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Examining the Concept of Space Mining Colonies: Expected Benefits and Legal Matters

INTRODUCTION

As population expansion and resource availability are inversely linked with rising energy demand worldwide, tensions will probably get worse. In the end, we would be forced to look to other planets and extraterrestrial resources to complement or replace those found on Earth (HANNON 2022). This is where the idea of colonies focusing on space resource extraction comes from.

As we delve further into this topic, it should be considered that we are mostly talking about the theoretical features of space-mining colonies. No operational mining colonies exist outside of Earth currently. In the future, there might be colonies involved in mining or colonies primarily focusing on mining activities. In this chapter, we examine the legal background for both, with a focus on the possibility of establishing highly specialised colonies with the purpose of resource extraction. By engaging in this conceptual research, we may look into potential results and implications for future space exploration and resource utilisation.

These colonies are currently only a speculative concept, but as technology advances and interest in space exploration grows, it is important to start discussing their economic benefits and the legal difficulties that may hinder their lawfulness.

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We can say that space-mining colonies might offer a promising solution to our resource scarcity problem by tapping into the vast resources available in space. Numerous experts have supported this theory, such as John S. Lewis, author of *Mining the Sky. Untold Riches from the Asteroids, Comets, and Planets*, in 1997 strongly arguing for the potential benefits of space mining to both science and the economy. Another notable example is Chris Lewicki, the CEO of Planetary Resources and a former NASA engineer, who has been a loyal supporter of space mining, emphasising how the technology may help future space exploration missions and enable sustainable resource utilisation beyond Earth.

But to be fair to the topic, we cannot deny that some think that this might not bring too much to our lives. As an example, NASA's researcher and planetary scientist Phil Metzger has questioned whether space mining is economically viable considering the high cost and challenging technology requirements of extracting and transmitting resources from space. Moreover, Martin Elvis has a similar opinion. He is an astrophysicist at the Harvard Smithsonian Center for Astrophysics, and he questioned the feasibility of space mining initiatives since he believes that the costs involved in extraction and transportation may be more expensive than any potential rewards. Whether these colonies will ever be established and if they might be economically viable remains to be seen. In this paper, we intend to examine certain aspects that might be relevant in case different spacefaring actors intend to start space resource extraction through permanent human settlements.

According to Bidshahri, these colonies should be self-sustaining habitats (BIDSHAHRI 2019) equipped with advanced technology and infrastructure, enabling humans to extract valuable minerals and rare elements from asteroids, moons and other celestial bodies (LE MEUR – LEVACHER 2022: 74–92). With the potential to revolutionise resource sustainability, space-mining colonies could pave the way for a new era of exploration and ensure the long-term survival of humanity. NASA thought that humans could effectively occupy space in the 1970s (JOHNSON–HOLBROW 1977). Now that it is becoming a near reality; Moon Express and ispace are planning to mine the Moon. Along with this,

Space Development Nexus has a plan to mine near-Earth asteroids (Nanalyze 2021). Many nations, including Australia, Canada, China, France, Germany, India, Japan, Russia, the United States and the United Kingdom (PELTON 2016: 105–120) have expressed interest in space mining (HANNON 2022).

According to the Harvard International Review, “mining just the top 10 most cost-effective asteroids is, those that are both closest to Earth and greatest in value would produce a profit of around US \$1.5 trillion”. The main-belt asteroid Psyche, according to the article, “has been reported to contain USD 700 quintillion worth of gold, enough to give each person on Earth about USD 93 billion” (YARLAGADDA 2022). Helium-3, which is present in rock and soil on the Moon, may one day prove to be a lucrative resource if nuclear fusion is made possible; It makes sense that businesses would seek to benefit from mining space resources (YARLAGADDA 2022).

But before continuing, it might be necessary to ask: Would not the world gold market be impacted if these enormous quantities became available? This is a legitimate worry since a sudden flow of resources from space mining may cause the dynamics of the market to change. Therefore, even if the finding of such a massive mineral deposit in space is fascinating, care must be taken to properly evaluate its practical consequences for market dynamics and financial distribution.

Mining colonies may be essential for future power generation in outer space, necessitating exploration and maintenance of base stations and stopover sites (MADHAVAN NAIR et al. 2008: 1337–1342). However, as space colonies live their own lives, they may evolve independently and lose their relationship with Earth confronting a variety of obstacles, including technical failures and the psychological effects of isolation, which could ultimately cause them to fall apart or be abandoned (POWELL et al. 2001: 737–765).

Space-mining colonies might be the next big human endeavour. Yet, there is a gap between corporate entities’ ambitions and international and domestic space legislation that is still unfilled. The Outer Space Treaty might present the simplest framework for colony establishment, yet it raises more concerns than solutions. In this article, we will attempt to address the following question:

What are the economic benefits and the legal concerns associated with the creation of mining colonies in space?

To answer this question, this article will adopt a normative methodology with an economic approach that integrates a normative legal framework supported by quantitative statistics to address this subject. By examining the potential benefits and challenges, this approach aims to provide a comprehensive analysis of the feasibility and sustainability of such mining colonies. Additionally, it will consider the implications of international law and regulations on such ventures, ensuring a well-rounded evaluation of the topic.

TERMINOLOGICAL CLARIFICATIONS

Before diving into the analysis of the topic, we must first identify the main terms that will be frequently used in this chapter.

Space mining

Space mining can be defined as “the exploration, exploitation, and utilization of natural resources to be found on the Moon, other planets, and near-Earth asteroids (NEAs)” (GRES 2022). Yet, when it comes to the expression “space resource extraction”, according to some experts, this is far more appropriate than “space mining” because it refers to the process of mining resources rather than space itself. Unlike traditional mining on soil, by using this term, we can both characterise the operation and emphasise how it differs from mining on Earth. We may further refine our definition by distinguishing between “space resources” and “asteroid resources”. Any natural resource or substance that exists in space, especially on planets, and may be mined or used for a variety of purposes is referred to as a “space resource”. These resources consist of water, minerals, solar energy, helium 3, and so on (MCKAY et al. 1992).

On the other hand, “asteroid resources”, specifically refer to resources found on asteroids that can be mined and utilised. Due to the size difference between

meteoroids and planets, asteroids are frequently referred to as “minor planets” (New Space Economy 2023).

In light of this, we may question if space mining is justified legally and whether current laws allow such actions, given that space mining is not a novel idea but rather an ongoing mission that mankind is continuously attempting to achieve. This matter will be tackled in the coming paragraph after identifying our second main term, colony.

Colony: Space colonisation or space settlement, any differences?

The term colony can be tricky to define and use without being in the realm of criticism. According to the Cambridge Dictionary, the word colony refers to “a country or area controlled politically by a more powerful country that is often far away”. Furthermore, “a colony is also a group of people with a shared interest or job who live together”.

Within the space sector, space colonisation is a literal translation of “human habitation in space, other than Earth, it could be anywhere. It might exist in orbit, on Mars, or another planet” (MANE 2022). A possible form of space colonisation would be an orbiting space station. Right now, there is just one fully functional low Earth orbit space station, which is the International Space Station (ISS) (MANE 2022).

This definition can be simple and accurate, but the word colony does hold other concepts that cover the meaning. Especially with colonialism, the term “colony” may carry unfavourable historical connotations of exploitation, oppression and lack of autonomy. Thus, many experts on the subject prefer to use other names, such as “settlement” or “station”, when referring to habitations or installations in space. Despite this, we can see that most different futuristic space projects are still using mainly the word “colony” or “space colonisation”.

In the context of space exploration, the term “colony” has evolved to refer to the establishment of a human settlement on a celestial body, like the Moon or Mars, mainly not for controlling purposes. This change is revealing a more positive and broad vision for space exploration in the future. It also demonstrates

the possibility of international cooperation in building viable communities outside of Earth. Likewise, the usage of the term in numerous space projects might be an effort to get the attention of the audience, raising appreciation for the excitement of these missions and greater hopes for the future. In this case, the second meaning of the term “colony” cited in the Cambridge Dictionary above “a colony is also a group of people with a shared interest or job who live together” may be applicable in the space sector.

REASONS: WHY SPACE MINING COLONIES?

The construction of space colonies in the future could be motivated by the possibility of finding water, fuel sources, and rare minerals on distant planets or asteroids, so we can gain financially from them. Furthermore, space colonisation may serve as a foundation for upcoming interplanetary travel and other technological breakthroughs.

Natural and geopolitical reasons

The first reason are rare earth elements (REE) (ZAMPA 2021). These kinds of elements can be found on the Moon and other celestial bodies (STAEDTER 2020). Additionally, and most intriguingly, platinum, palladium and rhodium have been discovered on our Moon (GOCHA 2020), along with water ice (KERR 2009). As a result, exploring and utilising these resources could reduce our dependence on Earth’s limited minerals and open up new possibilities for space exploration and the colonisation of other mining planets.

The second reason is geopolitical; control and access to REE and other materials have become a strategic concern for countries worldwide, leading to intense competition and conflicts over their acquisition and trade. For example, China has been the dominant producer of REE for many years. This has given China significant influence in international trade negotiations and has caused other countries to seek alternative sources and develop their

domestic production capabilities (SEAMAN 2019). For example, the United States is now investing in REE projects to reduce its reliance on Chinese supply and safeguard its technological advancements and national security interests (HANNON 2022). This makes us wonder if the success of such projects could potentially reduce the motivation for space mining in the future.

Economic reasons

Going back to one of the main focuses of this article, if there are minerals worth mining in space, it means that we can benefit economically from them. Using these elements can lead to job creation and financial growth. Furthermore, the development of space mining technologies and infrastructure can boost innovation and drive advancements in other industries, ultimately benefiting the global economy.

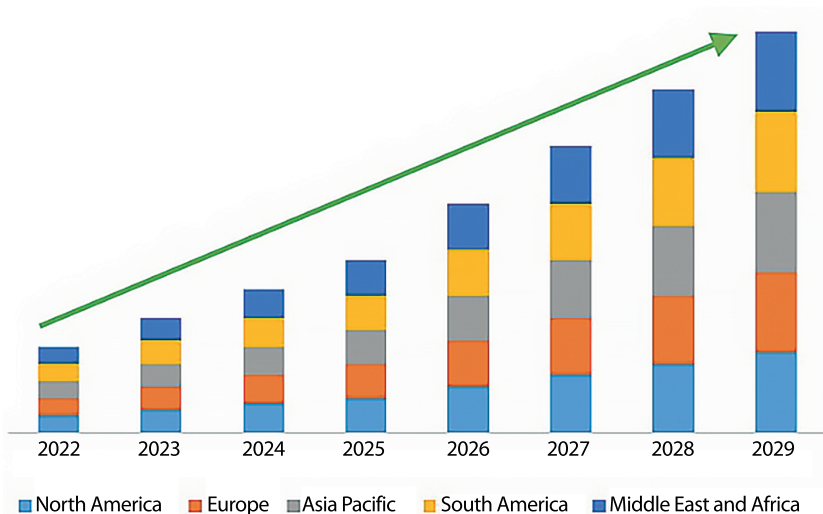


Figure 1
Global space mining market by regions, 2022 to 2029
Source: Data Bridge Market Research 2023

Figure 1 demonstrates how space mining has a significant potential for financial gain. Space mining companies and states can extend their operations and generate new revenue streams by extracting precious resources from celestial bodies, such as water and rare metals. In fact, the space mining market is expected to increase at a Compound Annual Growth Rate (CAGR) of 20.48% to reach USD 5,068.06 million by 2029 from its value of USD 1,141.62 million in 2021, according to Data Bridge Market Research (Data Bridge Market Research 2023).

Also, if mining is already profitable on Earth, then colonising other planets has the enormous potential to bring far higher profits. Building space mining colonies would open new possibilities for resource discovery and utilisation, resulting in previously unheard-of technological advancements and economic growth, in addition to expanding the volume of resource extraction. Moreover, according to some experts, space mining colonies are just like “establishing markets in space” (WEINZIERL 2018).

Strategies for establishing a futuristic Moon mining colony

Since this vision is so close to becoming a reality, a variety of strategies designed to promote transparency in the management structures for future lunar colonies reflect inclusive and sustainable space exploration methods. To build a comprehensive framework that addresses multiple interests while adhering to existing space treaties, SGAC’s E.A.G.L.E. Project, for example, promotes collaboration among numerous stakeholders, such as governments, business entities, academics and international organisations (SGAC 2021). Comparably, to enable a variety of individuals to engage in decision-making procedures and get access to lunar resources, the Open Lunar Foundation promotes an open-access strategy that emphasises equality and transparency. As a result, these approaches seek to advance economic development and innovation in lunar operations while balancing the interests of many investors (UNOOSA 2023). In addition, there are a few other points that emphasise the need for a flexible governance structure adapted to the opportunities and challenges

of space settlement. These include decentralised models powered by commercial space firms like SpaceX and Blue Origin, government-led strategies, and collaborative concepts like the Moon Village promoted by the European Space Agency.

THE LEGAL FRAMEWORK: WOULD SPACE MINING COLONIES BE LEGAL?

The legality of future space colonies involved in mining activities is mostly linked to the legality of the mining operation itself. The legality of space mining is debatable, and international negotiations are currently underway to establish a more comprehensive legal framework for space mining colonies. In this section of our paper, we will first explain why this controversy exists, which is mostly due to the ambiguity of the terms used in space law relating to this topic. Second, we will analyse both sides of the debate, focusing on the arguments of each as well as the international community's position on resolving this matter through accords or domestic legislation.

Space mining and International Law

The legal ambiguity surrounding the space mining activities

This section of our chapter will primarily focus on the Outer Space Treaty (OST), which serves as a key legal framework governing space activities and is also known as the *Magna Carta* of international Outer Space law, as well as the Moon Agreement, which addresses the exploitation of natural resources in space.

The debate about whether space mining is fully legal or not is mostly based on the vague language used in the OST. This created two opinions: the first States affirming its legality and having already started with the preparation of their space mining projects, and the second States that are still against it

concerning its illegality and the consequences that can occur from mining natural resources in space in the absence of clear regulations in place.

To analyse the uncertainty about whether space mining is legal or not, we can start with the ‘ordinary meaning’ of the terms used in the OST. Even though space mining is not expressly covered, all space-related activities are still governed by the various obligations under that treaty. In this instance, the word “use” in Article I does not specify whether the extraction of space resources qualifies as “use”, nor does its ordinary meaning indicate whether property rights over extracted space resources can be obtained (BYERS–BOLEY 2023).

Referring now to Article II of the treaty, it is forbidden for any country to appropriate space “by claim of sovereignty, by means of use or occupation, or by any other means”. As “national appropriation” is also ambiguous under this context, some scholars said that it has no ordinary meaning and it is unclear if this refers to the dominant exploitation of a resource or territory by a single nation or not (BYERS–BOLEY 2023).

When it comes to the Moon Agreement, it contains less ambitious language compared to the OST; we must first mention that this agreement, which is ratified by 18 countries, none of whom are major spacefaring states, may be due to an implied language prohibiting lunar resource exploitation. For some, Article II(2) of the Moon Agreement mirrors the restrictions outlined in Article II of the OST (FREELAND–JAKHU 2009). However, one of the primary objectives of the Moon Agreement is to promote the “exploitation” of the Moon’s natural resources through the Agreement’s existing provisions and the eventual establishment of an international framework. It follows that the restriction on natural appropriation in Article 11(2) of the Moon Agreement does not, by itself, restrict the use of natural resources; doing so will require removing such resources from their “place” on the Moon (BYERS–BOLEY 2023). The uncertainty of what could be the right expression of the terms frosted the debate on the legality of space mining activity.

Analysing the lawfulness of space mining:
Identifying different positions

Possible barriers to confirming the legality of space mining

The doubt and uncertainty about the legality of space mining is due to the existence of some signs that restrict this activity and, as a result, limit the existence of space mining colonies in the future. These forbidden indicators, based on international space law, can be primarily related to the expression used in the OST “appropriation” mentioned in its Article II, which can be defined based on the Cambridge Dictionary, as “the act of taking something for your use, usually without permission”.

States and private entities may be restricted from mining space

These can also be referred to as the “subject” of the *non-appropriation*. Article II of the OST mainly aims to limit states’ ability to engage in “national appropriation” by prohibiting it. Supporters counter that this prohibition does not apply to private entities, which means they are free to appropriate, use, or claim celestial bodies for their own financial advantage (POP 2008). However, the Chinese translation of the treaty appears to restrict the ban on appropriation to State parties alone “state appropriation”, whereas the English, French, Russian and Spanish versions of the document refer to a broad prohibition on appropriation “national appropriation”. An inaccurate translation could be the cause of this disconnect (JINYUAN 2017). In this case, we can say that Article II is interpreted to allow private appropriation, which is said to go against the intent of the OST because appropriation by private entities or States interferes with unlimited access to space. The term “national appropriation” was meant to refer to both public and private appropriation, as the Outer Space Treaty’s writing history attests to (FREELAND–JAKHU 2009). Conforming to Article VI of the treaty, State parties are responsible for maintaining responsibility for national activities conducted in space by governmental and non-governmental entities

and for making sure that such activities comply with the treaty's provisions. Therefore, private companies' appropriation of space should be viewed as non-appropriation by their States (TRONCHETTI 2014: 193–196). In light of this, we can mention a court case – such as the United States of America v. One Lucite Ball Containing Lunar Material (One Moon Rock) and One Ten Inch by Fourteen Inch Wooden Plaque (2003)² – in which the judge claimed that it was illegal to own or sell celestial bodies as a whole or in parts (FREELAND–JAKHU 2009). This therefore strengthens this interpretation of the prohibition mentioned in Article II (JINYUAN 2017).

The uncertainty of the legal status of the celestial
bodies and their resources is identical

This can be referred to as the “object” of the *non-appropriation*, in other words, are the resources of celestial bodies non-appropriable, just like the celestial bodies themselves? (JINYUAN 2017). If this is the case, then resource exploitation, which is essentially a “taking of possession” and an “exercise of control” over them, amounts to a partial appropriation of celestial bodies. Opinions on this matter diverge. While some contend that both space and its natural resources are covered by the non-appropriation principle of Article II (GOROVE 1973), some maintain that while the concept applies to space, it does not apply to its natural resources (WILLIAMS 1987: 142–151). The Outer Space Treaty forbade states from claiming space and celestial bodies as their own territory, to prevent sovereignty claims over outer space. This treaty was ratified in the 1960s when the mining of these resources was a low-priority concern and public interest in extracting natural resources from space only developed in the 1970s, but some support the idea that this restriction was mainly for military purposes (GABRYNOWICZ 2004: 1041). In other words, the activities that are prohibited are expressly stated in the treaty, and space

² For more information see www.collectspace.com/news/usvmoonrock.pdf.

mining is not expressly listed; nonetheless, the absence of an express statement of prohibition does not imply its legality (COFFEY 2009: 119).

There are two main concerns to answer: first, are there any naturally occurring objects in space that are not celestial bodies because of their significant differences in size and composition, and second, are tiny asteroids considered a material resource whose appropriation is not expressly prohibited? The term “celestial bodies” is mentioned several times in the OST, yet it does not define it. This lack of definition leaves room for interpretation regarding whether asteroids fall under the category of celestial bodies and if they fall under the same possible prohibition or not. Generally, since the OST did not make any observations or differences, it all falls under the used term of a celestial body and, as a result, under the same possible restriction (JINYUAN 2017).

The claims of sovereignty

Or referred to as the “means” of *non-appropriation*, Article II of the Outer Space Treaty specifically forbids appropriation using “sovereignty” claims. This includes claims over space, which qualify as appropriations. As an explanation, even in cases where no formal claim to sovereignty is made, arguing in favour of property rights over resources mined from space may constitute a *de facto* declaration of sovereignty. The non-appropriation principle may be broken if a state views resources from asteroids as belonging to its territory (TRONCHETTI 2014: 193–196). The use or occupation of space in a way that prohibits others from profiting from that present sovereignty is known as appropriation. The U.S. Space Resource Act, for example, acknowledges property rights over “asteroid resources or space resources obtained”, but it does not define the phrase “obtained” precisely. There have been several questions raised about the U.S. federal legislation governing the unextracted, *in situ* asteroid resources and whether it equates to “other means” of national appropriation (JINYUAN 2017).

The Moon Agreement prohibits the use of space, especially for things and subjects. It declares that the Moon’s surface, subsoil, or natural resources should

not be owned by any state, international organisation, country, or person. Unlike the Outer Space Treaty, it states that the Moon and its resources are the common heritage of mankind (JINYUAN 2017).

Principles supporting the possibility of the legality of space mining

The principle of freedom of exploration and use of outer space

Supporters of mining space are looking at it as the manifestation of the principle of the freedom of use of outer space, which is expressly guaranteed by the OST (SCHMITT 2021: 21–26). In common usage, “use” means applying or employing something; yet, some understand it to mean both non-commercial and commercial use, such as using space and celestial bodies for profit (FREELAND–JAKHU 2009). The IISL Board of Directors maintains that there is no global consensus over whether freedom of use encompasses the ability to obtain and use non-renewable natural resources, such as water and minerals found on celestial planets (HOBE 2016). Based on the Vienna Convention on the Law of Treaties 1969, “a treaty should be interpreted in good faith [...] and in the light of its object and purpose”. Considering this, we may assert that the Outer Space Treaty aims to encourage free space exploration and utilisation rather than impose restrictions on it. The fact that state parties have acknowledged that it is in the common interest of all mankind to encourage space exploration and peaceful uses makes this statement most likely true.

We can support this freedom position with one of the latest declarations from Michelle Hanlon, director of the Center for Air and Space Law Research at the University of Mississippi in the United States. She said: “At present, everything is permitted on the Moon.” Furthermore, she explained that existing laws stipulate the Moon’s use exclusively for peaceful purposes and prohibit the establishment of military installations. Essentially, she emphasised that while there are regulations in place, they do not impose significant restrictions on what can be placed on the Moon, except for the prohibition of nuclear weapons (GODDARD 2024).

However, ownership of mineral resources is not assumed by legal text. Under the laws of various regulations, wild animals, for example, are *res nullius*, or ownerless property. They can be considered private property when reduced to possession by being killed or captured (Byers–Boley 2023). By contrast, mineral resources could be generally owned by States or private entities and are not subject to the Mineral Resources Law of the People’s Republic of China, Article 3, which provides that ‘[m]ineral resources belong to the State’.

Mineral resources, do not follow the “first come, first served” as mentioned in the Mineral Resources Law of the People’s Republic of China. Similar regulations have been set by the UN Convention in some regions outside of national borders, such as the freedom of access to high seas fisheries as long as conservation measures are taken (UNCLOS Article 116). Yet, these norms cannot be extended to outer space to prohibit the exploitation of its natural resources because the preceding domestic legislation and international treaties prohibiting mineral exploitation are based on agreements between states. In addition, the natural resources in outer space, like those in the deep bottom, are not defined as the “common heritage of mankind” under the UNCLOS in Article 136. Outer space is not subject to national sovereignty, space resources are effectively in a “state of nature”. The Earth’s resources can no longer be used without considering the interests of others due to industrialisation and population growth. Considering how plentiful these resources are, one might conclude that mining minerals in space is legal if one considers the opportunity that others must engage in similar activities, and it is not a privilege for a few countries (JINYUAN 2017).

The principle of the collective interests of all nations
and the common heritage of humanity

In Article I of the OST, outer space exploration and use, “shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind”. This means that any activity in space should be done to benefit all nations and

all humankind. It is important to ensure that the resources are utilised fairly and equitably to uphold this principle. The use of the term “shall” emphasises the necessity of such action, and as a result, it “should be treated as a binding legal obligation” (CHENG 1997). When Article 11(2) of the Moon Agreement forbids the possession of lunar resources, it does not forbid using and accessing them. Rather, it highlights the necessity of safe management and regulation to guarantee that the utilisation of these resources is carried out in a way that aligns with the values of equity, sustainability and the common interest of all countries.

The concept of common interest governs the freedom of use of space, to ensure that the interests of all nations are considered while exploring and using space. In principle, all nations would gain from the extraction of natural resources in space, as it could help with the shortage of resources on Earth and encourage advancements in science and technology. Yet, as the advantages and interests shared by all nations are not equal to those shared by each nation, what is advantageous to one state may not be to another. Although, it is sometimes challenging to achieve each state’s benefits and interests (HUDGINS et al. 2002).

Despite the mode of production, the exploitation of space resources should be carried out by a collective body or capable entities in a free market. And the benefits should be distributed according to distributive justice, with all states entitled to an equal share (PAXSON III 1993: 487).

What about the international customary law position?

Regarding space mining operations, customary international law presents a nuanced and dynamic position. It is debatable whether new customs laws adapted specifically to space mining are necessary, even if several well-known concepts, like the prohibition on space appropriation, have been recognised as components of customary law. In actuality, the evolution of customary law on this subject is influenced by several factors, including the duration of time, consistency and generality of state practice. Space mining operations do not yet have enough developed norms. Nevertheless, customary law, which

allows scientific research but forbids commercial space exploitation, makes it difficult to draw a clear distinction between the two types of activity. Moreover, although accords like the Moon Agreement forbid commercial mining until an international framework is established, their recognition and customary standing remain questionable (JINYUAN 2017). Actually, “the true test of the Moon Treaty both as treaty and customary law will not come until the exploitation of extraterritorial resources becomes technically and economically feasible” (LISTNER 2011).

*The Artemis Accords: Consolidation or fragmentation
of the space mining legal framework?*

Initially, the Artemis Accords were a series of 13 guidelines meant to promote international cooperation in space exploration. They were first signed on 13 October 2020, by eight states: Australia, Canada, Italy, Japan, Luxembourg and the United States. Signing the Artemis Accords is a requirement for NASA's larger Artemis Program, which aims to put a human again on the moon and conduct further human exploration of Mars (ZIELINSKI 2023). In alignment with the purpose of this paper, when it comes to the debate of space mining lawfulness, can the Artemis accords provide a clearer solution to the issue?

The most “controversial” aspect of the Accords is Section 10, dealing with the utilisation of space resources (BARTÓKI-GÖNCZY – NAGY 2023: 888–898). It emphasises the potential benefits of using space resources for sustainable and safe space activities. While stating that the extraction of these resources rarely corresponds to national appropriation under Article II of the Outer Space Treaty. As mentioned in the previous section of this article, the ambiguity of the OST regarding the space mining activity and the identification of the “national appropriation” can lead to confusion between different perspectives as it “leaves room for different interpretations” (BARTÓKI-GÖNCZY – NAGY 2023: 888–898).

These accords go by the USA approach to space mining, depending on the principle of freedom of exploitation established by Article I of the OST, which

is also adopted by its domestic laws, the Commercial Space Launch Competitiveness Act of 2015, which we will tackle in the next section. Regardless, it may create difficulties in international cooperation and regulation of space mining activities.

Another concept emphasised in the Artemis guidelines that we have to highlight is the “safety zones” to protect ongoing mining activities and prevent interference from other entities. Thus, it may raise concerns about the right to property in outer space as a territorial claim and potential conflicts in space governance as the characteristics of these zones, such as the size and scope, are not explicitly fixed, giving them flexibility depending on the “nature of the operation”, which could be a risk to interfere with the OST requirements (BARTÓKI-GÖNCZY – NAGY 2023: 888–898). As critics, China has expressed doubts about the concept of the safety zones delineated in the accords, and the head of Russia’s space program has stated that the accords are now too “U.S.-centric” to be approved (OSBURG–LEE 2022).

In sum, the Artemis Accords initiated discussions within the framework of the United Nations regarding the legal issues surrounding the exploitation of space resources. Yet, criticism can be seen as an act of unilateral action, negating multilateralism, which, as a result, can lead to the fragmentation of international space law. In addition, the lack of provisions regulating the liability of futuristic activities and environmental protection principles could lead to ongoing gaps in the space legal framework (BARTÓKI-GÖNCZY – NAGY 2023: 888–898).

SPACE MINING AND DOMESTIC LAWS

United States of America

After being signed into law by President Obama in 2015, the United States passed the “Commercial Space Launch Competitiveness Act” (CSLCA). The establishment of a stable and predictable legal framework aims to provide

American companies that collect and utilise space resources not only legal protection but also freedom, such as the ability to own, transport, or sell asteroid and space resources (TRONCHETTI 2014: 193–196). As mentioned in this paper, conceding that there is no clear indication of whether mining space is completely legal or not, this act is the subject of criticism from a lot of scholars, especially those who are against space mining depending of its illegality. Furthermore, this domestic law was reinforced later with the Artemis Accords, discussed above, which further solidified the U.S. stance on commercial space activities. But it also makes us question whether it is a sort of planned dominance or just to harmonise its legislation.

Luxembourg

To provide stability and a high degree of security for investors, explorers and miners, Luxembourg constructed an effective legal and regulatory framework in 2017 that includes specialised space regulation (Legilux 2017). By adopting this, it positions itself as the second nation in the world and the first in Europe to provide a legal framework for space resource exploration and utilisation. Following the provisions of Article II of the Outer Space Treaty, this statute is not intended to facilitate the “national appropriation” of any part of outer space, including the Moon and other celestial bodies. The objective is to elucidate Luxembourg’s national stance regarding the permissible status of resources that can be retrieved from certain celestial bodies and space overall. It also lays out the guidelines for managing and approving private space exploration projects, which include both resource use and exploration (Legilux 2017).

The United Arab Emirates

The United Arab Emirates implemented Federal Law No. 12, which governs the space industry, in December 2019. This legislation addresses a wide range of space-related operations, such as resource transfer, space mining and vehicle launches. The Director General of the UAE Space Agency, Dr Mohammed

Al Ahbabi, referred to this law as a “law for tomorrow” (WARNER 2021). Addedly, “space resources” are defined as “any non-living resources present in outer space, including water and minerals”. It is interesting to note that the law does not expressly say that using space resources is legal; instead, it lists “space resource exploration or extraction activities” and “activities for the exploration and use of Space Resources for scientific, commercial, or other purposes” as regulated space activities.

This legislation has liability provisions, which set it apart from previous domestic laws: According to Article 14, if the international community finds that the UAE violated the OST, the operator might be held accountable (Federal law no. 12 on the regulation of the space sector 2019).

Japan

Japan is the fourth country to establish a legal framework that supports the entry of its businesses into the economic exploitation of asteroids and other planets, joining the United States, Luxembourg and the United Arab Emirates (PONS 2021). Under Japan’s Space Resources Act (JSR Act), companies can acquire property rights over space resources “if the government approves their notified research methods, timing, and objectives”. Water, minerals and other natural resources that exist in outer space, including the moon and other celestial bodies, are selected as space resources. The legislation is silent on the definition of “natural resources” and whether they are inanimate or abiotic. Furthermore, resources located on or within celestial bodies are treated equally by the law with the celestial body itself. The law does, however, recognise obligations to abide by international law, which may indicate restrictions on asserting ownership over a whole celestial body.

Just as in the United Arab Emirates, authorisations are transferable only with the prime minister’s prior consent. Lastly, in addition to permitting space operations, the Space Resources Act specifies the property rights that the licence holder will possess. According to Article 5, a person who obtains ownership of space resources due to actions carried out under their authorisation does so

when they “possess the resource intending to own it”. Japan acknowledges the ownership of resources collected from space by a private entity (DEPAGTER 2023). However, an English version is not there yet from the Japanese Government, this claim can be due to the uncoherent translation used by some scholars.

In conclusion of this section, we can say that the jurisdiction mentioned above covers mainly space mining activities and not the regulation of establishing the colonies that will probably one day serve the extraction of space resources. However, these laws could shape the legal framework applied to the space mining colonies – if they come into existence – since they have already established the basis of the activity. Yet, it contains some lacunae that may need to be addressed in the future to ensure clarity and consistency in the regulation of space mining colonies and the effectiveness of the mining activity itself.

CRIMINAL JURISDICTION OF THE SPACE MINING COLONIES: A NEAR FUTURE OR A SCIENCE FICTION?

“That’s how justice works around here. We don’t have jails or fines. If you commit a serious crime, we exile you to Earth” (WEIR 2017). Our question here is, what if a crime occurred in these colonies if they existed, is space law able to cover this topic? The incident that occurred on the International Space Station (ISS) is an example since we can consider it as an orbital colony. Yet, investigators do not count it as the first crime in outer space since the damage and the plaintiff were on Earth. In 2019, NASA astronaut Anne McClain faced accusations that she had inappropriately accessed her divorced spouse’s bank account while living on the ISS (BAKER 2020). In Article 22 of the 1998 ISS Intergovernmental Agreement, nations agreed that jurisdiction over space-based personnel would be assigned according to their nationality. However, McClain was not prosecuted by the state, and the matter was settled in private between the parties.

Currently, the Space CSI investigates murder in microgravity, and this issue is also the subject of research by detectives. Michelle Hanlon predicted

that “Jurisdiction will be tricky”. The OST is silent when it comes to criminal jurisdiction, and these kinds of crimes can be out of reach of the liability convention. Another claim made by the CEO of For All Moonkind Inc. is that, according to the OST and the liability convention, space objects remain under the jurisdiction and control of the state that launched the object. “But what happens if the crime occurs in an object made in space? Jurisdiction will be even more complex!” (SERRIE 2024).

The lack of clear regulations surrounding space crimes raises concerns about accountability and enforcement in outer space when thinking about establishing mining colonies. It is suggested by White (2021) to create an Outer Space Criminal Statute (OSCS). By creating a common norm for future activities and addressing inadequacies in current criminal law. This would contribute to ensuring that those who operate in space, including individuals and private entities, are held responsible for any illegal activity they may have committed.

CONCLUSIONS

Considering all that has been discussed, we can sum up the matter by stating that the idea of establishing space mining colonies in the future holds enormous potential, driven by our natural curiosity, global needs and economic ambitions. Nonetheless, this ambitious objective presents a variety of legal concerns that must be addressed. The legality of space mining operations is a major topic of debate, and we can say that it has a direct impact on the possibility of establishing colonies for these kinds of operations. This debate is a result of the ambiguity in the terms and provisions of the current space law and whether the current domestic laws that are trying to govern this activity are in harmony with international space law or not. This, for sure, will necessitate careful interpretation of the rules and principles that govern space activities in general. In addition, if these colonies become a reality, it raises worries about the applicable legal framework in cases of criminal acts. We cannot deny that the concept of establishing space mining colonies is promising for humankind’s

future exploration and resource use in outer space. Yet, a compromise between the different nations and the adoption of a clear position toward the lawfulness of space resource extraction activities that will enhance the probability of creating space mining colonies should be a priority.

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