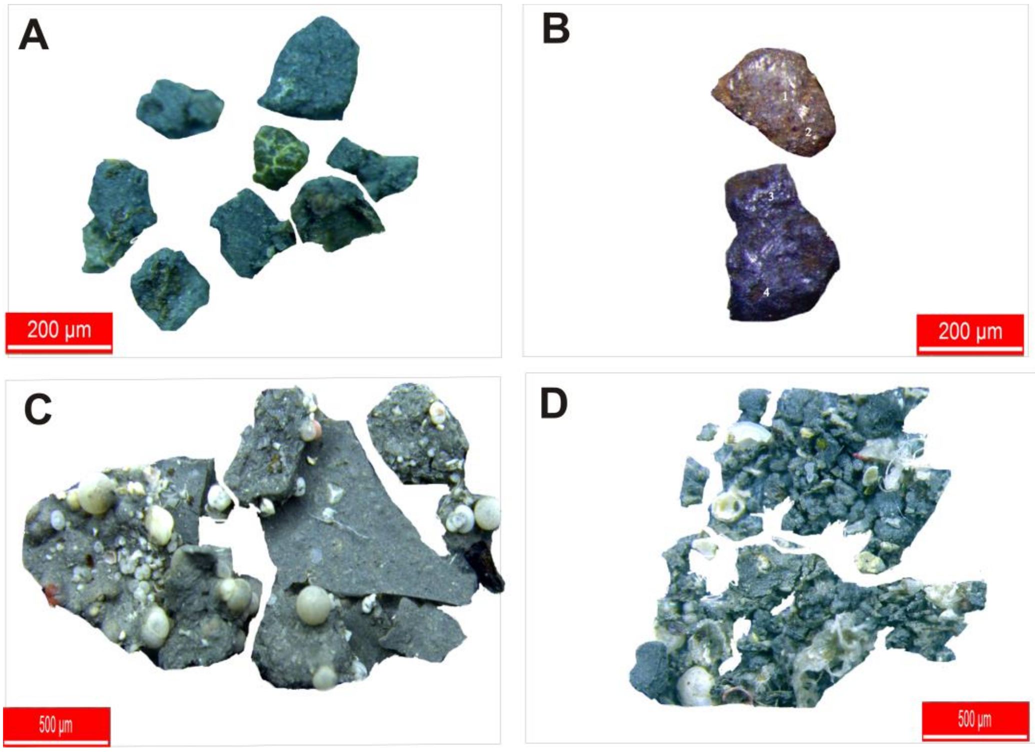

Figure 1. The recovered micro-nodule from sediment core DY26III-Nig-S60-GC2, in the western Nigerian continental margin.

Generally, the potential risks of developing countries in the process of exploration and extraction of deep-sea mineral resources are summarized below:

1) Technological setbacks and difficult international negotiations
2) The limited availability of technology
3) The cost–benefit dilemma which makes the high-cost investments
4) Lack of general knowledge of deep sea area, marine policy and legal framework
5) The potential and expected environmental impacts
6) Inadequate research and development
7) Incapacitated marine and maritime agencies and institutions
8) Lack of sound maritime regulatory framework
9) Limited access to funding

4. The role of international seabed authority in capacity development of developing states

The International Seabed Authority (ISA) is an intergovernmental body based in Kingston, Jamaica. ISA was established to organize, regulate and control all mineral-related activities in the international seabed area beyond the limits of national jurisdiction[16]. ISA was established on the 16th November, 1994, upon the 1982 United Nations Convention on the Law of the Sea.

ISA has been carrying out capacity-building programmes since its establishment in 1994. The ISA Capacity-building/development programmes and activities are: Contractors Training Programme (CTP), Endowment Fund for Marine Scientific Research (MSR), Internships, information workshops, Voluntary Commitments, Joint training Center[17]. Others includes African Deep Sea Resources Project (ADSR)[18], and Women in Deep sea research project.

The African Deep-Sea Research (ADSR) Project is implemented by International Seabed Authority (ISA) in partnership with the African Union (AU) and Norwegian Agency for Development Cooperation (NORAD). Activities are undertaken in close cooperation with States parties to United Nations Convention on the Law of the Sea (UNCLOS), relevant international and regional organizations and experts. They also represent a unique opportunity for decision-makers and experts to discuss strategies that could help African States to build necessary capacities to benefit from their Blue Economies, particularly about increased participation of African States in deep seabed activities undertaken in the Area. As a beneficiary of ADSR project, I was able to understand the overview of the reserved areas, the mining code and the legal regime for the protection and preservation of the environment under the mining code, the roles and mandate of ISA with respect to capacity-building, the marine scientific research and biodiversity in the Area beyond national jurisdiction, and increased knowledge on policy and legal frameworks of the Area beyond national jurisdiction. Other capacity building experience includes enhanced knowledge about the environmental management in relation to activities in the Area beyond national jurisdiction, the formation, occurrence and variety seabed minerals. Additionally, I was privileged to use ISA facilities, and took part in the ISA 26th session of the Assembly (**Figure 2**).

Figure 2. ADSR Experts (L-R): Mr. Gerald Mwila (Zambia), Dr. Samuel Popoola (Nigeria) and Mr. Godwin Dimike (Nigeria).

The aforementioned ISA capacity development programs have enabled the transfer of knowledge and technology to developing States through theoretical and practical lectures on deep-sea topics such as mineral resources, marine biodiversity and environmental protection, deep sea technology, marine imaging and sea training on board marine vessels. These trainings have really developed the capacity of developing countries in the deep sea research, and will further enhance the active participation of developing countries in deep sea mining and deep sea scientific research for a sustainable. Blue economy.

5. Conclusions

Prevalent issues such as lack of financial support, inadequate modern technologies, inadequate marine scientific research, and lack of endowment fund for marine scientific research have undermined and derailed the deep seabed exploration efforts in the developing nations within her continental shelves, exclusive economic zones and ability to apply for exploration license in the Area beyond national jurisdiction. There is a need for functioning laboratories in the developing countries, collaborations with developed countries in marine scientific research. There is a need for developing countries to partner with developed countries and ISA in the application of exploration license in the Area Beyond national jurisdiction. More trainings and capacity development programs are needed on deep sea technology and its application towards explorations of the reserved areas. The oil and gas industries in the developing countries have developed drilling techniques up to 2000 m, there is a need to take a leap from them for adequate utilizations of the continental shelves resources in the developing countries, for a sustainable blue economy.

Conflict of interest

The author declares no conflict of interest.

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