# Prescribing the Best Medicine for the Struggling Space Mining Industry: An International Regulatory Agency or a New NASA Office?

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**Abstract**

The space mining industry is literally having trouble getting off the ground. Although there is an abundance of valuable mineral resources on the Moon and near-Earth asteroids and supportive legal instruments, no commercial space mining missions have launched as of this writing. Moreover, the two most prominent space mining companies were bought by other companies at the end of 2018, and their space mining plans seem to be on hold. No matter the cause of this stalemate, it is argued in this paper that the near-term establishment of an international space mining authority with regulatory power would be detrimental to the already fragile industry. While over-extraction and ownership of space resources are serious concerns, provisions of the Outer Space Treaty, national legislation, and non-binding international guidelines will sufficiently mitigate the impacts of these legal questions on the industry in the near-term. Rather than implement a binding legal agreement on commercial space mining or establish an international agency to regulate the industry, it is proposed that a space mining technology office be established in NASA's Space Technology Directorate. Discussions about the legal challenges of commercial space mining should continue, but it is necessary for NASA to assist this industry so that lunar resource extraction will play a critical role in the Artemis program, which aims to achieve a sustained lunar presence by 2028. The Artemis program is steaming ahead, but lunar mining companies, whose achievements will significantly enhance the scientific value of the Artemis program, must not get left behind.

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## 1. Introduction

Over the past year, there has been a significant shift in the global commercial space mining industry. The first winds of change were the acquisition of the two most prominent U.S. commercial space mining companies, Planetary Resources and Deep Space Industries in late 2018.[1, 2] The second was the announcement of the U.S.'s plan to return American astronauts to the Moon by 2024, which was made by Vice President Mike Pence in March 2019 at a meeting of the National Space Council.[3]

This announcement led to the establishment of the "Artemis" program and the selection of several companies as lunar payload service providers by the National Aeronautics and Space Administration ("NASA"). Companies who have been awarded development contracts for their lunar missions include Moon Express, Astrobotic, Honeybee Robotics, and Maxar.[4] The Japanese company iSpace, while not a member of NASA's lunar robotic exploration initiative, is planning several robotic missions on the Moon's surface through the 2020s, which will coincide with crewed and uncrewed U.S. lunar missions.[5]

Despite the greater economic lure of asteroid mining compared to lunar, the only active company pursuing such missions is the U.K.'s Asteroid Mining Corporation. The company plans to use an Earth-orbiting satellite launched in 2021 to scan Near-Earth Objects and determine the best candidates for further study. In 2023, a spacecraft will be sent to the most attractive asteroid to study its metallurgical properties. Finally, in 2028, a robotic spacecraft will land on the asteroid, recover several tons of resources, and return them to Earth orbit for later use, thus beginning the company's asteroid mining operations.[6]

The two events mentioned earlier have led to a global shift from commercial asteroid mining missions to commercial lunar mining missions. This shift is justified by findings from both India's Chandrayaan-1 and NASA's LCROSS spacecraft, which both independently verified the presence of water-ice on the Moon's surface, which is ultimately more useful to astronauts than the rare

1 A. Boyle, 'Why in the Universe is a Blockchain Company Buying the Assets of a Formerly High-Flying Asteroid Miner?', *GeekWire*, 31 October 2018.
2 J. Foust, 'Deep Space Industries Acquired by Bradford Space', *SpaceNews*, 2 January 2019.
3 'Remarks by Vice President Pence at the Fifth Meeting of the National Space Council', *White House*, 26 March 2019.
4 'Astrobotic Awarded $79.5 Million Contract to Deliver 14 NASA Payloads to the Moon', *Astrobotic*, 31 May 2019; 'NASA Announces New Partnerships for Commercial Lunar Payload Delivery Services', *NASA*, 29 November 2018; 'NASA Selects 12 New Lunar Science, Technology Investigations', *NASA*, 1 July 2019.
5 'Project', *iSpace*, 2019.
6 'Our Missions', *Asteroid Mining Corporation*, 2019.

metals found on nearby asteroids.[7, 8] This discovery, along with decades of robotic spacecraft orbiting the Moon, makes the Moon the best space mining location in the short-term, and the companies mentioned earlier have taken notice.

Unfortunately, despite the internal activities of multiple commercial space mining companies around the world and widespread industry and legal support, no commercial space mining missions have been launched as of January 2020. Nations such as the United States, the United Kingdom, and Luxembourg have enacted laws that offer legal support to commercial space mining endeavors, and there is an active international working group that is collaborating on the study of an international framework for space mining governance. The financial value of commercial space mining is high, but the technical challenges of commercial space mining are higher, and the industry remains grounded.

The acquisition of the two most prominent commercial space mining companies by new buyers should serve as an inflection point for the industry. Going forward, technology development, not legal debate, needs to be the priority of commercial space mining stakeholders. The ownership and protection of extraction sites on asteroids or on the Moon is indeed a legal question, but debating this issue has not and will not get commercial space mining missions off the ground faster. It is evident that space mining companies have struggled with sample collection technology, based on multiple delayed launches, so NASA should consider establishing a technology development center to disseminate research on space mining worldwide.

Furthermore, a binding international agreement on commercial space mining should not be established in the near future, as its drafting will likely only cause more debate, and will not advance commercial space mining missions to the launch pad.[9] Ratification of such an agreement by the United States, the U.K., or Luxembourg in the near-term would be detrimental to the already fragile industry. A U.N. agency should also not be established to assist the commercial space mining industry at this time because it would also likely hinder, not help, space mining missions from getting off the ground.

In order to develop a sustainable lunar program by 2028, space mining companies cannot be hindered by legal debate and must be provided with research and development support. As discussed in this paper, the best way to achieve these goals is for NASA to establish an office dedicated to

7 C.M. Pieters, et al., 'Characterization of Spatial Distribution of OH/$H_2O$ on the Surface of the Moon Seen by M3 on Chandrayaan-1', *Science* (24 September 2009).

8 A. Colaprete, et al., 'Detection of Water in the LCROSS Ejecta Plume', *Science* 330 (22 October 2010) 463-467.

9 *See* M. Weinhoffer, International Management of Space Resource Extraction: Don't Put the Cart Before the Horse, 43 J. Space L., 171 (2019).

commercial space mining technology development. Space resource extraction will be critical to establishing a sustainable human presence on the Moon, and it is inappropriate to debate legal issues related to commercial space mining without considering the immediate needs of commercial space mining companies, which is to execute their mission on the Moon as soon as possible.

## 2. International and National Regulation of Commercial Space Mining

A review of the current legal regime for commercial space mining shows that the sector has sufficient support to launch and operate missions to either the Moon or asteroids. The principal document that is used in the legal discussion of commercial space mining is the 1967 United Nations *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* ("Outer Space Treaty" or "OST").[10] Many of the principles established in the OST have been recognized as customary international law, meaning that even nations who have not ratified the treaty adhere to those principles because of *opinio juris,* or a belief that they should.[11] Russia, China, and the United States are the most notable parties to the treaty, having launched national astronauts into outer space on their own rockets. The articles that are most applicable to the legality of space mining are Articles I, II, and VI.

Article I mandates that "the exploration and use of outer space, including the Moon and other celestial bodies shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development," and that "there shall be free access to all areas of celestial bodies" by all nations.[12] Article II of the OST states that "Outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[13] Finally, Article VI of the treaty states that private space activities (such as commercial space mining) "shall require authorization and continuing supervision by the appropriate State Party to the Treaty."[14] These

10 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, (1967), 18 U.S.T. 2410, TIAS 6347 [hereinafter Outer Space Treaty or OST.

11 According to Soucek, "customary law requires an objective or material element – State practice ('material facts') – and a subjective or psychological element – the belief that the practice is lawful ('opinio juris')." Soucek notes that the "three freedoms" granted by Art. I of the OST: freedom of access to, exploration, and use of outer space, may have the status of customary international law. A. Soucek, Space Law Essentials – Volume I: Textbook (p. 12). Vienna: Alwa & Deil, 2016.

12 Outer Space Treaty, *supra* note 10, art. I.

13 *Id* art. II.

14 *Id* art. VI.

three articles are perhaps the most fundamental of the Outer Space Treaty, but proposed space mining activities have reignited debate internationally over their proper interpretation.

No article of the OST states or implies that any commercial space activity requires international governance. State parties to the OST have the responsibility to ensure that all national space activities are in accordance with the OST. While the OST has an inherently international scope, it leaves governance of specific activities, such as commercial space mining, to the State parties to the Treaty. While companies are prohibited from claiming ownership of a celestial body by Article II of the OST, resources on celestial bodies should be allowed to be owned. A similar arrangement is apparent on the High Seas, where a company can claim ownership of caught fish while being prohibited from claiming ownership of the ocean itself.

Because space mining activities can and should be regulated on a national level, there is no need for a binding or non-binding international agreement in the near-term. Articles of the OST, national legislation, continued discussion at the U.N. Committee on the Peaceful Uses of Outer Space ("COPUOS") and the meetings of Hague Space Resources Governance Working Group, which is the international commercial space mining study group mentioned in Section 1, are sufficient mechanisms for the governance of commercial space mining in the near-term. For example, the United States and Luxembourg have enacted laws that guarantee ownership rights to celestial resources that are extracted by non-governmental entities and will legally support any commercial space mining company who is granted a license under either nation's regulatory regime.[15, 16] An international agreement may be necessary down the road to clarify ownership rights, but the near-term focus of the industry should be on the development of resource extraction technologies. regime. At this time, there is no need for an international agreement on commercial space mining, and Section 3 of this paper will argue that a new international agency is also inappropriate at this time, despite such agencies being established for other private activities, namely telecommunications and deep-sea mining.

15 U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 70 (2015) [hereinafter the CSLCA].

16 Loi 674 du 20 juillet 2017 sur l"exploration et l"utilisation des ressources de l"espace [Law 674 of July 20, 2017 on the Exploration and Use of Space Resources], Journal Officiel du Grand-Duche de Lux, 28 July 2017 [hereinafter the Luxembourg Space Resource Law].

### 3. International Regulation of Satellite Telecommunications and Deep-Sea Mining

The International Telecommunications Union (ITU), a U.N. agency, regulates satellites communications on an international scale as part of its role in the information and technology sector. Part of the mission of the ITU Radiocommunication Sector is "to ensure rational, equitable, efficient and economical use of the radio-frequency spectrum by all radiocommunication services, including those using satellite orbits…"[17] The Hague Space Resource group applies this principle to space resources through building block 4f, which states that an international framework for commercial space mining should "promote the rational, efficient and economic use of space resources."[18] The ITU fulfills their mandate by allocating and assigning radio frequencies to specific space services, such as maritime, mobile, broadcasting, space research, and amateur services. This complex and lengthy process ensures the optimal use of radio frequencies.

A regulatory agency for commercial space mining could use similar mechanisms to prevent overexploitation of certain minerals on the Moon or on asteroids. Such an agency may assign scientific and/or economic values to extractable resources, and then impose limits or freedoms on the amount of that mineral that may be extracted from one site. The value of space resources would be subject to debate, and the more nations that are involved in commercial space mining, the more complicated the system gets, similarly to telecommunications. Adopting radio frequency allocation principles for the equitable extraction of space resources is a possible way to regulate the commercial space mining industry, but it would likely fall victim to heavy-handed regulations.

A second regulatory agency that deals with ensuring the rational use of natural resources is the International Seabed Authority (ISA), which was established by Article 156 of the United Nations Convention on the Law of the Sea (UNCLOS). The ISA is mandated with organizing and managing all mineral-related activities of the members of UNCLOS in the international seabed area.[19] The "international seabed area" is defined by the U.N. agency as "the seabed and ocean floor and the subsoil thereof, beyond the limits of national jurisdiction," which accounts for about 54 percent of the area of the world's ocean.[20] The ISA is currently accepting comments on proposed deep-

17 'Radiocommunication Mission Statement', *International Telecommunications Union*, 2019.

18 Building Block 4.2f, The Hague Space Resources Governance Working Group, Draft Building Blocks for the Development of an International Framework on Space Resource Activities, September 2017.

19 United Nations Convention on the Law of the Sea, Art. 156, Dec.10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

20 'Frequently Asked Questions (FAQS)', *International Seabed Authority*, 2019.

sea mining regulations, which were most recently discussed at a meeting of the agency's members in July 2019.[21] It is important to note that the United States has not ratified the UNCLOS, which means that it is not a member of the ISA (However, the U.S. is an active member of the ITU, and has a commanding presence at the World Radiocommunication Conferences). The agency has contracted with twenty-nine companies of various States to harvest minerals from select areas of the ocean since 2001, but no resource harvesting has been undertaken.[22] A regulatory agency for commercial space mining could operate in a similar fashion by entering into contracts with specific mining companies or those that are developing resource extraction technologies. The agency would only enter into a contract when it is satisfied that the company will not harm the celestial environment and will ultimately be a good steward of space exploration. Companies would also be bound by the articles of a specific commercial space mining treaty, and the regulatory agency would also be established in this treaty, just like the ISA.

Although the ISA has been in operation in Kingston, Jamaica for twenty-five years, no commercial deep-sea mining operations have taken place, which is likely due to a combination of slow regulatory discussions and technology development challenges for the extraction of minerals on the seabed. An agency that largely adopts the practices of the ISA and applies them to space resources will likely suffer from similar challenges, and it is hard to see how such an agency would be of assistance to commercial space mining companies while they conduct initial missions. Ultimately, a regulatory agency for commercial space mining would likely hinder the commercial space mining industry more than help it, but fortunately there is an attractive alternative that focuses on the most basic current need of commercial space mining companies, which is technology development assistance.

## 4. The Best Medicine for the Commercial Space Mining Industry

The best medicine for the commercial space mining industry is outlined in the Space Resource Institute Act of the 116th Congress of the United States.[23] The Act, introduced in February 2019 in both houses of Congress, calls for a report to be issued by NASA "on the merits of, and the options for, establishing an institute relating to space resources to advance the objectives of NASA in maintaining United States preeminence in space." The report must include an assessment of "whether partnering with institutions of higher education and the aerospace industry, and the extractive industry as

21 International Seabed Authority, Draft regulations on exploitation of mineral resources in the Area, ISBA/25/C/WP.1, (22 March 2019).

22 'Deep Sea Minerals Contractors', *International Seabed Authority*, 2019.

23 U.S. Congress, Space Resource Institute Act (H.R. 1029/S. 381). Introduced in House February 6, 2019.

appropriate, would be effective in increasing information available to the institute with respect to advancing the objectives described…" Such objectives include "encouraging the development of foundational science and technology" and "reducing technological risks associated with identifying, developing, and distributing space resources."[24]

This legislation received little to no attention among the space industry media, but the bill, introduced by Representative Tipton and Senator Gardner, both of Colorado, should be studied by both the commercial space mining industry and NASA. Even if the bill does not become law, it would benefit the commercial space industry if NASA writes and publicly releases a report on the commercial space mining market and either support or reject the notion of a new office for commercial space mining technology development. If an office is established, NASA should be open to partnerships with academic institutions and commercial space mining companies that have been awarded contracts for their services on the Moon. Although the Artemis program will initially be a domestic effort, NASA should invite foreign contributions to technology development efforts as appropriate. NASA would also need to set guidelines on the specific functions of the office while ensuring that intellectual property is protected. It should be up to NASA to decide if the establishment of such an office will be helpful to the Artemis program and determine what specific help it will provide to commercial space mining companies.

A commercial space mining technology development office within the Space Technology Mission Directorate should initially focus entirely on technology development assistance for lunar mining because there are many more companies pursuing lunar mining than asteroid mining at this point. NASA's DART and Psyche missions, both involving asteroids, will further develop asteroid mining technologies such as proximity operations and mineral characterization. NASA should wait until the Artemis program is either well underway or completed before broadening the space mining office's focus to include asteroid mining so that asteroid mining technologies continue to mature through NASA's own deep-space missions.

Even if a dedicated office is not established, NASA should offer greater assistance to commercial space mining companies and publicly show support for the industry. It would be difficult to find a space professional who is not convinced that space resource extraction and utilization will play a crucial role in humankind's expansion into the solar system. A "sustained lunar presence," which is desired by NASA as the ultimate goal of the Artemis program, will not be achieved without comprehensive investigations on the Moon into lunar resource extraction. Fortunately, NASA has expertise in this domain thanks to sample-acquisition technology developed for the OSIRIS-

24 *Id* §2(a) and §2(b).

REx spacecraft and the proposed Europa Lander mission. Engineers at NASA's Jet Propulsion Laboratory have experimented with a variety of sampling saws and centrifugal and pneumatic sample collection devices for a proposed Europa Lander mission, and this technology can be modified for the lunar surface or even tested on a commercial lunar vehicle in preparation for sample collection on Europa.[25] The OSIRIS-REx spacecraft features a "reverse vacuum" sample collection arm that could be shrunk to fit a commercial lunar vehicle.[26] Robotically collecting lunar regolith should not be a great technical challenge since the technology for doing so is present in current NASA missions, but efforts to do so ought to be consolidated in a new NASA office based at either JPL or the Goddard Space Flight Center, which are the premier facilities for robotic space research.

The core elements of the Artemis program are the SLS rocket, the Orion crew capsule, the lunar Gateway, and the associated ground systems at the Kennedy and Johnson Space Centers. Commercial lunar mining should be included as a core element, as the utilization of lunar resources will allow both crewed and uncrewed spacecraft to fly farther into the solar system through the use of converted fuels. Like most new space ventures, lunar mining, not to mention asteroid mining, will not become a commercial reality unless NASA makes it an agency priority, and fortunately this activity fits quite well with the goals of the Artemis program. Only a "freeze" on new international regulations for lunar mining and a dedicated technology development effort with result in a thriving lunar mining industry, and a new NASA office is a great step towards this goal.

## 5. Conclusion

NASA would benefit from establishing a commercial space mining office within the Space Technology Directorate because a dedicated office would lead to the development of new commercial resource extraction technologies that would strengthen the scientific value of the Artemis program. A commercial space mining office should initially focus on technology development for lunar resource extraction, but eventually expand its scope to include asteroid mining. An international regulatory agency for commercial space mining, even if it adapts successful regulatory mechanisms from the ITU and ISA, would likely be more harmful to the commercial space mining industry then helpful, and is not the path forward in the near-term. While

25 *See* NASA JPL presentation on "Sampling Chain Development Status" (May 2019) for the proposed Europa Lander mission, found at NASA JPL's Europa Lander webpage.

26 For further information on this technology, please see E.B. Bierhaus, et al., 'The OSIRIS-REx Spacecraft and the Touch-and-Go Sample Acquisition Mechanism (TAGSAM)', (*Space Science Review*, 20 September 2018).

there are legal challenges for commercial space mining ahead, it is more important for the United States to focus on the success of the Artemis program than engage in prolonged and nuanced debates regarding ownership rights for space resources. Fortunately, the United States legally supports commercial space mining, so it is now time to demonstrate space resource extraction technologies on the Moon. A new NASA office dedicated to technology development for space mining would offer the support the industry requires, instead of a new regulatory agency that would unduly burden bold "NewSpace" companies who want to reap the benefits of space resources as efficiently as possible. Commercial lunar mining companies cannot be expected to execute their lunar missions with little to no assistance from NASA, and the scientific value of the Artemis program increases significantly if NASA makes lunar resource extraction an agency priority. The solution proposed in this paper involves two steps, but they should be done concurrently to maximize the chance of lunar resource extraction missions taking place under the scope of the Artemis program in the late 2020s.