AVOIDING CONFLICT IN ASTEROID RESOURCE EXTRACTION

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I. INTRODUCTION: AN OPPORTUNITY WITH ASTRONOMICAL POTENTIAL

Asteroids are brimming with critical and strategic minerals – considered vital for the economic well-being of the world's major and emerging economies – and are seen by many as a solution to these minerals' terrestrial depletion.[1] Solar panels, electric car batteries, and new advances in technology all increasingly rely on these rare minerals; new mines in space could provide a much-needed new source of the rare elements required to assuage Earth's current environmental crisis.

While mining in space may be a concept considered "out of this world" for most, the terrestrial mining industry is showing interest considering the potential astronomical profits. Of the identified asteroids, there are 711 known asteroids with an estimated value exceeding $100 trillion each.[2] The three "most cost effective" asteroids alone have an estimated combined value of over US$100 billion.[3] What's more, some of these asteroids have orbits that pass between

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[1] Ezzy Pearson, *Space Mining: The New Goldrush,* BBC SCIENCE FOCUS (Dec. 11, 2018).

[2] *See* ASTERANK, http://www.asterank.com/ (last visited Dec. 15, 2022). Asterank is a scientific and economic database that compiles data from the NASA Jet Propulsion Laboratory's Small Body Database and the Minor Planet Center to rank asteroids by likely potential value, cost effectiveness for mining, and other metrics [hereinafter Asterank].

[3] *Id.*

Earth and the Moon. For example, the Ryugu Asteroid's minimum orbital intersection distance is 95,400 km, equivalent to 0.23 lunar distances – requiring significantly less fuel to get to and yielding more profit than scientific missions to the Moon or Mars.[4]

Although not yet economical, a significant hindrance to asteroid mining investments are the risks associated with uncertain legal interpretations. Two, once promising, asteroid mining start-ups have failed at their goal of cultivating extraterrestrial mines due to difficulties in maintaining the high amount of investment needed. The first, Planetary Resources, flew some successful tests in Earth's orbit, inducing initial investments from high-profile businesspeople,[5] but eventually ran out of that funding amid uncertainty in the legal realm as to private property rights of the proposed resources.[6] Planetary Resources was acquired by blockchain company Consensys in 2018 to incorporate their technology into an open-source real-time satellite tracker called TruSat.[7] The second start-up, Deep Space Industries, was sold to Bradford Space without any clear indication of continuing asteroid mining purposes.[8] Nonetheless, commercial entrepreneurship in this sector is proving persistent with Astroforge, an asteroid mining start-up formed in January 2022, recently announcing initial funding of US$13 million and a test-run of its new asteroid-processing technology on a SpaceX Falcon 9.[9]

While exploration costs and technological challenges still exist, it is foreseeable that these challenges will have solutions in the near future.[10] However, the legal challenges may not be amenable to as

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[4] JAPAN AEROSPACE EXPLORATION AGENCY, *What Kind of Asteroid is Ryugu?*, https://www.hayabusa2.jaxa.jp/topics/20180404_e/ (last visited Dec. 15, 2022).

[5] Associated Press, *Asteroid Mining Venture Backed by James Cameron, Google CEO Larry Page,* CBS NEWS (Apr, 24, 2012), https://www.cbsnews.com/news/asteroid-mining-venture-backed-by-james-cameron-google-ceo-larry-page/.

[6] Nikola Schmidt & Martin Svec, *Breaking the Deadlock in the Space Mining Legal Debate*, 10 NEW SPACE 115, 119 (2022).

[7] Jemayel Khawaja, *Moonshot 3.0 – Inside ConsenSys Space and TruSat*, Consensys Blog (Nov. 4, 2019), https://consensys.net/blog/news/moonshot-3-0-inside-consensys-space-and-trusat/

[8] *See* Schmidt & Svec, *supra* note 6, at 119.

[9] Mike Wall, *Asteroid-mining Startup AstroForge Raises $14 Million, Books Launch for Test Mission*, SPACE.COM (May 26, 2022), https://www.space.com/asteroid-mining-startup-astroforge-2023-launch.

[10] *See* Andrew Zaleski, *How the Space Mining Industry Came Down to Earth*, FORTUNE (Nov. 24, 2018), https://fortune.com/2018/11/24/asteroid-mining-space-planetary-resources/.

straightforward a solution. Can any nation or company simply travel to space and stake a claim over space-based resources? How will ownership of these resources be determined upon return? This paper will assess the current international and national legal frameworks that exist for asteroid mining, analyze the implications of various legal approaches for the industry moving forward and briefly address how conflicts among differing approaches may be mitigated. Ultimately, it concludes that a trilateral approach that includes the input of private space actors, national legislators, and the international community could result in a successful implementation of uniform or at least mostly uniform asteroid mining frameworks.

II. BACKGROUND

A. Commercial Space Actors are Guiding the Future of Sovereignty in Space

Commercial space actors are growing in prominence, especially in the United States, where these entities have proven their ability to complete complicated missions at competitive rates.[11] However, international space law treaties have left the legality of mining asteroids open to interpretation. Varying analyses have led to contentious debates over whether the current treaty regime allows for asteroid resources to be legally extracted and owned.

In 2018, legal experts held a workshop to discuss the national authority to govern space mining.[12] The arguments expressed at the workshop still persist, with some arguing that national laws are contrary to international customary law and others viewing the national laws as a step toward new international custom.[13]

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[11] *See generally,* Mischel Carmen Belderrain et al., *The Road to Privatization of Space Exploration: What is Missing?*, presented at 64th IAC (2013), https://www.researchgate.net/profile/Mischel-Neyra-Belderrain/publication/289635460_The_road_to_privatization_of_space_exploration_What_is_missing/links/5af968bc0f7e9b026bf73382/The-road-to-privatization-of-space-exploration-What-is-missing.pdf.

[12] The Workshop was a part of the 34th Space Symposium and brought space experts from various walks of life together to debate whether national law or international law should govern space mining. This topic is also discussed *infra*, at Section V.

[13] Debra Werner*, Space-Law Workshop Exposes Rift in Legal-community Over National-authority to Sanction Space-mining*, SPACENEWS (April 17, 2018),

Nonetheless, this uncertainty of interpretation creates the possibility of stoking international tension.

Arguably, if legal scholarship and multilateral treaty building do not fill the gaps in the law, private industry will. An example can be found with SpaceX, currently the largest privately owned space company, which has been criticized for conducting risky and abnormal space faring activities. For example, in 2019, SpaceX declined to alter the orbital path of its new Starlink satellite constellation, even though it was at risk of collision with a European Space Agency (ESA) satellite's well-established orbital path.[14] In December 2021, Josef Aschbacher, the ESA Director General, warned that commercial space actors are being allowed to "make the rules" in space.[15] Highlighting Elon Musk's recent activities through his company SpaceX, Aschbacher warned that:

> You have one person owning half of the active satellites in the world. *De facto*, he is making the rules. The rest of the world including Europe … is just not responding quick enough. At the speed he is putting [objects] into orbit, he is almost owning those orbital-planes, because no one can get in there. He is creating a Musk sovereignty in space.[16]

As commercial actors are increasingly leading their own space missions without hands-on governmental oversight, the need for clear international guidelines and regulations has become increasingly necessary. More robust, universally accepted outer space rules and regulations would likely serve to deconflict future space activities. Not only would clarifying rules and regulations prevent conflict between nations, but also between nations and the commercial space industry.

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https://spacenews.com/space-law-workshop-exposes-rift-in-legal-community-over-national-authority-to-sanction-space-mining/.

[14] Jonathan O'Callaghan, *SpaceX Declined yo Move A Starlink-Satellite At Risk Of Collision With A European-Satellite*, FORBES (Sept. 2, 2019), https://www.forbes.com/sites/jonathanocallaghan/2019/09/02/spacex-refused-to-move-a-starlink-satellite-at-risk-of-collision-with-a-european-satellite/?sh=7dd8b4651f62.

[15] Peggy Hollinger & Clive Cookson, *Elon Musk Being Allowed to 'Make-the-rules' in Space, ESA-chief Warns*, FINANCIAL TIMES (Dec. 6, 2021), https://www.ft.com/content/7d561078-37c7-4902-a094-637b81a26241.

[16] *Id.*

B. The Risks of Inaction: The Need to Deconflict Future Asteroid Mining Activities

Inaction with respect to the establishment of a decisive regulatory framework for asteroid mining could have long-lasting effects universally. Private investment in space mining has amounted to billions of dollars.[17] Historically, commercial investors have placed an emphasis on driving profits on their investments over international goals like peace, security and global development.[18] Bohacek notes that an unrestrained race for control over space-based resources – alongside inadequate regulatory mechanisms surrounding property ownership, profit sharing and safety measures – can lead to conflict.[19] These conflicts could materialize in various forms, including, *inter alia*: legal disputes; transnational rifts; or disruptions in terrestrial technological operations or space operations.[20]

Private space companies are inherently headquartered in a nation and, under international law, that nation is responsible for the authorization of a space company's activities. Geopolitical disputes could arise if these companies were to claim large swaths of celestial bodies without clear legal frameworks having first been agreed to on a global scale. Thus, the inherent risk of allowing private companies to engage in asteroid mining without the proper regulatory frameworks in place is that a larger conflict could be created. In turn, it is important to solve the current deadlock that exists between the interpretation of present space treaties and their interaction with national legislations that allow for space mining.

III. EXISTING INTERNATIONAL SPACE TREATIES AND AGREEMENTS

A number of international treaties and agreements on the peaceful and scientific uses of space have been proposed and

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[17] Mehak Sarang, *The Commercial Space Age is Here*, HARVARD BUS. REV. (Feb. 12, 2021).

[18] *See* Schmidt & Svec, *supra* note 6, at 123.

[19] Petr Bohacek et al., *Benefit-Sharing as Investment Protection for Space Resource Utilization*, 10 NEWSPACE 127, 128 (2022).

[20] David Thompson, et al.*, Space as a War-fighting Domain*, 32 AIR & SPACE POWER J. 2, 4 (2018).

adopted with varying degrees of international acceptance.[21] The most widely accepted of these treaties, the Outer Space Treaty,[22] culminated among the Cold-War era apprehension that the first nation to set foot on the Moon would use that high ground to propel further military conflict.[23] Although all existing treaties were agreed upon to enable international cooperation in the exploration and uses of space, while also ensuring space does not become a forum for war, none of these treaties explicitly create a unified and mutually agreed upon framework for mining rights to resources in outer space.[24] The Outer Space Institute, a Canadian-run network of space experts, recently urged the United Nations to quickly begin work on a "Multilateral Agreement on Space Resource Utilization" through an open letter signed by 142 space professionals.[25] Considering this, and before discussing potential frameworks in higher detail, it is first important to assess the relevant international agreements as they relate to mining space resources.

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[21] *See generally* Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty]; Convention on the International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S 187 [hereinafter Liability Convention]. Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue Agreement]; Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention]; Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1362 U.N.T.S. 3 [hereinafter Moon Agreement].

[22] *See* Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcommittee on its Sixty-First Session, Status of International Agreements Relating to Activities in Outer Space as at 1 January 2022, U.N. Doc. A/AC.105/C.2/2022/CRP.10 (2022) [hereinafter Status of International Space Agreements]

[23] Joseph Crombie, *Mining of Celestial Bodies*, 10 SPACE & DEFENSE 9, 19 (2017); Hope M. Babcock, *The Public Trust Doctrine, Outer Space, and the Global Commons*, 69 SYRACUSE L. REV. 191, 208 (2019); Olaf Steffen, *Explore to Exploit: A Data-Centered Approach to Space Mining Regulation*, 59 SPACE POL'Y 101459, 101460 (pg.2) (2022).

[24] *See* Ram S. Jakhu & Yaw Otu Mankata Nyampong, *Some Legal Aspects of Space Natural Resources*, 18 EUR. J.L. REFORM 86, 88-89 (2016).

[25] Letter from U. British Columbia Outer Space Inst regarding Multilateral Agreement on Space Resource Utilization, to Tijani Muhammad-Bande, UNGA President (Aug. 31, 2021), http://www.outerspaceinstitute.ca/docs/InternationalOpenLetterOnSpaceMining.pdf.

A. The Outer Space Treaty of 1967

The Outer Space Treaty was formed to create a basic international legal framework for the peaceful uses of space.[26] Among other provisions, the Treaty bans military installations on celestial bodies,[27] creates liability for damage caused by a State Party's space object,[28] and stipulates that every nation has a right to the free exploration of space. Four provisions in particular carry a significant amount of weight in any future mining of critical and strategic minerals from asteroids – these are Articles I, II, VI and IX.

Article I states the exploration and use of outer space, including the Moon and other celestial bodies, should be carried out for the benefit of all [hu]mankind and shall be free for all States.[29]

Article II prohibits national appropriation of outer space including the Moon and other celestial bodies.[30]

Article VI declares State Parties shall bear responsibility for national activities in outer space regardless of whether such activities are carried out by governmental or non-governmental entities and that activities by non-governmental entities require authorization and continuing supervision by the appropriate State.[31]

Article IX creates three obligations: (1) to avoid harmful contamination; (2) to undertake consultations with a potentially affected State if there is belief an activity may harmfully interfere with that State Party's space activity, and; (3) to act with due regard to the interests of others.[32]

When combining the effects of Articles I and II, it is clear that every State is free to explore and use outer space, however, no State may exercise ownership rights over outer space including the Moon and celestial bodies.[33,] This generates the question, then, as to how profits may be earned through extracting asteroid resources, when ownership of celestial bodies is prohibited. For example, Article II could preclude staking a claim over asteroid resources, as this would carry quasi-sovereign rights, such as sole use over an

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[26] *See* Outer Space Treaty, *supra* note 21, at Preamble.
[27] *Id.* at art. IV.
[28] *Id.* at art. VII.
[29] *Id.* at art. I.
[30] *Id.* at art. II
[31] *Id.* at art. VI.
[32] *Id.* at art IX.
[33] *See* Jakhu & Nyampong, *supra* note 24, at 91.

unclaimed area for a potential mining site.[34] Some extremely profitable near-Earth celestial objects, such as the aforementioned Ryugu Asteroid, are only a few kilometers in diameter.[35] While staking a claim over the entirety of a relatively small celestial object could be possible within the precedents set from current large-scale mining operations on Earth, this would create significant tension with Article II of the Outer Space Treaty.[36]

Considering the stakes of the Cold War, it is possible the drafters of the Outer Space Treaty did not fully contemplate the legal nuances of a private, commercialized space industry.[37] It can thus be argued that the Outer Space Treaty does not create an international prohibition of the exploitation of space resources because mining operations are not specifically noted in the Treaty. Article IX suggests that as long as your mining activities do not create harmful contamination in space, and do not harm the activities of other Member States in space, that the operation can go ahead without consultation since there would be no potentially affected parties.[38] Moreover, it is arguable that space-based mining has already occurred without consultation with the United Nations, as, for just one example, the United States has already mined and brought to Earth approximately 842lbs of lunar rocks and soil over the course of six lunar missions.[39]

Finally, and most importantly, the boundaries for "harmful contamination" in space could be extremely narrow or even restricted to larger celestial objects such as quasi-habitable planets and moons.[40] For instance, most asteroids are often highly irradiated rocks with little discernable environmental features to protect

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[34] BIN CHENG, *Studies in International Space Law*, at 233 (1997); Frans G. von der Dunk, *Private Property Rights and the Public Interest in Exploration of Outer Space*, 13 Biological Theory 142, 2 on online PDF (2018), https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1095&context=spacelaw.

[35] Asterank, *supra* note 2.

[36] Khaled Abdel-Barr & Karen MacMillan, *The International Comparative Legal Guide on Mining Laws and Regulations*, GLOBAL LEGAL GROUP (2021).

[37] Babcock, *supra* note 23, at 209; von der Dunk, *supra* note 34, at 3.

[38] *See* Fengna Xu, *Environmental Protection in the Exploitation and Use of Space Resources*, 565 IOP CONF. SER: EARTH & ENVIRON. SCIENCE 012003, at 4 (2020), https://iopscience.iop.org/article/10.1088/1755-1315/565/1/012003/pdf.

[39] NASA, *Lunar Rocks and Soils from Apollo Missions*, CURATION LUNAR (Sept. 1, 2016), https://curator.jsc.nasa.gov/lunar/.

[40] *See* Xu, *supra* note 38.

and thus may not be subject to "harmful contamination" depending on its interpretation. An argument can even be made that the complete depletion of asteroids in near-Earth orbit may be in the best interest of all humankind, as these rocks can pose a greater threat of Earth-impact over years as their orbits are altered by the gravities of other celestial bodies.[41] Stemming from the varying interpretations of the Outer Space Treaty, the legal debate surrounding the mining of space resources still lacks consensus or clarity on an international scale. Major points still need to be clarified, such as whether the extraction of asteroid resources is considered national appropriation and whether national laws allowing entities to own asteroid resources can coincide with international obligations.

B. The Moon Agreement of 1979

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) sought to reaffirm provisions within the Outer Space Treaty while attempting to create an international governing regime for the exploitation of outer-space resources.[42] However, the agreement is not binding except to the small number of States that ratified it – most spacefaring nations did not sign this agreement, including the United States, China, Russia, India, and Canada.[43] While some attempted to compare the Moon Agreement to mining rights in the United States, another major critique of was that the agreement was opposed to free enterprise and private property rights.[44] Nonetheless, the Moon Agreement does attempt to set an international legal precedent on the mining of resources in outer space through Article XI. This Article states "[t]he moon and its natural resources are the common heritage of [hu]mankind" and that an international regime should be established to govern the orderly and safe development, rational management, and equitable sharing of "the natural

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[41] NASA, *Solar System Exploration: Asteroids* (July 19, 2021), https://solarsystem.nasa.gov/asteroids-comets-and-meteors/asteroids/in-depth/#:~:text=The%20orbits%20of%20asteroids%20can,orbits%20of%20the%20other%20planets.

[42] Moon Agreement, *supra* note 21.

[43] Status of International Space Agreements, *supra* note 22.

[44] Vidvuds Beldavs, *Simply fix the Moon Treaty*, SPACE REVIEW (Jan. 15, 2018); *see also*, *Hearing on S. Rept 96-567 Before the Subcomm. On Science, Technology, and Space*, 96th Cong. (1980).

resources of the moon."[45] However, likely due in part to the lack of specificity contained within the "equitable sharing" of resources provision, the Moon Agreement lacked sufficient support to create a lasting international framework for the exploitation of space resources.

C. The Artemis Accords of 2020

As of this paper's publication, the United States-led Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids (Artemis Accords) has 27 signatories.[46] The Artemis Accords cover a variety of topics from inter-governmental transparency through data sharing,[47] to the protection of space heritage sites,[48] the registration of lunar technologies deployed, and indeed the use of space resources.[49] The Artemis Accords were not created through any United Nations entity, but are rather principles to which the signatories subscribe a political commitment.[50] The Accords outline that space resource extraction and utilization can be conducted under the auspices of the Outer Space Treaty.[51] Specifically, the ability to mine and zone areas on the Moon, Mars, and asteroids is emphasized under Paragraph 2 of Section 10 and Paragraphs 6 and 11 of Section 11 in the Artemis Accords.

Paragraph 2 of Section 10 in the Artemis attempts to create an internationally recognized interpretation of the Outer Space Treaty by stating:

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[45] Moon Agreement, *supra* note 21, art. XI.

[46] The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids, NASA, https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf [hereinafter Artemis Accords]; As of December 2022, the current Artemis Accords signatories include Australia, Bahrain, Brazil, Canada, Colombia, Czech Republic, Ecuador, France, India, Israel, Italy, Japan, Luxembourg, Mexico, New Zealand, Nigeria, Poland, Republic of Korea, Romania, Rwanda, Saudi Arabia, Singapore, Spain, Ukraine, United Arab Emirates, the United Kingdom, and the United States.

[47] *See* Artemis Accords, *supra* note 46, § 8.

[48] *See id.* § 9.

[49] *Id.* § 10.

[50] *Id.* § 1.

[51] *Id.* § 10.

> The Signatories emphasize that the extraction and utilization of space resources, including any recovery from the surface or subsurface of the Moon, Mars, comets, or asteroids, should be executed in a manner that complies with the Outer Space Treaty and in support of safe and sustainable space activities. The Signatories *affirm that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty,* and that contracts and other legal instruments relating to space resources should be consistent with that Treaty.[52]

This is controversial as, some scholars argue that the United States is trying to become the global regulator of commercial space activity, as opposed to following the global spirit of the Outer Space Treaty.[53] An article published in the journal *Science* by two Canadian space experts argues a US-centric and capitalist approach is likely to create rampant exploitation of space resources at the expense of science.[54] This could see the United States leveraging signatories' political commitments, alongside lucrative financial contracts, to reinforce its own political agenda with regards to the Outer Space Treaty.[55] Others argue that this American attempt to sculpt the interpretation of international space law through the Artemis Accords is another reason why existing treaties, such as the Moon Agreement and Outer Space Treaty, should be amended to have specific stipulations and procedures surrounding mining rights.[56]

Advocates for the Artemis Accords, however, recognize its utility in using a bottom-up approach to build customary international law regarding asteroid resource utilization instead of waiting for an

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[52] *Id.* § 11(6) (emphasis added).

[53] Bob McDonald, *Canada Just Signed a New Moon Pact — is it a Good Idea?*, CANADIAN BROADCASTING CORP. (Oct. 16, 2020), https://www.cbc.ca/radio/quirks/canada-just-signed-a-new-moon-pact-is-it-a-good-idea-1.5763940.

[54] Aaron Boley & Michael Byers, *U.S. Policy puts the Safe Development of Space at Risk*, 370 SCIENCE 174, 174-75 (Oct. 9, 2020).

[55] Christopher Newman, *Artemis Accords: Why Many Countries are Refusing to Sign Moon Exploration Agreement*, THE CONVERSATION (Oct. 19, 2020), https://theconversation.com/artemis-accords-why-many-countries-are-refusing-to-sign-moon-exploration-agreement-148134.

[56] Boley & Byers, *supra* note 54, at 174-75.

international consensus.[57] This may even be coming to fruition, with some nations who are or were signatories or Parties to the Moon Agreement now subscribing to the Artemis Accords, it shows that the Moon Agreement and Artemis Accords can either coexist together or, otherwise, the Moon Agreement does not reflect customary international law.[58]

Additionally, Section 11(7) proposes the use of "safety zones" which are referred to as the area wherein notification and coordination of space activities will be implemented to avoid harmful interference.[59] Some worry these "safety zones" would also operate similar to the ownership of property, and provide the respective nation with exclusive uses to a specific extraterrestrial area for a supposed temporary period of time.[60] Some experts view such safety zones in contravention of the ban against claiming exclusive use and extraterrestrial sovereignty as laid out in Article II of the Outer Space Treaty.[61] Others argue safety zones are not intended to keep other actors out, but would exist to protect ongoing space activities by avoiding harmful interference and ensure other actors behave with due regard.[62]

IV. REACHING FOR THE STARS: NATIONAL STATUTES FOR MINING RESOURCES IN SPACE

Currently four nations – the United States, Luxembourg, the UAE, and Japan – have passed national legislation that grants their respective citizens a legal basis to engage in asteroid mining operations and associated rights to any resources that citizens mine in space. Other nations – namely Russia, Israel, and China – are slowly developing policies on the space mining issue.[63] However, as

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[57] See Walker A. Smith, Using the Artemis Accords to Build Customary International Law, 86 J. AIR L. & COM. 661, 690 (2021).

[58] *See id.* at 684; *see also* Stephan-Michael Wedenig & Jack Wright Nelson, *The Moon Agreement: Hanging by a Thread?*, MCGILL INST. AIR & SPACE L. (2023).

[59] Artemis Accords, *supra* note 46, § 11(7).

[60] *See* Rossana Deplano, *The Artemis Accords: Evolution or Revolution in International Space Law?*, 70 INT'L & COMPAR. L. Q. 799, 807 (2021).

[61] Outer Space Treaty, *supra* note 21, art II; Lucas Mallowan et al., *Reinventing Treaty Compliant "Safety Zones" in the Context of Space Sustainability*, 8 J. SPACE SAFETY ENG'G 155, 160 (2021).

[62] Mallowan, *supra* note 61.

[63] Senjuti Mallick & Rajeswari Pillai Rajagopalan, *If Space is 'The Province of Mankind,' Who Owns its Resources*?, OBSERVER RSCH. FOUND. (Jan. 24, 2019).

these policies are currently not in the form of a statute, this analysis will be restricted to ratified national legislation for space mining.

In particular, it is important to assess how well each piece of national legislation aligns with the provisions in Article VI of the Outer Space Treaty. Article VI provides that "…The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require *authorization and continuing supervision by the appropriate State Party* to the Treaty."[64]

In essence, Article VI is an important component of the Outer Space Treaty that each Member State takes responsibility for the actions of their citizens in space, and does so via direct authorization and continuing supervision of any space activities.

Each law's substance is discussed in the paragraphs below. A major point of contention that is worthwhile to note prior to discussing the laws, is that each provides the right to its citizens to own space resources that they may extract or collect. However, none of them seem to make any explicit reference to the Outer Space Treaty or the non-appropriation principle. This potential grinding of ideologies is further discussed in Section V, *infra*.

A. The American SPACE Act Amendments of 2015

In 2015, the United States enacted the Commercial Space Launch Competitiveness Act (SPACE Act).[65] The portion of the Space Act most relevant to this article is codified in 51 U.S.C. §§ 51301-51303. Most notably, § 51303 gives Americans who successfully extract natural resources from outer space the property rights over those resources by stating that "[a] United States citizen engaged in commercial recovery of an asteroid resource … shall be entitled to … possess, own, transport, use, and sell the asteroid resource … in accordance with applicable law, including the international obligations of the United States."[66]

At the time of enactment, the SPACE Act of 2015 was the first national codification of asteroid mining rights worldwide. The Act was controversial due to its incentivization for asteroid mining within the American commercial sector regardless of a possible

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[64] Outer Space Treaty, *supra* note 21, art VI (emphasis added).

[65] U.S. Commercial Space Launch Competitiveness Act of 2015, H.R.2262, 114th Cong. (2015) [hereinafter SPACE Act].

[66] *Id.* § 51303.

violation of the Outer Space Treaty.[67] The Act attempts to fit into international law by clarifying any private exploitation could not result in the national appropriation of the celestial body; thus claiming accordance with Article II of the Outer Space Treaty.[68] Notably, the other three national laws vaguely outline a regulatory regime for the authorization of their respective nations' private actors; this is something absent from the United States SPACE Act. Instead, the SPACE Act demands the President to submit a report to Congress suggesting the federal agency to be in charge of such licensure.[69] Considering the technology to carry out asteroid mining was not available at the time of enactment, the Act's likely primary concern was to create the right to collect and own resources in order to incentivize commercial investments and further technological innovations.[70]

B. The Luxembourg Space Resources Act of 2017

Luxembourg has a well-established space industry which has played a significant role in the development of worldwide satellite communication systems.[71] Growing from this history, Luxembourg has launched an ambitious plan to extract resources from celestial bodies, such as asteroids.[72] Through this plan, Luxembourg hopes to position itself as Europe's center for space mining.[73]

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[67] Gbenga Oduntan, *Who Owns Space? US Asteroid-mining Act is Dangerous and Potentially Illegal*, THE CONVERSATION (Nov. 25, 2015), https://theconversation.com/who-owns-space-us-asteroid-mining-act-is-dangerous-and-potentially-illegal-51073; Jakhu & Nyampong, *supra* note 24, at 100.

[68] *See* Fabio Tronchetti & Hao Liu, *The White House Executive Order on the Recovery and Use of Space Resources*, 57 SPACE POLICY 101448, at 2; Space Act, Pub. L. 114-90, Title IV § 403.

[69] 51 U.S.C. § 51302(b).

[70] Tronchetti & Liu, *supra* note 68; Jakhu & Nyampong, *supra* note 24, at 100; von der Dunk, *supra* note 34, at 11.

[71] Société Européenne des Satellites (SES), *SES in Luxembourg is a World-leading Satellite Operator*, Luxembourg Space Agency (Sept. 4, 2019), https://www.science.lu/fr/video-transmission-and-data-networks/ses-luxembourg-world-leading-satellite-operator.

[72] Cecilia Jamasmie, *Luxembourg Shoots for the Stars, Invests $28 Million in Planetary Resources*, MINING.COM (Nov. 3, 2016), https://www.mining.com/luxembourg-shoots-for-the-stars-invests-28-million-in-planetary-resources/.

[73] Cecilia Jamasmie, *Luxembourg Joins Race to Conquer Space Mining*, MINING.COM (Feb. 3, 2016).

Through passing the Law of 2017 on the Exploration and Use of Space Resources (Luxembourg Space Resources Act), Luxembourg became the first European Union nation to pass a space mining law.[74] The Act hoped to boost exploration and commercial utilization of critical and strategic minerals from near-Earth objects.[75] The Luxembourg Space Resources Act lays out a clear framework for the authorization of space mining activities, including the filing of an application by the company which outlines the activities to be carried out on the mining mission,[76] authorization by the ministers in charge of the economy and space activities,[77] the "constant supervision" of space activities by Luxembourgish authorities,[78] and the personal and non-assignable nature of any authorization to conduct space mining operations.[79] Most importantly, Article 1 of the Space Resources Act states that "[s]pace resources are capable of being owned."[80]

The Space Resources Act is further bolstered by the recent Law of 15 December 2020 on Space Activities[81] (Luxembourg Space Activities Act) that imposes fines and sanctions on individuals that do not follow the aforementioned approval process, monitoring requirements, or do not conduct themselves within the bounds of their approved permissible activities.[82] Depending on which articles of the Luxembourg Space Activities Act are breached, punishments can include up to a €1.25 million penalty, imprisonment of up to five years, or even a €1 million per day fine for not obeying a discontinuance order.[83]

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[74] *Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace*, Journal Officiel du Grand Luxembourg, July 20, 2017 (entered into force J uly 20, 2017), https://data.legilux.public.lu/ file/eli-etat-leg-loi-2017-07-20-a674-jo-fr-pdf.pdf [hereinafter Space Resources Act].

[75] *Id.*

[76] *Id.* at art, 12.

[77] *Id.* at art. 2.

[78] *Id.* at art. 15.

[79] *Id.* at art. 5.

[80] *Id.* at art. 1.

[81] *Loi du 15 décembre 2020 portant sur les activités spatiales et modifiant : 1° la loi modifiée du 9 juillet 1937 sur l'impôt sur les assurances dite « Versicherungssteuergesetz »*, Journal Officiel du Grand-Duché de Luxembourg, Dec. 15, 2020 (entered into force Dec. 28, 20 20), https://space-agency.public.lu/en/agency/legal-framework/Lawspaceactivities.html [hereinafter Space Activities Act].

[82] *Id.* at art. 14.

[83] *Id.* at art. 14.

The Luxembourg Space Activities Act goes further than any other national legislation thus far by describing what kind of information is needed in the application for authorization. Article 7 specifies that authorization is subject to proof that the technical, financial, and governance outlooks are "comprehensive and proportionate to the nature, scale and complexity of the risks inherent to the business model."[84] Luxembourg likely enacted such detailed processes as it seeks to fully clarify its national regulatory scheme.[85]

In contrast to the American legislation, Luxembourg adds regulatory provisions to its space mining legislation to align with the obligations of Article VI of the Outer Space Treaty by overseeing the authorization of space mining operations, supervising activities on a constant basis, and punishing those circumventing these regulatory processes. Although owning space resources outright could nonetheless still be in contravention of Article I and Article II of the Outer Space Treaty, Luxembourg's space mining legislation could be used as a great starting point for other nations to replicate and expand upon within their own pieces of national legislation.

C. The United Arab Emirates Federal Law on the Regulation of the Space Sector of 2019

In 2019, the United Arab Emirates (UAE) enacted Federal Law No. 12 of 2019 on the Regulation of the Space Sector (UAE Federal Space Law).[86] The goal of the UAE Federal Space Law is to create a regulatory framework that allows the nation to achieve the objectives it set forth in its National Space Policy, including the exploration, exploitation, and use of "space resources."[87] Space resources are defined under Article 1 as "[a]ny non-living resources present in outer space, including minerals and water." Under Article 4, the UAE Federal Space Law explicitly states that "This Law

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[84] *Id.* at art. 7.

[85] Tronchetti & Liu, *supra* note 68, at 3.

[86] UAE Federal Law No. 12 of 2019 on the Regulation of the Space Sector (Dec. 19, 2019), https://www.moj.gov.ae/assets/2020/Federal%20Law%20No%2012%20of%202019%20on%20THE%20REGULATION%20OF%20THE%20SPACE%20SECTOR.pdf.aspx [hereinafter UAE Federal Space Law].

[87] National Space Policy of the United Arab Emirates (Sept. 2016), https://space.gov.ae/Documents/PublicationPDFFiles/UAE_National_Space_Policy_English.pdf [hereinafter UAE National Space Policy).

regulates… space resources exploration or extraction activities" whether that is for "scientific, commercial or other purposes."[88] Article 14.1 prohibits any space activities from taking place without obtaining a Permit from The United Arab Emirates Space Agency. Article 18 goes further by specifically noting that "the conditions and controls relating to Permits for the exploration, exploitation and use of Space Resources … shall be determined by a decision issued by the Council of Ministers of whomever it delegates" and that this decision will encompass the "ownership, purchase, sale, trade, transportation, and storage" of any space resources.[89]

The UAE statute is less regulatorily specific than the Luxembourg statute, but more specific than the American statute. Article 14.4 provides a blanket statement regarding the application for authorization by simply stating "[t]he Agency shall ensure" the application meets certain terms and conditions.[90] However, the "terms and conditions" it refers to are not elaborated upon. Similarly, the law outlines that an operator of a permit is culpable to administrative penalties or sanctions, but does not define what such penalties or sanctions might entail.[91]

Unlike the United States and Luxembourg laws, the UAE law does not expressly state that space resources are capable of being owned. But it does imply ownership by adding that "ownership, purchase, sale, trade, transportation, and storage" can be part of the terms and conditions related to the authorization granted by the Council of Ministers or its delegated grantor.[92] Thus, this law will likely face the same non-appropriation challenges as the other national laws.

D. The Japanese Space Resources Act of 2021

On 23 June 2021, the Japanese Diet passed the Act on Promotion of Business Activities Related to the Exploration and Development of Space Resources, Act No. 83 of 2021 (Japanese Space

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[88] UAE Federal Space Law, *supra* note 86, art. 4(i)-(j).
[89] *Id.* at art. 18.1.
[90] *Id.* at art. 14.4.
[91] *Id.* at art. 14.5.
[92] *Id.* at art. 18.

Resources Act) which came into force on 23 December 2021.[93] The act creates a framework for Japanese nationals to conduct business activities for the exploration and development of space resources, including the ability to have ownership over those resources.[94]

The authorization for a permit under the Japanese Space Resources Act is in combination with a permit under the Japanese Space Activity Act of 2016, which regulates the permitting of artificial satellites.[95] Under the Japanese Space Activity Act, a permit can be obtained from the Japanese Prime Minister to launch satellite from Japan after the applicant obtains the requisite certificate for a rocket design and radio equipment.[96] Additionally, the applicant must have insurance for any potential damage.[97] These are similar to most countries' national legislation related to private satellite launches and third-party compensation.[98]

To receive a permit under the Japanese Space Resources Act, the application requires the fulfillment of the aforementioned permitting requirements under the Japanese Space Activity Act, in addition to the submission of a business activity plan. This plan must include the purpose, term, location, methods of mineral extraction for the space mining activity, and any other matters that a future Cabinet ordinance will specify.[99] In order for the Japanese government to grant the permit, the applicant must have adequate ability to fulfill the business activity plan and the business activity plan must conform to Japan's Basic Space Law principles. This includes not producing any likely impediment to public safety or the implementation of conventions related to the development and use of

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[93] Japan Act no. 83 of 2021 on Promotion of Business Activities Related to the Exploration and Development of Space Resources https://kanpou.npb.go.jp/old/20210623/20210623g00141/20210623g001410004f.html [hereinafter Japan Space Resources Act]; Library of Congress, *Japan: Space Resources Act Enacted*. 2021, www.loc.gov/item/global-legal-monitor/2021-09-15/japan-space-resources-act-enacted/ [hereinafter Japan Space Resources Act].

[94] Hiroko Yotsumoto et al., *the Space Law Review: Japan*, THE LAW REVIEWS (Dec. 9, 2021), https://thelawreviews.co.uk/title/the-space-law-review/japan#:~:text=On%2015%20June%202021%2C%20the,and%20to%20acquire%20ownership%20of

[95] Japan Space Resources Act, *supra* note 93; Currently, both Acts are only available in Japanese so research regarding them was done through outside sources.

[96] Japan Space Resources Act, *supra* note 93.

[97] *Id.*

[98] *Id.*

[99] *Id.*; Yotsumoto, *supra* note 94.

space.[100] Additionally, one unique specification of the Japanese Space Resources Act is that, upon granting the permit, the Prime Minister must issue a public announcement proclaiming the name of the permit grantee and their business activity plan. Again, due to the law's express declaration that anyone who mines or otherwise collects space resources acquires ownership of those resources, this law is likely to face the same non-appropriation challenges as the others.

V. TRENDS AND ANALYSIS: TOP-DOWN OR BOTTOM-UP?

The four aforementioned national laws affecting potential asteroid mining efforts are quite similar with respect to their overall goal of bolstering economic interest in the prospect of asteroid mining. Their main differences arise out of the regulatory and permitting guidelines provided. The Luxembourg law is arguably the most comprehensive law of the four and is the only one to go so far as setting tangible sanctions for those who violate the law. The Japanese law is the only one to expressly state that the permit's grantee must be publicly declared. However, the omission of public declaration by the other national laws likely will not prove to be an issue since all four countries are parties to the Artemis Accords and the Outer Space Treaty. The Artemis Accords reaffirm the commitment of informing the United Nations, the public, and the scientific community regarding an entities' space resource extraction activities in accordance with the Outer Space Treaty.[101]

Additionally, the United States, Japan, and UAE laws are less comprehensive administratively than Luxembourg, however, the wording of these three laws imply forthcoming rules by whichever entity these States delegate such authority. First, the American law states that the President shall designate the authorization and oversight of space resource extraction to a federal agency.[102] Second, the Japanese law states that any further requirements regarding application materials will be released by a future ordinance.[103] Last, the Emirati law states the "conditions, regulations and

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[100] Yosumoto, *supra* note 94.

[101] Artemis Accords, *supra* note 46, § 10(3); Outer Space Treaty, *supra* note 21, art. XI.

[102] SPACE Act, *supra* note 65, § 51302.

[103] Yotsumoto, *supra* note 94.

procedures related to the Authorization. . . shall be determined by a Decision issued by the Council of Ministers or whomever it delegates."[104] These countries likely did not include these specifics in their national laws because they want to outwardly induce commercial investment and spur the technological feasibility of asteroid mining while their respective regulatory systems determine the internal specifics.

The most notable and significant similarity between the four national laws is their recognition of private actors' rights to own the space resources that they extract or collect. Again, all four nations are also signatories to the Artemis Accords. The Artemis Accords, however, do not explicitly specify any ownership of extracted space resources, instead it stops at the claim that resources may simply be extracted without violating the Outer Space Treaty. The Accords expressly state, "[t]he Signatories affirm that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty, and that contracts and other legal instruments relating to space resources should be consistent with that Treaty." However, considering the loud stance of the United States, the recognition of ownership rights by the national legislation may be bolstered by the recognition that resources can be extracted at all by the increasing number of signatories to the United States-led Artemis Accords. This textualist interpretation is supported by scholarly claims that the omission of a mention to private actors from Article II is indication that individual or private extraction and ownership of resources from celestial bodies is permissible.[105]

Contrarily, other experts claim that any national legislation recognizing property rights of mined asteroid resources and granting permits to extract such resources are void from the outset.[106] This view stems from the notion that private extraction is prohibited by the Outer Space Treaty because a private entity claiming ownership implies a country licensed that entity to claim such ownership.[107] Von der Dunk explains this view by stating, "[s]ince a celestial body cannot be subjected to any single state's territorial

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[104] UAE Federal Space Law, *supra* note 86, art. 14.2

[105] Tronchetti & Lui, *supra* note 68, at 2; Crombie, *supra* note 23, at 10.

[106] *See* CHENG, *supra* note 34.

[107] *Id.*; von der Dunk, *supra* note 34, at 3.

jurisdiction, no single state's domestic laws. . . can apply on any celestial body."[108] Schmidt and Svec argue that the perspective that private companies can achieve ownership of space resources is contrary to the ordinary meaning and purpose of the "benefit and interest of all countries" phrasing found throughout the Outer Space Treaty.[109] The underlying assumption that stems from the creation of national legislation regulating asteroid mining is that these companies, who would be only able to act under their State of registry, are likely being empowered to pursue their interests at the expense of others – as opposed to having the view that they are "members of the international community, as actors paying due attention to general interests such as peace, security, and development, and as actors actively creating harmony in international relations as well as in outer space."[110]

Nonetheless, the textualist interpretation seems to be gaining traction as more countries sign the Artemis Accords and create national legislation. In less than three years of existence at the time of writing this paper, the Artemis Accords now has 27 total signatories,[111] which is nine more than the Moon Agreement.[112] It should be noted that the Artemis Accords are not a United Nations sanctioned international agreement like the Moon Agreement. The recent 2022 addition of France to the Artemis Accords carries particular weight due to the nation's influence in the European Union and broader international community – it is also the fourth country to have signed both the Moon Agreement and the Artemis Accords.

Romania and France both signed the Moon Agreement, but did not ratify it, while Australia and Mexico have both ratified it. All four have now signed the Artemis Accords. This is significant because, although the Artemis Accords and Moon Agreement are not expressly contradictory, two core principles of the Moon Agreement are that the Moon's resources are the "common heritage of humankind" and that the parties are committed to "establish an international regime" to govern the extraction of resources on the Moon –

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[108] *See* von der Dunk, *supra* note 34, at 3.

[109] *See* Schmidt & Svec, *supra* note 6, at 123.

[110] *Id.*

[111] The Artemis Accords, https://www.nasa.gov/specials/artemis-accords/index.html (last visited July 15, 2023).

[112] *See* Status of International Space Agreements, *supra note* 22.

both of which are absent from the Artemis Accords.[113] Regardless, since no international regime was ever established to govern space resource extraction as specified in Article 11 of the Moon Agreement, none of the four countries who signed both the Moon Agreement and the Artemis Accords will likely face criticism when it comes to their perspectives on asteroid resources. It is unclear whether the Artemis Accords and Moon Agreement can coexist,[114] however the signing of France, Australia, Mexico, and Romania show that the economic opportunities in space that the Artemis Accords encourage through its "bottom-up" approach is drawing countries who once were ready to undertake negotiations for a "top-down" approach.

A "bottom-up" approach means that countries develop their own national legislation or bilateral agreements to tackle space mining issues as opposed to a "top-down" approach where an international treaty sets a regime.[115] A hope behind the "bottom-up" approach is that any individual actions may eventually develop into customary international law.[116] A "bottom-up" approach is undoubtedly faster and more convenient than negotiating an internationally-recognized treaty, but the short-term benefits for individual countries may not outweigh the long-term dangers on the international stage if countries start developing parallel, yet opposing, national legislations on space mining.[117] Such simultaneous, incongruous regimes could lead to inhibited market growth in the sector and conflict both on Earth and in space.[118] Tronchetti notes that although countries have the absolute right to make bilateral and multilateral agreements, they should do so with mindfulness of their international obligations and understanding of the legal ramifications of their actions.[119] Some view the four current national legislations as a failure to this cosmopolitan mindfulness because they all omit any recognition of Article 1 of the Outer Space Treaty that the exploration and use of space shall be carried out for the

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[113] Moon Agreement, *supra* note 21, art. 11.
[114] *See* Smith, *supra* note 57, at 674.
[115] von der Dunk, *supra* note 34, at 11.
[116] *Id*.
[117] Tronchetti & Liu, *supra* note 68, at 5.
[118] Crombie, *supra* note 23, at 16; *See* Tronchetti & Liu, *supra* note 68, at 5.
[119] *See* Tronchetti & Liu, *supra* note 68, at 5.

"province of all [hu]mankind."[120] However, the national laws likely omitted reference to Article 1 as a political precaution, as the debate over benefit-sharing of asteroid resources looms even larger than the debate over ownership of asteroid resources.

A consensus on property rights over asteroid resources will be difficult to meet internationally without a concurrent agreement on how to divvy those rights for the "province of all [hu]mankind." This has been another pressing debate regarding space resources with some claiming space should be a global commons owned by all and thus shared by all, regardless of the origins of investment into the mining operations. The global commons view adopts the concept of space as a "common heritage for [hu]mankind" (the CHM Principle), which was introduced in the United Nations Convention on the Laws of the Sea (UNCLOS) and carried into the Moon Agreement. Notably, the CHM Principle was a major reason many countries neglected the Moon Agreement.[121]

The CHM Principle is not thoroughly defined, but benefits derived from the international seabed area are to be distributed evenly.[122] UNCLOS outlines two main characteristics of the CHM Principle as it applies to the extraction of resources from the international seabed. First, the CHM Principle applies to the entirety of the international seabed area and its resources (the Area),[123] which are defined as "all solid, liquid or gaseous mineral resources in situ in the Area at or beneath the seabed."[124] Secondly, the CHM Principle is understood as having a universalist intention, designed to support the ultimate objective to achieve a more egalitarian society – an objective that is a shared responsibility on all Member States and organizations.[125] Yu and Ji-Lu state that "Safeguarding the common heritage of [hu]mankind is the common responsibility of the international community."[126] This means that both landlocked

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[120] *See* Schmidt & Svec, *supra* note 6, at 123.

[121] Carl Q. Christol, *The 1979 Moon Agreement: Where Is It Today*, 27 J. SPACE L. 1, 31 (1999).

[122] Crombie, *supra* note 23, at 15; John S. Goehring, *Why Isn't Outer Space a Global Commons*, 11 J. NAT'L SEC. L. & POL'Y 573, 580 (2021).

[123] United Nations Convention on The Law of the Sea, art. 1(1) & 136, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

[124] *Id.* at art.133(a).

[125] *Id.* at art.139.

[126] Jia Yu & Wu Ji-Lu, *The Outer Continental Shelf of Coastal-States and the Common-Heritage of Mankind*, 42 OCEAN DEV. & INT'L L. 317, 326 (2011).

and coastal States have a shared responsibility to protect the seabed Area from unlawful mining infringements that do not duly adhere to the mining regiment outlined by the International Seabed Authority (ISA). Parallels could be drawn that the Outer Space Treaty places a similar level of responsibility amongst signatories to adhere to the CHM Principle as it could be interpreted to pertain to any mining activities on asteroids. Using the CHM Principle as a guideline, nations that have developed sophisticated spacefaring capabilities should strive to adhere to and emulate the objectives of the CHM Principle, as their actions have the potential to impact the shared resources of currently non-spacefaring nations.

The United States, thus far, has been the only country to outright decline the global commons characterization of space through executive action, but has not defined what that means or how else to characterize space.[127] Traditionally, the term "global commons" has two conceptual understandings: (1) an enabling geopolitical understanding and (2) a restricting economic understanding.[128] The enabling concept is that if an area is a global commons jurisdictionally, countries are able to freely traverse that area as it is free of geopolitical limitations.[129] The restrictive concept is that of shared ownership of the area and its resources, and thus indicates limitations on any uses economically.[130] Goehring offers a simple example of these different uses of "global commons" by referencing countries' freedom to roam the high seas as an enabling global commons and the international seabed's CHM Principle as an example of the constraining global commons.[131] Although the United States has not officially specified which concept of global commons it is rejecting, it is likely referring to the economic standpoint.[132] Even still, this type of vague blanket statement only creates more confusion and uncertainty around how asteroid resource activities should be

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[127] Exec. Order No. 13914, 85 Fed. Reg. 20381 (April 10, 2020); *see* Tronchetti & Liu, *supra* note 68, at 6.

[128] Goehring, *supra* note 122, at 574.

[129] *Id.* at 574-75.

[130] *Id.* at 577.

[131] *See id.* at 579.

[132] *See id.* at 582-83.

conducted since no other alternative characterization has been put forward.[133]

An ideal top-down approach would include a new international agreement to regulate and disincentivize a monopolistic beginning to the asteroid mining sector. Many scholars have already suggested how an agreement could work such as: a lottery for the resources, application of terrestrial mining laws, or a moratorium on resource extraction altogether until a different approach than "first in time, first in right" was adopted.[134] Likely, however, such an agreement would need to focus on more than the physical resources of water and metals.

Currently, if following the legislation of one of the four aforementioned countries that states resources are able to be extracted without regulation, the first in time, first in right concept rings true. The companies with the most capital can claim the rights to the first few prospected asteroids that they reach. Likely these will be the most valuable asteroids within accessible limitations. As this value to accessibility gap broadens, mining operations will have an increasing initial investment, thus preventing other actors from entering the market.[135]

The data from prospecting asteroids could play a key role in creating an equitable agreement without hampering investors. Not only is this data valuable for the global space mining community, but it will produce information for scientific investigation as well.[136] Creating a regulatory body around the data from prospecting asteroids allows for a better estimate of how many asteroids are likely viable or worthwhile – knowledge which, in itself, can assist in mining regulation.

In seeking and considering a new international agreement, new perspectives to discuss can include the need to create principles in a regulatory scheme that may endow equitable concepts, but are more modern, adaptive, definitive, and unique than the CHM Principle as seen in UNCLOS. Such a scheme should be more

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[133] Tronchetti & Liu, *supra* note 68, at 6; *See also* Hertzfeld et al., *How Simple Terms Mislead Us; The Pitfalls of Thinking about Outer Space as a Commons*, presented at IAC 2015 (No. IAC-15 - E7.5.2 x 29369), https://swfound.org/media/205390/how-simple-terms-mislead-us-hertzfeld-johnson-weeden-iac-2015.pdf.

[134] *See* Steffen, *supra* note 23, at 6.

[135] *Id.* at 5.

[136] *Id.* at 7.

accommodating to recognize the geopolitical realities of today. It should be more adaptive to the increasing technological capabilities of private companies. It should be more definitive in what the purposes and outcomes are expected to be, including definitions on use, celestial bodies, and appropriation. It should be unique in that it should not be called the CHM Principle or allude to it, as the negative connotation behind that UNCLOS principle will likely deter nations from the outset.

In the hopes of resurging discussions surrounding international frameworks, the Hague International Space Resources Working Group (Hague Working Group) formulated a set of talking points pertinent to space resource governance. The Building Blocks for the Development of an International Framework on Space Resource Activities (Building Blocks) is a draft guideline outlining principles that stakeholders ought to consider for an international framework for space resource utilization.[137] The Building Blocks are not binding, but are influential by guiding potential negotiations for a legal framework as well as providing insight into how international custom may form without an international framework. Hopefully, further clarification and consensus-building on how the international space treaties interact with national laws and new technological developments for the space sector may be assisted with dialogue formed using the Building Blocks.

Additionally, the united, global effort to achieve the United Nations Sustainable Development Goals (SDGs) creates a possible route for the coexistence of a capitalistic asteroid mining industry that also aligns with the goals of the Outer Space Treaty by allowing for a portion of profits to be used for the "benefit and interest of all countries." SDGs were agreed upon by United Nations Member States as a method to solve some of the most significant challenges that humanity currently faces. However, as Schmidt and Svec note, SDGs consistently suffer from a lack of funding and resources.[138] Through the creation of a percentage-based funding mechanism, that portions some profits received through asteroid mining, then

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[137] BUILDING BLOCKS FOR THE DEVELOPMENT OF AN INTERNATIONAL FRAMEWORK FOR THE GOVERNANCE OF SPACE RESOURCE ACTIVITIES, https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht—en-ruimterecht/space-resources/bb-thissrwg—cover.pdf. [hereinafter BUILDING BLOCKS].

[138] Schmidt and Svec, *supra* note 6, at 124.

the majority of profits for asteroid mining companies can be realized, while also adhering to the core aspects of the Outer Space Treaty. Without a globally agreed upon framework, Bohacek *et al.* theorized that those engaged in space mining could pre-emptively contribute a portion of their realized profits towards existing, internationally agreed goals, such as SDGs or the Paris Agreement, as a form of investment protection to avoid possible legal action and ensure they are in compliance with Art. 1 of the Outer Space Treaty.[139] Percentages or base amounts could also be further set in national space mining legislation, if a nation sees it as necessary.

This approach would allow for national governments and private companies to decide the legislative scheme that works best for their own space actors, while adhering to globally agreed to principles within the Outer Space Treaty and stabilizing many of the legal uncertainties that have plagued space mining investments. Ultimately, the goal of this approach would be to maximize the autonomy of nations to decide their space policy while also creating a geopolitical environment where a peaceful space environment can be fully realized.

VI. CONCLUSION

Asteroid mining is no longer a vision from science fiction novels and companies' failed ventures. With rapid technological advancements, the proposition of mining asteroids is becoming more of a reality every day. Many spacefaring countries are recognizing the attainability of extraterrestrial resources and are clinging to these resources' potential. Along with the ability to cost-effectively access and use these resources, however, returns the questions that have haunted space explorers, advocates, and lawyers for decades. Geopolitical conflicts are inevitable if these legal questions are not resolved, and the seemingly opposing views of global space treaties are reconciled with national asteroid mining legislation.

Although the American-led Artemis Accords have been attracting a growing number of signatories, two major spacefaring nations, Russia and China, are unlikely to sign. Russia and China have shown interest in forming their own path into cosmic expansion and resource mining. With the likely surge in national

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[139] Bohacek, *supra* note 19, at 128.

legislation and regional agreements, the possibility of differing views on regulatory schemes for asteroids will increase. Such conflicting regimes in the international community heightens the likelihood of conflicts terrestrially and in space

Stepping back to look at the other aspects of space mining, such as the prospecting data and supply-chain logistics involved, could provide areas of agreement and compromise for an international agreement. Furthermore, pre-emptively sharing portions of asteroid mining proceeds to align with internationally agreed upon goals, like SDGs, may allow for private space actors to ignite further investment while shielding themselves from international legal action. A trilateral approach that includes the input of private space actors, national legislators, and the international community could result in a successful implementation of uniform or nearly uniform asteroid mining frameworks.