



# Exploring The Role Of Space Mining To Save The Earth From Environmental Degradation

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## ARTICLE INFO

## ABSTRACT

Mankind has always ventured for the upper skies i.e beyond the confines of the atmosphere exploring and mining the vast expanse of the cosmos, initially with the pioneering efforts of space agencies like NASA and Roscosmos and subsequently with the emergence of private companies such as SpaceX and Blue Origin. It is worthwhile to mention that the allure of space has primarily been one of discovery and scientific exploration and more recently with the advent of technology and the emergence of new frontier i.e The mining of the resources in outer space though would seem like a science fiction to the naked eyes, but is rapidly becoming a reality moreso with the introduction of the Artemis Accords by NASA and the participation of both governmental and private entities. Thus, the concept of mining resources in Space has taken a giant leap forward. Even the scientists claim, it possesses immense potential to reshape not only our understanding of the universe but can also be the very foundation of our economy and resource management as a travel to and fro from the Earth to the Moon and back to near-Earth asteroids, celestial bodies are bulging with valuable resources that could revolutionize our standard of living and help sustain our growing civilization. However the researcher claims that this giant leap into the cosmos raises questions of doubt in abstract about legality, ethics, sustainability and the future of space governance at the cost of environmental pollution and degradation. Scientists in the recent times claim that Resource Mining on Space will prove highly beneficial for Earth and its habitats owing to presence of metallic minerals in meteorites and other space rocks. The researcher embarks on a journey to unravel the wonderful opportunities and mysteries of resource mining in the Outer-Space- a journey that scientists claim to benefit mankind in the near future but the research paper also alongside explores the technical snags, faulty governance and legal frameworks which might severely hinder the execution of the same.

## 1. INTRODUCTION:

Since time immemorial Space Mining has aroused much curiosity and kept mankind fascinated as the concept of Space Mining relates to in depth scientific and economic discussion that in turn includes within its concept the extraction of valuable minerals and other geological materials derived from asteroids, comets and other celestial bodies. Such process beholds immense potential to ensure a sustainable future for earth by providing a celestial solution for earth's crisis of resources.

Alarmingly with time the earth's resources are becoming finite. With the ever increasing population, man's consumption patterns continue to expand which in turn is rapidly depleting our planet's valuable resources leading to a myriad of environmental and economic challenges ranging from deforestation, pollution to scarcity of valuable resources and spreading widely economic inequalities. However, as an alternative, space mining can evolve as a potential solution to save the mother earth as it provides not only an alternative source of resources finding but the mining of asteroids and the other celestial bodies which are enriched with minerals like Iron, Nickel, cobalt as well as rare Earth metals proves to be crucial for modern technology. Also by such mining of resources in space can just not help alleviate the extensive demand for Earth's valuable resources but their availability for future generations can also be ensured from the upper realms.

Moreover, space mining significantly can aid in reduction of environmental impact of resource extraction on earth as traditional mining practices on earth consisted of severe Environmental degradation which included

within its ambit habitat destruction, water pollution and emission of greenhouse gas. Comparatively space mining if done responsibly could minimize such degrading impacts.

The last but not the least, the advancement in space mining Technology could instigate not only innovation and economic growth but it could pave ways for creation of multifarious jobs and develop economy by providing opportunities for scientific discovery and technological advancement.

However it is necessary to highlight the grey areas as well which would emancipate while executing space mining as it gives rise to significant technical hurdles and several ethical issues related to the ownership when valuable resources are extracted and also gives rise to barbaric exploitation of celestial resources as well. Addressing these challenges will require extensive International cooperation and cautious vigilance and regulation.

Space mining no doubt beholds a promising sustainable growth of Earth, so by providing an alternative source of beneficial resources would aid in substantial reduction of the environment impact of resource extraction subsequently leading to potential development and assurance of long term sustainability of our planet. However attaining this dream will never be so easy like a bed of roses as technological and legal hazards will hinder the smooth execution of resource Mining in space.

## **2. COINING THE TERM SPACE MINING:**

Space mining<sup>1</sup> is also coined as asteroid mining which involves the process of extracting precious minerals and resources from celestial bodies pinned in the solar system. It is the concept that has been accelerating round for decades but has gained momentum in recent times owing to technological upgradation in space exploration. Space mining is mainly executed in Asteroids and Moon.

### **Asteroids:-**

Asteroids enriched with plethora of valuable resources such as Iron, Nickel and Cobalt. It is believed that some asteroids also contain expensive metals like Platinum and gold.

It is also worthwhile to mention that it is easier to travel towards the asteroids in comparison with the moon.

### **Moon**

The moon being the closest neighbour of our Planet Earth contains abundance of resources such as Helium 3 which serves as a potential fuel for nuclear fusion and also contains water which can be used for fuel and supporting life.

Space mining involves extracting resources in abundance from the space bed which are hardly found on earth which are:-

### **Water:-**

Water aims to provide as an eminent resource when long duration space missions are involved in particular. Water plays a key role for supporting life, enhancing food growth and serves as a vital resource for rocket fuel.

### **Valuable metals:-**

Asteroids behold a reservoir of valuable metals such as gold, Platinum and Palladium. These metals could be put to use for not only making of creative jewelries and ornaments but also can be used for building various applications on earth and on space.

#### **Helium 3:-**

For nuclear fusion Helium 3 is a highly potential fuel that that aids in providing clean and Virtually limitless energy which is found in abundance on the surface of the Moon making it a prime focus for mining in space.

## **3. HOW SPACE MINING CAN SAVE OUR EARTH FROM ITS DEPLETING RESOURCES:-**

A significant portion of Earth's sustainable growth may blossom from space mining and resultantly it would not only lead to lessening the burden on earth's resources but alongside would guarantee the availability of such space resources for the future generations to come. Extraction of helium 3 has the potential to fully transform the energy sector by providing efficient and Clean Energy. Furthermore extraction of water from space would help in sustaining extended space trips paving the way for further additional research as well as providing a possibility for colonization of several other planets in the solar system.

A time in the future is envisaged where resources would not be restricted to those only found on earth but mining of resources from the upper realms would also be given equal importance. Space mining may become a key component of mankind's plan for long term sustainable development as Man continues to explore the Cosmos.

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<sup>1</sup><https://newspac economy.ca/2023/03/12/a-short-history-of-asteroid-mining/#:~:text=The%20primary%20focus%20of%20space%20mining,currently%20is%3A%20asteroids%20C%20the%20Moon%20and%20Mars.>

On the cusp of a new era, space mining present itself as a viable answer to the ecological issues facing Earth. This article portrays the myriad ways in which space mining might come to the rescue by promoting renewable energy, lessen Terrestrial pollution and help in retaining Earth's resources which our detailed below:-

#### **a. Preservation of Earth's resources**

Retaining Earth resources can be greatly added by space mining. Presently the earth's resources are reaching a level of scarcity and the rate at which man are consuming them up raises an alarming concern. To minimize such crisis, resources can be extracted from heavenly bodies such as the asteroids, moon and Mars as the celestial bodies present in the space terrain are rich in resources such as water, rare of elements and precious metals. Thus the burden on earth's resources can be lessened and the durability can be guaranteed by extracting this resources from the space bodies.

#### **b. Endorsing renewable energy**

Space mining also shows enormous potential to assist renewable energy sources. Recovering Helium 3 from the lunar surface is one of the most exciting aspects of space mining as Helium 3 promises to be a key fuel for nuclear fusion which produces enormous amounts of energy without creating hazardous by-products. Furthermore since space-based solar panels are not affected by atmospheric interference or the day night cycle they are able to absorb solar energy more efficiently. Accordingly there will be less need for such resources on earth, since the materials needed to make the solar panels can be obtained exclusively from space.

#### **c. Cutting down on land pollution**

Mining in space would lead to a viable solution to lesson the pollution on earth as traditional mining methods on earth are frequently linked to environmental deterioration like soil erosion, water pollution and deforestation. Since Space mining occurs in a totally different environmental pane, this negative impact are curtailed to a great extent.

Furthermore space mining can dramatically lower air pollution and greenhouse gas emissions by increasing the use of clean energy sources such as nuclear fusion and solar energy and decreasing dependency on fossil fuels.

To sum up space mining offers a viable answer to some of the most important sustainability problems our world is currently facing. Space mining has the potential to be extremely important in maintaining sustainability for future generations by protecting the planets resources, promoting renewable energy sources and cutting down on pollution. To avoid transferring our issues from Earth to space, (*"Outer Space Mining may make the Same Mistakes in Space as we have on Earth"*)<sup>2</sup>, one must establish ethical space mining techniques as Man continues to explore this new Frontier. A sustainable future can only be dreamt with regard to space mining with careful planning and international cooperation as well as proper framing of laws, rules and vigilance.

### **4. WAYS IN WHICH SPACE MINING COULD HELP STIMULATE GROWTH AND INNOVATION IN OTHER SECTORS:-**

Space mining yields a lot of financial advantages. For example asteroids are abundant in water and other resources as well as valuable metals like Platinum. Asteroid enriched in Platinum has the potential to be worth billions of dollars for exceeding the total value of all Platinum mined on earth till date.

Additionally it is expected peace mining might prove beneficial to lesson the stream on earth resource base. The idea of using the nearly limitless resources in space appeals to us more and more as we continue to exhaust earth's resources which in turn could lead to a potential reduction in environmental and social cause connected with mining on the base of the earth.

#### **4.A ROLE OF SPACE MINING IN STIMULATING GROWTH AND INNOVATION IN OTHER SECTORS**

In addition to the obvious financial games Space mining may revolutionize Innovation and expansion in other industries but for that space mining need to undergo developments that have far reaching effects.

The construction of autonomous Space robots for example as the potential to completely transform sectors of the global economy that function in hazardous or challenging environment. Similarly improvements in spaceship propulsion and design may find use in the energy and aviation industries.

A new Space based economy may also be facilitated by the evolution of a Space sector which would include not only mining but also the production and refinement of commodities in space resulting in the creation of new avenues in jobs and business prospects.

The effects of space mining on the economy are significant. It is relatively young but nevertheless it gives an overview of a lot of potential advantages in the upcoming future but along with it, it also promises quite a number of difficulties ranging from ethical, legal and technological snags. To guarantee the fair and sustainable use of space resources it is crucial to minimize these challenges as we forge ahead on this new Frontier.

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## 5. THE CHALLENGES INCLUDING TECHNICAL AND LEGAL AND VIABLE SOLUTIONS ASSOCIATED WITH SPACE MINING AND RELATED SUSTAINABLE GROWTH ON EARTH:-

Space mining no doubt has the potential to contribute enormously to enhance the environmental sustainability on earth. Higher it also presents several technical legal and ethical challenges which are as follows:-

**A. Distance and Accessibility:-** The vast distances between Earth and potential mining sites present significant challenges.

**Solution:-** Advances in propulsion technology and autonomous systems can make space travel more efficient and cost-effective.

**B. Harsh Environment:-** The harsh environment of space, including extreme temperatures and microgravity, can damage mining equipment and pose risks to human operators.

**Solution:-** The development of robust, resilient technologies and the use of teleoperation or fully autonomous systems can mitigate these risks.

**C. Resource Extraction and Processing:-** Extracting and processing resources in microgravity conditions is a complex task.

**Solution:-** Research and development in zero-gravity extraction and processing techniques are required. In-situ resource utilization (ISRU), which involves using materials found in space to support exploration activities, can also be a viable approach.

### 5A. Legal and Ethical Considerations and Solutions

**A. Ownership and Exploitation Rights:-** The Outer Space Treaty of 1967, which forms the basis of international space law, states that outer space is not subject to national appropriation. This raises questions about who has the right to exploit space resources.

**Solution:-** Clear legal frameworks need to be established at the international level to regulate space mining activities and ensure fair and equitable distribution of benefits.

**2. Environmental Impact:-** Mining activities could potentially disrupt the celestial bodies and contaminate both the mining sites and the Earth's environment with extraterrestrial materials.

**Solution:-** Strict environmental protocols need to be developed and enforced to minimize the impact of space mining on the celestial environment.

**3. Social and Economic Impact:-** The potential wealth from space mining could exacerbate social and economic inequalities if not managed properly.

**Solution:-** Policies should be put in place to ensure that the benefits of space mining contribute to sustainable development goals and are shared equitably.

While space mining presents significant challenges, it also offers immense opportunities for sustainable growth on Earth. With the right technical innovations and legal and ethical frameworks, it can become a key contributor to our planet's long-term sustainability.

## 6. CONCLUSION:

Space mining which includes the process of extracting valuable resources from celestial bodies has the potential to support sustainable growth by providing an abundant supply of resources which are not found in plenty on the base of the earth. Such resources can be used to power Industries, instigate clean Energy technology and stimulate economic development.

Although Space Mining gives rise to challenges due to factors like distance and harsh environment, these obstacles can be overcome with advancements in technology and increased investment in research and development. Efforts to address these challenges can lead to the development of efficient and cost effective solutions for space mining.

Furthermore legal and ethical aspects like ownership right, environmental impact, and social and economic implications are of immense importance in the development of space mining. It is essential to establish clear legal frameworks, rigorous environmental protocols and fair benefit distribution policies to ensure responsible and sustainable space mining practices.

Needless to mention that since space mining is crucial for earth's sustainability, it is essential for securing the future of our planet in the face of resource depletion, climate change and population outburst. Space mining presents a feasible opportunity for addressing these pressing challenges.

However Space Mining's full potential can only be achieved through collaboration among government business institutes, research Institutions and civil society to develop necessary technology, establish legal and ethical frameworks and ensure responsible practices. Action is also needed by investing in research and development for space mining in order to secure sustainable future for earth and explore the endless opportunities Space Mining has to offer.

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