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Asteroid Mining, the beginning of an in-space based industry that will build our future and save our planet

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Abstract

The main objective of this paper is showing why mining near Earth asteroids could be a good alternative instead of regular mining. Legal and illegal mining are one of the principal causes of our running out resources and the destruction of our ecosystems. Thanks of these reasons engineers need to find solutions for this problematic preserving our goods and environment.

In this paper both parts are going to be compared, providing information about how regular mining (illegal and legal) affects a country and how asteroid mining could be the alternative that we were waiting for. In addition, this paper will describe how asteroid mining works, if this type of mining is feasible nowadays, what politics are involved and what is the government doing, and the environmental benefits will be described as a prove of the efficiency of asteroid mining. Finally, it will be necessary to provide an effective conclusion of the final comparison between regular mining and asteroid mining in order to show why space mining is most likely to become the industry of the future.

Keywords: *Mining, illegal mining, asteroid mining, asteroids, materials, and mineral from space, mining of the future, space utilization, climate action, responsible production and consumption, life on land, sustainable cities and communities.*

Introduction

We all have seen sci-fi movies about space when we were kids, movies in which we see spacecrafts and space bases using resources from different planets or asteroids; but have you ever thought whether this could become a reality?. Illegal mining is one of the main causes why we are running out our resources. Engineers, and environmentalists have given ideas to protect our planet and our resources. Nevertheless, with illegal mining or not, in the future we will not have enough goods to live, so we need to explore innovative ways to extract minerals in order to save our planet. Asteroid mining might sound like an insane idea from movies or video games, but in the future, it will be considered feasible. Asteroids have a huge amount of materials and minerals, some of them also have water; so if we find a way to extract these materials from them not wasting that much, we will be able to preserve our ecosystems. The way I will address this paper is making it easy to understand to make even students get into it.

First of all, we need to know what asteroids are capable of being mined, then we will learn what benefits each one has, what is the best way to extract minerals and metals from them, how feasible is to develop this activity nowadays, what politics are involved in this field, how many ways asteroid mining would help our environment, and finally if asteroid mining will become the beginning of the space industry.

Background

Nowadays so many countries are suffering the impact of illegal mining. In fact, illegal mining involves serious environmental and social issues, affects the economic growth, and the quality of people's health(including workers and populations near the area)(Kleinhenz, 2017). Nevertheless, legal mining also affects our environment in different ways; underground mining involves movements of waste rock and vegetation, this activity can release toxic compounds into the water and air affecting near areas where people live ("Environmental Risks of Mining," 2016). The toxic compounds not only affects population causing ailments; otherwise carbon output, erosion and endangered species habitat and water use and wastewater also are environmental issues associated with mining("Environmental Risks of Mining," 2016) that make us ask ourselves, In the future will we be able to preserve our goods in order to satisfy our necessities and solve our biggest problematics?

Illegal mining and legal mining are activities that we can find in lot of countries. In Peru, we see illegal mining with the gold industry. Kleinhenz(2017) explains that Illegal gold mining in Peru is the driver of serious environmental and social issues and a root of corruption. This quote is truth considering how many damage this activity produces to our country. Despite that operations like artisanal and small scale gold mining are illegal here in Peru, huge groups are making billions of dollars from gold shipped to developed countries (Kleinhenz, 2017). These types of mining are so popular in places like the Amazon, as a result of them we can see environmental disasters like the occured in Madre de Dios Fish were poisoned by mercury, so animals and people that consumes this food got poisoned too (Kleinheinz,2017), this disaster was occasioned by the cheap equipment used by the illegal

miners and as a result of that, they split of mercury into the rivers. We can use this catastrophe as an example of how much illegal mining can affect a country but that is not all; if these activities continue, we will not able to use our resources in the future as we are using it now. We will not have enough minerals to build infraestructures or help us to confront obstacles of the following years.

As happened to Peru, many countries experiment the same problem or even worse. That is the mainly reason of how fast we need to search for alternatives to these actions in order to keep our ecosystems, our rivers, and lakes and most importantly, our planet.

Asteroid mining comes up like an innovative way to safeguard our naturals resources by mining near-Earth asteroids. Practising this activity would be great for the preservation of our goods. Imagine living in a place where mining is controlled, and we can find as many minerals as we want from the space using them for operation research, extraction of resources, propellant making and to provide supplies for space missions. In fact, there are asteroids classified by their composition.

As Bonsor(2000) reported, asteroids fit into three different categories:

C-type: More than 75 percent of known asteroids fit in this category. Their composition is similar as the sun´s, without hydrogen, helium and other volatiles.

S-type: About 17 percent of known asteroids are this type. These asteroids contain nickel, iron, and magnesium.

M-type: A reduced number of asteroids are this type, they contain nickel and iron.

As we can see, there are bunches of groups when we are referring to asteroids. A NASA report estimates that the mineral wealth of asteroids in the asteroid belt might exceed $100 billion for each of the six billion people on Earth (Bonsor 2000). With this in mind, asteroid mining sounds like a worthy activity; nonetheless, to proceed with the asteroid mining

process we need to keep in mind in which category it is. According to Blair(2010), before extracting materials from them, a site preparation and a mine development is needed. Firstly they need to construct an operation platform system in which they would bring support and equipment. Once the last is done, the extraction operation, beneficiation, and processing are able to proceed. The last step of mining an asteroid is transportation, in this process the main body or fragments are carried to Earth or space bases. Some methods are used in order to get these materials, they have calcifications depending what type they are. Blair (2010) classifies these methods in three groups:

Classified by fragmentation energy storage:

Self supporting

Artificially supported

Caving

Classified by access:

Surface

Underground

Classified otherwise:

Spin- assisted

Ross(2001) argues that some near Earth asteroids offer very promising targets as future ore bodies for in-space resources, for reasons of accessibility, ease to return and variety of source materials. Asteroids have an amazing potential for the mining in-space industry, therefore future engineers need to start thinking of how important it would be for our planet.

Body Paragraph

In an age in which the sustainable development is required in every field, we need to consider different activities instead of the common mining. Hein, Saidani and Tollu (2018) explain that mining near Earth asteroids has been frequently proposed as a source of resources for space and terrestrial applications. Besides, there is an abundance of materials that can be found. Metzger(2018) says that compared with breathtaking bridges that engineers build on Earth, asteroid mining is a simple and small scale operation requiring only modest technological advances. That is why asteroid mining is likely to become an important industry in the future, there is an abundance of materials that can be found in near Earth asteroids that could support activities in Earth orbit (Dorrington, Olsen and Kinkaid, 2016). However, even if we know the potential of asteroids, we cannot extract a huge amount of materials because we would cause the break of the mineral market, so what we need to firstly obtain from them is water. According to Metzger(2018) for asteroid scientists, water is the raw material for propellant. Launching water from Earth into space consumes a lot of propellant. However, once separated from the minerals, water can be split by electricity into hydrogen and oxygen to produce rocket propellant, one of the most important components of rocket fuel. Water based propellant sourced from these asteroids can be used to provide a number of services such as a satellite station keeping (Dorrington, Olsen and Kinkaid, 2016).

Feasibility of the in-space industry nowadays :

Most of the materials we use nowadays to make artefacts like computers, cell phones or some others are most likely to disappear in 20 years. Some of these materials are irreplaceable because of their properties, this makes the labor of finding and extraction harder with the pass of years. So if we cannot find them on Earth, we will have to begin searching the rest of our solar system, starting with asteroids (Greenspon, 2016). As we see in the background, asteroids contain minerals, metals, rocks, and water. According to Greenspon (2016), a single asteroid with the right composition could be worth trillions of dollars in raw materials. On the other hand, asteroid mining is not feasible nowadays. All the procedure of investigation, extraction, and transport are too expensive, so if we want to start an in-space industry in which we could use all the resources from outer space, firstly we need to keep two things in mind. Fist of all, mining asteroids and transporting them from space needs to become cheaper than mining from Earth sources. Also, mining and processing materials in space for use in space has to become cheaper than launching and sending spacecraft with those materials from Earth (Greenspon, 2016). D Ross (2002) argues that there may be a future market for asteroid derived materials, this market include deliver into low Earth orbit for sale to operators and constructors of infrastructures such as space stations. Mined materials could also be processed in space or on a future space colony in order to directly construct structures for use in space(D Ross, 2002). Since the cost of launching materials of Earth is extremely expensive, delivering the raw or processed materials directly from an asteroid could save on rocket construction, fuel, and time needed to deliver resources(Greenspon, 2016).

Politics involved :

There are many economic limitations when we talk about the feasibility of asteroid mining. However, if we make this activity feasible, would it be legal?. Nobody can be the owner of celestial bodies, that is the case of the moon, other natural satellites or asteroids. The Outer Space Treaty(OST) established in 1967 had decreed that outer space, including the moon and other celestial bodies, "is not subject to national appropriation by claim of sovereignty" (Davies, 2016). Thanks to the imminent necessity of mining space resources from corporations, this law is being staking out. Davies(2016) thinks that the reason lawyers could soon be poring over that 52-year-old document is that space mining could become a reality within a couple of decades. For this reason, the OST law needs to change; some countries are starting to join up with small companies to make asteroid mining a reality. We can see as an example the company named Deep Space Industries. This company wants to send small satellites called Fireflies to harvest, transport, and store raw materials (Davies, 2016). However, due to these hurdles Davies(2016) exhibits that the US government updated the law on space mining, producing a bill that allows companies to "possess, own, transport, use, and sell" extra-terrestrial resources without violating US law. On the other hand, if this law gets updated to allow organizations to appropriate of the materials extracted from these celestial bodies this could be the beginning of the space mining industry, an industry in which new resources would change the way we build the future.

Environmental Benefits of Asteroid Mining:

Mining activities in Earth has been the responsible of multiple environmental catastrophes. On the contrary, space mining seems to be the solution for most of these issues. The main idea of asteroid mining is to create a completely new industry based in in-space resources, so the mainly idea is to bring back expensive and scarce resources such as platinum, because these materials are too expensive in the mineral market; resources like water should be used as supplies for spacecrafts or space bases to ease labors of launch. Taking these measurements will cause a reduce in carbon footprint occasioned by rocket launches and will reduce how many space junk is generated per year. To take this point lets compare the Earth platinum mining and the space platinum mining. Both of them release a significant amount of greenhouse emissions. Even so, fuel on board of a rocket burns in Earth's atmosphere to form carbon dioxide (Emerging Technology, 2018). For kerosene-burning rockets, one kilogram of fuel creates three kilograms of CO2 (Emerging Technology, 2018). There is a complete different story when we talk about reentrance. Emerging Technology from the arXiv(2018) informs that reentries produces NO_x such as nitrous oxide (N_2O), a greenhouse gas that is about 300 times more potent than CO_2.

On the other hand, we need to compare emissions of CO2 between asteroid mining and regular mining. In case of regular mining, platinum mining generates significant greenhouse gases, mostly from the energy it takes to remove this stuff from the ground (Emerging Technology, 2018). Actually, one kilogram of platinum mined is equal to 40,000 kilograms of carbon dioxide emaned to the atmosphere (Emerging Technology, 2018). In the case of asteroid mining, this number is reduced to 150 kilograms of CO2 produced by 1 kilogram of

platinum released into Earth's atmosphere (Emerging Technology, 2018). As we can see, the difference between them is huge, asteroid mining could reduce these emissions even more if rockets start using green fuels.

Discussion

The results of this paper show that asteroid mining is a good source of resources that can be used in different fields of the industry. This type of mining also helps with the environment preservation and establishes the beginning of an in-space industry. Due to diverse issues, regular mining has being the cause of dangerous environmental accidents that affected not only animals, otherwise population who lives near mining areas. With applying asteroid mining, we can solve the problem of running out materials, and our endangered ecosystems. However, this paper has some limitations; some of them are the environmental impact of rockets when they are launched. Most of the rocket are propelled by liquid hydrogen fuel, therefore, the vapour emanated from them is water. Nonetheless, propellant and hydrogen production causes carbon emissions, being the responsible of significant damages to the environment.

Moreover, another limitation is space junk produced while rockets are launched for mission. This environmental issue could be reduced applying new techniques of recycling them in order to use them in other missions. For instance, there is an innovative practice to capture space junk by using a net, Grush(2018) says that this net (expected to use satellites to take the net to the space) named RemoveDEBRIS is meant to try out numerous methods for clean up space junk, which has become a growing problem ever since we started launching rockets into orbit. In addition, one of the most limitation seeing in asteroid mining is the

amount of resources needed for this labour. For this reason, is planned to use asteroids as a constant source of supplies for spacecrafts and space mission; by using them for the water, materials, and minerals extraction. These topics could be researched in next papers exhibiting the environmental issues that rocket launches causes and how can they being solved in order to reduce our carbon footprint with more details.

Conclusion

As we can see, mining near Earth asteroids would most likely be an entire new solution for the preservation of our goods. Asteroid mining also creates a completely new industry helping us to satisfy our necessities and to protect our ecosystems. However, fields related to this industry need to start using these materials for launching because if this technique is implemented, space industry could save money and time and with this helping our planet.

The biggest finding of this paper is how can out of mind solutions would help us in the protection of our planet. In this paper is showed the regular mining impact in our living, keeping this in mind we may be able to use this idea as the beginning of something great, the begging of the extraction of new materials from space, the beginning of the space industry. Moreover, this paper was made to make people understand that our resources are starting to running out, and we need to find out new alternatives to protect our environment, as asteroid mining there are some other alternatives that can make people take conscious and think about their future. However, the space politics need to clarify some laws in order to make legal and feasible mining mission in the outer space. As is mentioned before these paper limitations makes a call to action, some of these points can be used of topic of a different essay complementing this one and used to reatificate this argument.

Asteroid mining has the potential of become a huge industry in which all of us would be beneficiated, engineers need to start thinking in our future and in which ways we can use our technologies to solve issues and to start building a future in which we would like to live.

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