International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 7 Issue 3, May-June 2023 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Deep Sea Mining and the Circular Economy: Opportunities and Challenges

Manish Verma

Scientist D, DMSRDE, DRDO, Kanpur, Uttar Pradesh, India

ABSTRACT

Deep Sea mining has the potential to play a significant role in the circular economy, which aims to minimize waste and maximize resource efficiency by reusing and recycling materials. By extracting valuable minerals from the ocean, deep-sea mining can reduce the reliance on non-renewable resources and support the development of a more sustainable and circular economy. Also, there are significant challenges associated with integrating deep-sea mining into the circular economy. For example, the recovery of minerals from the ocean floor can generate significant amounts of waste and create new environmental risks. Additionally, there may be concerns about the social and economic impacts of deep-sea mining on coastal communities, particularly those that depend on traditional fishing or tourism activities. The bottom of the ocean bed is rich in cobalt-rich crusts, polymetallic nodules, polymetallic sulfides, and rare earth-rich sediments. There are wide deep-sea reserves of Ni, Co, Mn, etc. To maximize the opportunities and minimize the challenges associated with deep-sea mining and the circular economy, it is important to develop robust regulatory frameworks that prioritize sustainability and social responsibility. This may include measures such as environmental impact assessments, community engagement and consultation, and the establishment of protected areas to preserve vulnerable ocean ecosystems. This paper discusses the various aspects of deep-sea mining skillfully.

How to cite this paper: Manish Verma "Deep Sea Mining and the Circular Economy: Opportunities and Challenges" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-7 | Issue-3, June 2023, pp.21-27, URL: www.ijtsrd.com/papers/ijtsrd56278.pdf

IJTSRD56278

KEYWORDS*: Deep Sea mining, circular economy, deep-sea reserves, minerals, ChatGPT*

I. INTRODUCTION

Deep sea mining refers to the extraction of minerals and resources from the ocean floor at depths of 200 meters or more. The environment of deep-sea mining is extremely harsh and unique, with high pressure, darkness, and extreme cold being some of the major challenges. Here are some of the key characteristics of the environment of deep-sea mining:[1-10]

High Pressure: At depths of 200 meters or more, the pressure is immense, with pressures up to 1,000 times greater than at the surface. This high pressure can make it difficult to extract minerals and resources, and can also make it difficult to design equipment that can withstand the pressure.

Darkness: At these depths, there is no light, which makes it difficult for mining operations to navigate and find the resources they are looking for.

Extreme Cold: The deep sea is very cold, with temperatures ranging from -1 to 4 degrees Celsius. This can be a challenge for mining equipment, which needs to be designed to withstand these extreme temperatures.

Unique Ecosystems: The deep sea is home to a variety of unique and fragile ecosystems, which can be disrupted by mining operations. Mining companies need to be careful to minimize their impact on these ecosystems.

Limited Knowledge: The deep sea is still relatively unexplored and little is known about the ecosystems and resources that exist at these depths. This makes it difficult to fully understand the environmental impacts of mining operations and to develop effective regulations and guidelines for deep-sea mining.

Overall, the environment of deep-sea mining is a challenging and complex one, and careful consideration must be given to the environmental impacts of mining operations to ensure that they are conducted responsibly and sustainably.

II. ChatGPT Chatbot and its features

As an AI-based chatbot, ChatGPT is designed to engage in conversations with users and provide helpful responses to their queries. Here are some of the features and capabilities of ChatGPT:

Natural Language Processing (NLP): ChatGPT is built using advanced NLP algorithms that enable it to understand and interpret human language, including nuances and idiomatic expressions.

Contextual awareness: ChatGPT can maintain context across conversations, which means it can understand and respond appropriately to follow-up questions or statements.

Broad knowledge base: ChatGPT has access to a vast amount of information and knowledge from various sources, which allows it to provide accurate and helpful responses to a wide range of queries.

Multilingual support: ChatGPT can engage in conversations in multiple languages, making it a useful tool for users from different parts of the world.

Personalization: ChatGPT can learn from previous interactions with users and personalize its responses based on their preferences and interests 24x7.

Overall, ChatGPT is a highly sophisticated and intelligent chatbot that can provide valuable assistance and support to users on a wide range of topics. [10-12]

III. The risks associated with marine oceans

Here are many risks associated with marine oceans:

Climate Change: Rising sea levels, increasing temperatures, and ocean acidification are some of the major risks associated with climate change. These can have significant impacts on marine ecosystems, leading to the loss of biodiversity and changes in ocean currents and weather patterns.

Overfishing: Overfishing can deplete fish populations and disrupt entire marine ecosystems, causing imbalances in food webs and reducing biodiversity.

Plastic Pollution: Plastic waste has become a major problem in the ocean, with millions of tons of plastic ending up in the ocean every year. This can harm marine life and damage ecosystems, as well as impact human health through the food chain.

Habitat Destruction: Human activities such as mining, dredging, and construction can destroy habitats such as coral reefs and seagrass beds, leading to the loss of biodiversity and damaging the ability of the ocean to provide important ecosystem services.

Invasive Species: Invasive species can be introduced to marine ecosystems through ballast water, fishing gear, or other means, and can have significant impacts on native species and ecosystems.

Oil Spills: Oil spills can have devastating impacts on marine ecosystems, killing wildlife and damaging habitats for years or even decades after the spill occurs.

Ocean Noise: Anthropogenic noise from activities such as shipping, sonar, and oil exploration can disrupt the behavior and communication of marine animals, leading to negative impacts on their survival and reproduction.

Marine Debris: Debris such as abandoned fishing gear, plastic, and other materials can entangle and harm marine wildlife, as well as damage habitats and impact marine ecosystems.

Harmful Algal Blooms: Some types of algae can produce toxins that can harm marine life and humans, leading to illness or even death in some cases.

Ocean Warming: As the ocean warms, it can cause shifts in marine ecosystems and alter the distribution and behavior of marine species. This can have significant impacts on the functioning of the ocean and the services it provides to humans.

IV. The Ways to Minimize the Impact of deep-sea mining on the Environment

Here are a few ways to minimize the impact of deep-sea mining on the environment:

Implement Regulations: Governments can implement regulations and guidelines to ensure that deep-sea mining operations are conducted responsibly and sustainably. These regulations should take into account the potential environmental impacts of mining and require companies to take measures to minimize their impact on the environment.

Conduct Environmental Assessments: Mining companies should conduct thorough environmental assessments before beginning operations. These assessments should identify potential environmental impacts and provide recommendations for minimizing these impacts.

Use Sustainable Mining Techniques: Companies can use sustainable mining techniques that minimize the amount of waste generated and reduce the impact of mining on marine ecosystems. For example, using remotely operated vehicles (ROVs) to collect minerals can reduce the need for large mining vessels that can damage the seafloor.

Reduce Noise Pollution: Mining companies should take steps to reduce noise pollution from mining operations, which can have negative impacts on marine life. This can be done by using quieter equipment and avoiding sensitive areas during certain times of the year.

Protect Sensitive Areas: Companies should avoid mining in sensitive areas such as coral reefs, seagrass beds, and other important habitats. If mining is necessary in these areas, companies should take measures to minimize their impact on the environment.

Monitor Impacts: Mining companies should conduct regular monitoring to assess the impact of their operations on the environment. This can help to identify potential problems early and allow for corrective action to be taken.

Implement Restoration Plans: If mining does cause damage to marine ecosystems, companies should implement restoration plans to restore habitats and minimize the long-term impact of mining operations.

V. Regulation deep sea mining from above

Here are a few suggestions for regulations for deep-sea mining:

International Regulations: The United Nations Convention on the Law of the Sea (UNCLOS) provides the legal framework for deep-sea mining in international waters. The International Seabed Authority (ISA) is responsible for regulating mining activities in the international seabed area.

National Regulations: National governments can also implement regulations for deep sea mining within their jurisdictions, including within their exclusive economic zones (EEZs).

Environmental Impact Assessments (EIAs): Companies that wish to conduct deep sea mining operations must conduct EIAs to assess the potential environmental impacts of their activities. These assessments are used to inform regulatory decision-making and identify ways to mitigate any potential negative impacts.

Licensing and Permitting: Companies must obtain licenses and permits from regulatory authorities before conducting deep-sea mining operations. These licenses and permits outline the specific conditions under which mining activities can take place.

Financial Assurance: Companies may be required to provide financial assurance to demonstrate their ability to cover any potential environmental damages or other liabilities resulting from their mining activities.

Transparency: Regulatory frameworks for deep sea mining should prioritize transparency and open communication between mining companies, regulatory authorities, and the public.

Liability: Liability for any potential environmental damages resulting from deep sea mining operations should be clearly defined in regulatory frameworks, and companies should be held responsible for any harm caused by their activities.

Monitoring and Enforcement: Regulatory authorities should implement monitoring and enforcement mechanisms to ensure that mining companies comply with regulations and take appropriate measures to minimize the environmental impacts of their operations.

Adaptive Management: Regulatory frameworks should allow for adaptive management, where regulatory authorities can adjust regulations and permit conditions based on new scientific information or changes in the environment.

Stakeholder Engagement: Regulatory frameworks should prioritize engagement with stakeholders, including local communities, indigenous peoples, and environmental organizations, to ensure that their perspectives and concerns are considered in decision-making processes.

VI. Digital opportunity and job creation in deep sea mining

Here is a few opportunities and job creation potential in deep sea mining:

Economic Growth: Deep Sea mining has the potential to stimulate economic growth, particularly in developing countries that have significant seabed mineral resources. This growth can be driven by increased demand for minerals and associated services, which can generate jobs and income.

Exploration and Surveying: Deep Sea mining requires significant exploration and surveying activities to identify mineral deposits and assess their viability. These activities can create jobs in fields such as geology, oceanography, and marine engineering.

Mining Operations: Deep Sea mining operations require a range of skills and expertise, including mining engineering, environmental management, and logistics. These operations can create a range of direct and indirect job opportunities, including for local communities.

Technology Development: Deep Sea mining requires specialized technology and equipment, which can drive innovation and create opportunities for companies that specialize in these fields. This can include the development of new materials, sensors, and robotics technology.

Supply Chain: Deep Sea mining can create opportunities throughout the supply chain, from mineral extraction and processing to transportation and marketing. This can include jobs in shipping, logistics, and marketing.

Research and Development: Deep Sea mining is a relatively new industry, and ongoing research and development are necessary to improve operational efficiency and reduce environmental impacts. This research can create opportunities for scientists and engineers.

Local Employment: Deep Sea mining operations can create job opportunities for local communities, particularly in areas with high unemployment or limited economic opportunities. These jobs can include roles in logistics, catering, and other support services.

Training and Education: Deep Sea mining requires specialized skills and expertise, and training and education programs can create opportunities for individuals seeking to enter the industry. This can include training in mining engineering, environmental management, and marine biology.

Entrepreneurship: Deep Sea mining can create opportunities for entrepreneurship, particularly in fields such as technology development and supply chain management. This can include opportunities for small and medium-sized enterprises to develop new products and services.

Collaboration: Deep Sea mining is a complex industry that requires collaboration between a range of stakeholders, including governments, mining companies, and local communities. This collaboration can create opportunities for partnerships and knowledge-sharing, which can lead to job creation and economic growth, and a more sustainable energy future.

Artificial intelligence (AI) and machine learning (ML): AI and ML technologies can be used to analyze and interpret data from sensors and other sources to optimize mining processes and increase efficiency. Job roles in this area include AI and ML specialists, software developers, and data analysts. Overall, the adoption of digital technologies in deep sea mining has the potential to create new job opportunities, particularly in areas such as robotics, data management, and AI/ML. However, it is also important to ensure that these technologies are developed and implemented responsibly and sustainably, taking into account the potential environmental and social impacts of deep-sea mining operations.

VII. The STEM fields in the Study of the pros and cons of deep-sea mining:

The study of the pros and cons of deep-sea mining in the STEM fields involves evaluating the potential benefits and drawbacks of deep-sea mining from a scientific and technical perspective. STEM stands for science, technology, engineering, and mathematics, which are all fields that play a critical role in deep-sea mining.

Pros of deep-sea mining from a STEM perspective include:

Access to valuable minerals: The deep sea is believed to contain significant reserves of minerals such as copper, nickel, cobalt, and rare earth metals, which are critical for a range of high-tech industries.

Scientific research: Deep-sea mining operations can provide valuable opportunities for scientific research, particularly in the areas of marine biology, oceanography, and geology.

Technological advancements: The development of new technologies for deep-sea mining can drive innovation and advancements in STEM fields, leading to discoveries and breakthroughs.

Cons of deep-sea mining from a STEM perspective include:

Environmental impacts: Deep-sea mining operations can have significant negative impacts on the marine ecosystem, including disturbance of marine habitats, destruction of marine biodiversity, and alteration of ocean chemistry.

Technical challenges: Deep-sea mining presents significant technical challenges, including working at extreme depths, operating in harsh conditions, and transporting minerals to the surface.

Cost and economic viability: Deep-sea mining operations can be expensive, and it is unclear whether the potential economic benefits will outweigh the costs in the long term.

Overall, the STEM fields play a critical role in understanding the potential benefits and drawbacks of deep-sea mining. While there are potential benefits to accessing valuable minerals and advancing scientific research and technology, it is important to carefully consider the potential environmental impacts and technical challenges associated with deep-sea mining operations. GIS-based suitability analysis can be a useful tool for identifying areas that are most appropriate for deep-sea mining **[13].**

VIII. Merits of Formation of Expert Committee on Regulation of deep-sea mining

Here are some of the merits of the formation of an expert committee on the regulation of deep-sea mining:

Purpose: The expert committee would be formed to provide guidance and recommendations on the development of regulations for deep-sea mining, including environmental protection measures, safety standards, and social and economic impacts.

Composition: The expert committee would be composed of individuals with expertise in fields such as marine biology, oceanography, mining engineering, environmental law, and economics. Members could be drawn from academia, industry, government, and civil society organizations.

Scope: The expert committee's scope of work would include conducting research and analysis on the environmental, social, and economic impacts of deep-sea mining, and developing recommendations for regulations that would ensure the sustainable and responsible management of deep-sea mineral resources.

Methodology: The expert committee would use a collaborative and interdisciplinary approach to develop its recommendations, drawing on the expertise of its members and engaging with stakeholders from a range of sectors.

Reporting: The expert committee would be responsible for producing reports and recommendations on the regulation of deep-sea mining, which would be submitted to relevant government agencies, international organizations, and other stakeholders.

Accountability: The expert committee would be accountable to the relevant government agencies or international organizations that commissioned its work, and would be expected to operate in a transparent and accountable manner.

Follow-up: Once the expert committee has completed its work, its recommendations would need to be reviewed and implemented by relevant government agencies or international organizations, with ongoing monitoring and evaluation to ensure that the regulations are effective and responsive to changing circumstances.

IX. Limitation and the minimize of pollution and negative effects on the deep ocean in respect of mining

Here are some ways to minimize pollution and negative effects on the deep ocean in respect of mining:

Develop and implement strict environmental regulations: Governments and international organizations can develop and enforce strict environmental regulations that ensure responsible and sustainable deep-sea mining practices.

Conduct thorough environmental impact assessments: Before mining operations begin, companies should conduct thorough environmental impact assessments to understand the potential impacts of mining activities on deep-sea ecosystems and develop appropriate mitigation measures.

Develop new technologies: Scientists and engineers can develop new technologies that enable more precise and efficient mining operations, reducing the amount of waste and pollution generated.

Adopt a circular economy approach: Mining companies can adopt a circular economy approach, where materials are recycled and reused rather than discarded, reducing the need for new mining and minimizing waste.

Engage with stakeholders: Governments, mining companies, and other stakeholders can engage in meaningful dialogue with local communities, indigenous groups, and other stakeholders to ensure that their concerns and perspectives are taken into account.

Develop partnerships: Governments, mining companies, and other stakeholders can develop partnerships with conservation organizations, research institutions, and other stakeholders to promote responsible and sustainable deep-sea mining practices.

Monitor and enforce regulations: Governments and international organizations can monitor and enforce environmental regulations to ensure that mining activities are conducted responsibly and sustainably, and take action against companies that violate regulations or cause harm to the environment.

As technology continues to improve and costs come down, these limitations will likely become less significant over time.

X. Applications of Deep-Sea Mining

The applications of deep-sea mining include:

Production of minerals: Deep Sea mining can be used to extract valuable minerals such as copper, nickel, cobalt, and rare earth metals that are used in high-tech industries such as electronics, renewable energy, and electric vehicles. [15-24]

Energy production: The deep sea can be a potential source of renewable energy through the development of technologies such as deep-sea thermal energy conversion and ocean thermal energy conversion.

Scientific research: Deep Sea mining operations can provide opportunities for scientific research in the areas of marine biology, oceanography, and geology.

Underwater infrastructure: The deep sea can be used as a location for the construction of underwater infrastructure such as underwater cables and pipelines for the transport of oil and gas.

Carbon capture and storage: The deep sea can be a potential location for carbon capture and storage, which involves capturing carbon dioxide from industrial sources and storing it in geological formations deep beneath the ocean floor.

Waste disposal: The deep sea can be a potential location for the disposal of waste, including nuclear waste, through the use of deep-sea disposal technology.

Aquaculture: Deep Sea mining operations can also create opportunities for the development of sustainable aquaculture systems that can help to meet global food demands.

In addition to fisheries, PNG is also believed to have significant potential for deep-sea mining. The country's Exclusive Economic Zone (EEZ) covers a vast area of the ocean and is believed to contain valuable mineral deposits, including copper, gold, and silver. The country has already granted exploration licenses for deep sea mining to several companies, and there is interest from others to explore the potential of PNG's ocean resources.

XI. Conclusion

In conclusion, deep-sea mining has the potential to provide valuable mineral resources, but it also poses significant environmental risks. Any expansion of deep-sea mining activities must be carried out responsibly and sustainably, with a focus on minimizing the environmental impact and ensuring that adequate regulatory frameworks are in place to protect the ocean and its ecosystems. GIS-based suitability analysis can be a useful tool for identifying areas that are most suitable for deep-sea mining or other activities. By considering a range of factors that affect suitability, this approach can help to minimize environmental impact and ensure that activities are conducted most responsibly and sustainably as possible. Ultimately, the long-term sustainability of deep sea mining will depend on a collaborative effort between governments, industry, and civil society to establish and enforce robust environmental regulations, monitor and mitigate environmental impacts, and promote responsible mining practices. Only through such efforts can we ensure that deep-sea mining is carried out in a way that benefits society while preserving the health and vitality of our oceans for future generations.

Acknowledgment

We are very thankful to Director DMSRDE, Kanpur for permitting this work.

References

[1] Van Dover, Cindy Lee. "The ecology of deep-sea hydrothermal vents." The Ecology of Deep-Sea Hydrothermal Vents. Princeton University Press, 2021.

[2] Van Dover, Cindy Lee. "Mining seafloor massive sulphides and biodiversity: what is at risk?." ICES Journal of Marine Science 68.2 (2011): 341-348.

[3] Da Ros, Zaira, et al. "The deep sea: the new frontier for ecological restoration." Marine Policy 108 (2019): 103642.

[4] Levin, Lisa A., et al. "Defining “serious harm” to the marine environment in the context of deep-seabed mining." Marine Policy 74 (2016): 245-259.

[5] Brewer, PETER G., J. P. Riley, and G. Skirrow. Chemical oceanography. 1975.

[6] Brewer, Peter G., ed. Oceanography: the present and future. Springer Science & Business Media, 2012.

[7] De Baar, Hein JW, et al. "Rare earth elements in the Pacific and Atlantic Oceans." Geochimica et Cosmochimica Acta 49.9 (1985): 1943-1959.

[8] De Baar, Hein JW, Peter G. Brewer, and Michael P. Bacon. "Anomalies in rare earth distributions in seawater: Gd and Tb." Geochimica et Cosmochimica Acta 49.9 (1985): 1961-1969.

[9] Day, Deborah. "A History of “The Oceans: Their Physics, Chemistry and General Biology”." Scripps Institution of Oceanography Archives (2003): day-oceans.

[10] Anderson, Neil R., et al. "Chemical Oceanographic Research: Present Status and Future Direction." (1972)

[11] Thorp, H. H. (2023). ChatGPT is fun, but not an author. Science, 379(6630), 313-313.

[12] Verma, Manish. (2023). Integration of AI-Based Chatbot (ChatGPT) And Supply Chain Management Solution To Enhance Tracking And Queries Response. *IJSART*, *9*(2), 60–63.

[13] Wolfl et al., Identifying Deep-Sea Target Areas for a Pilot Atlantic Seabed Mapping project using GIS techniques, The Journal of Ocean Technology, Vol. 12, No. 4 2017, 28-42

[14] Rogers, Alex D., et al. "The discovery of new deep-sea hydrothermal vent communities in the Southern Ocean and implications for biogeography." PLoS biology 10.1 (2012): e1001234.

[15] Blackford, Jerry, et al. "Marine baseline and monitoring strategies for carbon dioxide capture and storage (CCS)." International Journal of Greenhouse Gas Control 38 (2015): 221-229.

[16] Lichtschlag, Anna, et al. "Impact of shallow-water hydrothermal seepage on benthic biogeochemical cycling, nutrient availability, and meiobenthic communities in a tropical coral reef." Limnology and Oceanography 67.3 (2022): 567-584.

[17] von Strandmann, Philip AE Pogge, et al. "Assessing the role of climate on uranium and lithium isotope behaviour in rivers draining a basaltic terrain." Chemical Geology 270.1-4 (2010): 227-239.

[18] Petersen, Sven, Anna Krätschell, and Mark D. Hannington. "The Current State of Global Activities Related to Deep-sea Mineral Exploration and Mining." EAGE/DGG Workshop on Deep Mineral Exploration. Vol. 2016. No. 1. EAGE Publications BV, 2016.

[19] Petersen, S., Krätschell, A., Augustin, N., Jamieson, J., Hein, J.R. and Hannington, M.D. [2016] News from the seabed – geological characteristics and resource potential of deep-sea mineral resources. Marine Policy.

[20] Amon, Diva J., et al. "Assessment of scientific gaps related to the effective environmental management of deep-seabed mining." Marine Policy 138 (2022): 105006.

[21] Simon-Lledó, E., Bett, B. J., Huvenne, V. A., Köser, K., Schoening, T., Greinert, J., and Jones,D. O. 2019. Biological effects 26 years after simulated deep-sea mining. Sci. Rep. 9 (1), 1-13.

[22] Washburn, T. W. et al. 2019. Ecological risk assessment for deep-sea mining. Ocean Coast. Manag. 176, 24-39. https://doi.org/10.1016/j.ocecoaman.2019.04.014

[23] Wellmer, F-W., Buchholz, P., Gutzmer, J., Hagelüken, C., Herzig, P., Littke, R., Thauer, R. K.2019. Raw Materials for Future Energy Supply. Cham: Springer.

[24] Willaert, K. 2021. Under Pressure: The Impact of Invoking the Two Year Rule within the Context of Deep Sea Mining in the Area. The International Journal of Marine and Coastal Law 36 (3), 505-513. https://doi.org/10.1163/15718085-bja10068