



The Need for Strict Regulation of Asteroid Mining

Brittany Wojciechowski, Lucas Webb, Aubrey Koonce, Molly Williams
Wichita State University

We argue that while asteroid mining should be pursued, it should come with strict restrictions so as not to allow monopolies or depletion of asteroidal resources. We propose an international regulatory framework between countries wishing to participate in mining, an asteroid land rental fee, a rental time limit, and a space “customs” which inventories materials brought back to Earth. We agree with the UN that there should be special attention given to countries that lack space technology, and that arrangements should be made that will benefit them, such as aiding in funding their space programs or sharing the resources brought back from space. This paper produces a rough framework of a possible policy that should be considered as more formal asteroid mining policies take shape.

1 Introduction

For asteroid mining to be a possibility, frameworks need to be built and current space treaties need to be revisited. If there are no explicit frameworks in place, then investors are less likely to support asteroid mining initiatives, leading to the stagnation of asteroid mining efforts. This would be unfortunate, because there are numerous benefits of asteroid mining. For humanity to take hold of these benefits, we think it would be wise for asteroid mining to be regulated strictly. We must take steps to avoid depleting resources that could benefit future endeavours in space. To that end, we discuss the motivation behind asteroid mining and provide a proposal that could be beneficial for future asteroid mining policies.

2 Asteroid Mining Benefits

Concerns of human exhaustion of Earth’s resources have grown more serious in recent years due to the development of new technologies allowing the extraction of more resources at a higher rate. Eventually, non-renewable, but important resources, such as platinum as well as other mineral resources, will be depleted either completely, or to levels leading to market instabilities. In order to curtail this kind of outcome, some European and American based companies have already started to branch out beyond Earth in a search for resources. Kleos Space and Asteroid Mining Corporation are two European companies that have raced to the forefront of the new venture of asteroid mining. The appeal of conducting mining operations in such a harsh environment as outer space is driven by the excitement of

conquering a new frontier as well as (and probably mostly) the potential of entering what some claim will be a trillion, if not quintillion, dollar industry. The mining of asteroids would not only help humans on Earth, but also aid in future exploration of the solar system.

Asteroids have been classified into many different types according to the kinds of materials that they possess, but asteroid mining is specifically concerned with three types.¹ First are C-types, which contain many kinds of resources needed for human survival including, water, carbon, and other organic materials that could be useful for growing food.² Humans need four things in order to survive: food, water, shelter, and, due to our expansion into space, we must now also add oxygen. If there is a shortage of clean water on Earth or a lack of water for a crew in space, water could be extracted from C-type asteroids. Further in the future, asteroid water could be used to water crops within space settlements, producing food that settlers need. With regards to shelter, water could be used for radiation shielding of habitats and spacecraft.³ Through electrolysis water can be broken down into hydrogen and oxygen, contributing to air supplies. The other major asset of having water on asteroids is so that it can be used as a refueling station for rockets during exploration. Oxygen and hydrogen are two useful rocket propellants. Manufacturing propellants from asteroidal water would greatly cut down on fuel and launch costs, and decrease the price of space missions.⁴ Among near-Earth C-types which are at least as energetically accessible as the Moon, there is on the order of 8×10^{11} kg of water available in total.⁵ That is only considering a small fraction of the near-Earth asteroid population, which in turn comprises only a small fraction of the total asteroid population in our solar system.

Second are S-type asteroids that contain significant amounts metals such as iron, nickel and

cobalt,⁶ and could be potentially competitive in terrestrial markets. However, with new 3-D printing capabilities emerging, it is also possible to use some of these resources to 3-D print any necessary tools that may be needed in space. Lastly are M-types, which contain up to ten times the metal of S-types and contain more of the heavier or precious metals such as platinum and gold.⁷

Many people may be concerned that there are not enough mining candidates to meet current and anticipated resource demands. However, there is an almost inexhaustible amount of asteroids in our solar system. Nearly 19,000 near-Earth asteroids have already been identified by NASA JPL.⁸ John Lewis, a professor at the University of Arizona in the Lunar and Planetary laboratory says that, "The near-Earth asteroid population could easily support 10 to 40 times the population of Earth, with all the necessary resources to do that".⁹ Beyond near-Earth asteroids, the Main Belt asteroids number in the hundreds of millions, potentially worth one billion dollars for every person on Earth.¹⁰

Although we advocate for the use of space resources to greatly boost the world economy, it is evident that systems put in place with few restrictions often fail to benefit all of humanity (which is, of course, the goal of space exploration and utilization). To avoid monopolies and inequality, we propose strict regulations on asteroid mining. While we agree with several of the stipulations of Luxembourg's asteroid mining policies,¹¹ such as requiring licenses or contracts to mine, we believe that more stringent requirements are in order, which exceed what is mandated under the Luxembourg law (as well as the similar United States Commercial Space Launch Competitiveness Act). The purpose of our recommendations is to allow humanity to benefit from space resources without compromising equality and justice for nations that lack the

¹ Steigerwald, William. New NASA Mission to Help Us Learn How to Mine Asteroids. 2013.

<https://www.nasa.gov/content/goddard/new-nasa-mission-to-help-us-learn-how-to-mine-asteroids>

² Ibid.

³ Ibid.

⁴ Ibid.

⁵ Schwartz, James. Near-Earth water sources: Ethics and fairness. 2016. <http://dx.doi.org/10.1016/j.asr.2016.04.023>

⁶ Steigerwald, William. New NASA Mission to Help Us Learn How to Mine Asteroids. 2013.

<https://www.nasa.gov/content/goddard/new-nasa-mission-to-help-us-learn-how-to-mine-asteroids>

⁷ Ibid.

⁸ NASA Jet Propulsion Laboratory. Center for Near Earth Object Studies Discovery Statistics Cumulative Totals.

<https://cneos.jpl.nasa.gov/stats/totals.html>

⁹ Hsu, Jeremy. Why Asteroid Mining Makes Huge Dollars and Sense. 2012. <https://www.space.com/15401-asteroid-mining-huge-dollars-sense.html>

¹⁰ Ibid.

¹¹ Law of 20 July 2017 on the exploration and use of space resources. 2017.

<http://legilux.public.lu/eli/etat/leg/loi/2017/07/20/a674/jo>

resources to go into space. The only feasible way to do this, we believe, is through regulation of the practice.

3 Proposed Guidelines

In terms of policy recommendations, the aim is not to regulate the resources themselves but rather the activity of space mining. The Moon Agreement provides the groundwork for a stricter policy, which provides a model of how asteroid mining policies should be created and implemented.¹² Modeling new regulations based off of the Moon Agreement, we propose the creation of a mediating organization that oversees and enforces asteroid mining and its regulation. As in the Moon Agreement, this organization's focus should be on the "orderly and safe development of natural resources... the rational management of those resources; the expansion of opportunities... [and] the equitable sharing"¹³ of asteroidal resources.

We propose that asteroid mining firms must enter into a rental agreement with the mediating organizations. To gain access to mine space resources, Parties will be required to pay a small fee. This paid fee could then be applied towards administrative costs, but a portion could also be used to assist underdeveloped States' space programs. In this way the mediating organization would be similar to the International Seabed Authority under the UN Convention on the Law of the Sea.¹⁴ In order to restrict mining activity, Parties will have a duration of time (depending on extraction process of the mission) or until they meet a specific threshold of resources collected. If a Party does not exceed the threshold then they will have up until the end of the rental agreement to extract resources.

By attaching this additional restriction to rented spaces, subsequent mining expeditions will have an equal opportunity to collect the same quantity or as much feasible within the contract duration. Careful documentation of the minerals acquired will be necessary and upon return to Earth, and expeditions will be subject to something akin to a

space "customs". The customs procedures will be to ensure that proper inventory was taken, and no resources are absent or mismarked. Additionally, the Party shall submit a written statement including their own inventory that was taken that contains the type, quantity, etc. of the resources in their possession. This submitted inventory would be open to everyone, allowing for free access to said information. Also, underdeveloped countries would have the ability to petition for resources through the mediating organization. However, it is up to the country/company to decide whether or not they will extend a helping hand. Perhaps an incentive and/or a reciprocal agreement of sorts could be proposed in order to foster assistance between the developed and underdeveloped Parties of the proposal.

The proposal should be signed by nations that are interested themselves or have companies within them that are interested in space mining. Companies cannot sign the proposal themselves, however their governing country can sign and inform the mediating agency that they will regulate these companies and ensure they abide by the space mining regulations. Individuals or groups would be allowed to partner together, however the partnership should be outlined clearly within a contract and must be signed by all parties involved. Nations that have ratified the regulations will enforce the rules on the companies within their territory. The consequences of not following the rules of the proposal could include imprisonment and/or a large fine, like those described in Article 18 of Luxembourg's asteroid mining policies.¹⁵ Any companies and/or individuals that do not follow the rules of the proposal should also be reported to the mediating agency along with the consequence given to them.

Venturing forward into the opportunities that space provides humanity, equality and fairness should be at the forefront of new policies. While not every situation can be accounted for at the present time, by keeping these notions in mind, just systems can be formed to supply the foundation for future asteroid mining endeavors. The proposed

¹² Agreement Governing the Activities of States on the Moon and Other Celestial Bodies. 1979.

<http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/moon-agreement.html>

¹³ Ibid.

¹⁴ United Nations Convention on the Law of the Sea. 1982.

http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindx.htm

¹⁵ Law of 20 July 2017 on the exploration and use of space resources. 2017.

<http://legilux.public.lu/eli/etat/leg/loi/2017/07/20/a674/jo>

guidelines for a treaty in which countries can come together to be a part of something larger, in the scheme of space exploration, are rough ideas, requiring shaping. However, the authors believe that this outline embodies the key ideals needed for expansion into space.

4 Conclusion

For asteroid mining to become a reality collaboration with others needs to occur. Understanding the various aspects mining will include perspectives of multiple stakeholders, with

all needing to keep open minds. A key component of this process will be to revise or otherwise clarify the Outer Space Treaty¹⁶ (among other international agreements) as needed to ensure that international law is consistent with the policy recommendations outlined above. We encourage others to start thinking about what needs to be done for asteroid mining to become feasible and properly regulated. We also hope that the regulations provided will be of help in assisting in future policies. We must understand that strict regulations will be required to better ensure that asteroids will not become monopolized or depleted.

¹⁶ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon

and Other Celestial Bodies. 1967.
<https://www.state.gov/t/isn/5181.htm>

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