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International Legal Framework for Asteroid Mining: Treaty Interpretations

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International Legal Framework for Asteroid Mining: Treaty Interpretations

RESEARCH QUESTION:

Examine the current legal framework governing asteroid mining under international space law and conflicting interpretations of the Outer Space Treaty.

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Executive Summary

No binding international instrument currently governs the extraction of resources from asteroids or other celestial bodies, and the question of whether such extraction is legally permissible under the 1967 Outer Space Treaty remains genuinely contested among the world's principal spacefaring states. The treaty's simultaneous guarantee of free exploration and use (Article I) and its prohibition on national appropriation (Article II) were drafted in a Cold War context that did not anticipate commercial mining, and neither provision contains a definition that resolves whether "use" encompasses the removal and consumption of non-renewable resources or whether "appropriation" extends beyond territorial sovereignty to the depletion of a body's resource endowment [23][27][35]. In the resulting regulatory vacuum, the United States, Luxembourg, Japan, and the United Arab Emirates have each enacted domestic statutes conferring property rights over recovered space materials on private operators, each justified by a textual distinction between ownership of extracted resources and sovereignty over the celestial body itself [6][8][13][31]. Russia and China reject that reading in formal diplomatic settings, maintaining that Article II forecloses any private mining activity on celestial bodies [23][41]. The 1979 Moon Agreement, which would have resolved the dispute under a "common heritage of mankind" regime requiring an international licensing body before commercial exploitation, has been ratified by only 17 to 18 states—none of them major spacefaring powers—and is widely regarded as lacking practical legal force [2][8]. The Artemis Accords, a non-binding set of bilateral pacts with 45 signatories as of October 2024, assert that resource utilization does not constitute national appropriation, but they exclude China and Russia and carry no enforcement mechanism [36][53]. COPUOS's Working Group on Space Resources, established in 2021 with a five-year mandate, has not yet produced a binding instrument, and the Committee functions as a deliberative rather than a regulatory body [19]

[36]. The practical consequence is that the legality of commercial asteroid mining turns entirely on which interpretive camp prevails in the Article I–Article II tension, and no international adjudicative mechanism exists to settle that question. Meanwhile, the economic realities of the sector—exemplified by NASA's Osiris-Rex mission, which cost US\$1.16 billion to return a small sample of material from asteroid Bennu—suggest that the legal framework will not be stress-tested by large-scale operations in the near term [29].

The Outer Space Treaty's Core Provisions and Their Ambiguities Regarding Resource Extraction

The 1967 Outer Space Treaty, formally the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, is the foundational instrument of international space law, established under the auspices of the United Nations Office for Outer Space Affairs [2] [3]. Drafted during the Cold War competition between the United States and the Soviet Union, the treaty was designed primarily to regulate State actors and does not explicitly address the challenges posed by the modern commercialized "New Space" sector [10] [26] [30]. Its central structural ambiguity for space mining lies in the tension between Article I, which promotes the free "exploration and use" of celestial bodies, and Article II, which forbids the "national appropriation" of outer space and celestial bodies [27] [35]. The treaty contains no formal definition of "space mining" and does not explicitly specify whether the extraction and consumption of non-renewable resources such as minerals and water is permitted, creating a legal gray area that has persisted for more than five decades [6] [9] [17].

Article I: The "Province of All Mankind" and Free Exploration. Article I of the Outer Space Treaty establishes that the exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries and shall be the "province of all mankind" [13] [36] [49]. Outer space and celestial bodies are declared free for exploration and use by all States [10] [19]. The practical implication for asteroid mining is contested: the "province of all mankind" language is read by some scholars as suggesting that profits from resource extraction should not benefit a single nation or a narrow group of private operators alone [5]. At the same time, Article I's affirmation of free exploration and use is invoked by proponents of commercial mining as textual support for the permissibility of resource extraction, provided it is conducted for peaceful purposes [27] [35]. The treaty further requires that space activities be conducted "exclusively for peaceful purposes," a principle whose specific interpretation remains a subject of international contestation [18] [48].

Article II: Non-Appropriation and the Central Interpretive Dispute. Article II prohibits the national appropriation of outer space, including the Moon and other celestial bodies, by claim of sovereignty, use, occupation, or any other means [11] [16] [39]. This prohibition is binding on member states and is generally accepted as part of customary international law [39]. The

critical ambiguity is that the treaty does not explicitly define "national appropriation," nor does it state whether the prohibition extends to the extraction and use of resources found on celestial bodies [14] [16] [22]. A fundamental disagreement exists over whether the prohibition applies to natural resources in their original state or only to the act of claiming sovereignty over celestial bodies themselves [23]. One reading, advanced by the International Institute of Space Law, holds that the prohibition of national appropriation also precludes national legislation from validating private claims to property rights on celestial bodies, implying a state duty to ensure domestic legal systems do not recognize such claims [13]. An opposing reading interprets Article II as forbidding only sovereign claims over territory, not the use of resources from those bodies, provided no sovereignty is asserted [6]. The treaty does not explicitly state whether private or non-state actors are subject to the same restrictions as States, leaving open whether extracting resources constitutes a form of territorial appropriation prohibited by the treaty [41]. Current international space treaties remain untested regarding the ownership rights of minerals, gases, and water found in outer space, and the legal framework does not explicitly allow for the repatriation of resources for commercial purposes [31] [40].

Article VI: Authorization, Continuing Supervision, and the Private-Actor Gap. Article VI establishes that States bear international responsibility for national activities in outer space, including those conducted by non-governmental or private entities, and that such activities require authorization and continuing supervision by the appropriate State party [12] [27] [29] [31]. This provision creates the principle of state responsibility for private space actors: a State that authorizes a mining operation assumes international responsibility for its conduct [13] [46]. However, the treaty does not directly regulate private individuals or companies, creating a structural gap. A private entity could, in theory, exploit the "state-jumping" strategy of incorporating in a non-signatory nation to operate outside the treaty's supervisory framework [49]. The treaty also fails to address the ownership rights of private organizations regarding resources harvested from near-Earth objects such as metals, minerals, and gases, a lacuna that national legislatures have sought to fill [32].

Article IX: Due Regard and Harmful Contamination. Article IX mandates that States conduct their activities in outer space with due regard for the corresponding interests of other States and take appropriate measures to avoid harmful contamination of outer space or adverse changes in the environment of the Earth [47]. The treaty does not, however, prescribe specific mechanisms for resolving conflicts under this provision or for establishing exclusionary zones around active mining sites, leaving the practical implementation of the "due regard" obligation to bilateral or multilateral negotiation.

Taken together, these four articles produce a framework that simultaneously opens space to exploration and use while closing it to sovereign appropriation, and that places supervisory responsibility on States without defining the substantive rights that may be granted to private operators. The result is a legal architecture in which the permissibility of commercial asteroid mining turns entirely on how one resolves the Article I–Article II tension: whether "use"

encompasses extraction and consumption of resources, and whether "appropriation" is limited to territorial claims or extends to the depletion of a celestial body's resource endowment [23] [27] [35]. The treaty's vague language regarding the management of space resources has led states to define key terms based on their own national interests, and the absence of a binding multilateral definition of "space mining" or "resource extraction" means that divergent national interpretations will continue to generate friction until a more specific legal regime is negotiated [6] [37].

National Legislative Approaches to Asteroid Mining: The United States, Luxembourg, and Emerging Jurisdictions

The United States Commercial Space Launch Competitiveness Act, signed into law in 2015, is the first national statute to grant private entities explicit property rights over resources extracted from celestial bodies [8] [13]. Title IV of the Act—commonly referred to as the Space Resource Exploration and Utilization Act—authorizes U.S. citizens and legal entities to possess, own, transport, use, and sell natural resources recovered from asteroids, the Moon, or other space objects, including water ice and minerals [16] [17] [28]. The legislation was introduced in response to lobbying from private companies seeking a domestic legal pathway to hold titles to extracted minerals, and it was designed to discourage government barriers to commercial space mining operations [6] [11] [22]. Under the Act, spacecraft used for mining operations and the materials extracted during those operations are classified as private property, while the specific celestial area or object from which the materials are taken cannot be claimed as private property [38] [41].

The Act's central legal strategy for claiming compatibility with the Outer Space Treaty rests on a distinction between personal property and real property. The statute is deliberately framed to authorize the recovery of personal property—analogueous to fishing from the high seas—rather than to grant real-property interests in celestial bodies themselves [36]. Section 403 explicitly states that the law does not assert U.S. sovereignty or exclusive jurisdiction over any celestial body, a provision included specifically to avoid violating Article II of the Outer Space Treaty [17] [28] [39]. To address Article VI's requirement that states supervise the activities of their non-governmental entities, the Act mandates that the President submit a report to Congress recommending how federal agencies should allocate responsibilities for authorizing and supervising space resource mining [28]. Commercial entities are further required to obtain space resources in accordance with United States international obligations [1] [3]. The United States maintains that the Outer Space Treaty does not require a new comprehensive international regime for resource utilization, arguing that substantial human and robotic presence in the solar system will necessitate the use of resources located outside Earth's gravity well [19]. The Act aligns with the U.S. interpretation of Article I(2) of the Outer Space Treaty, which guarantees freedom of exploration and use [4]. Nevertheless, legal experts have

argued that the domestic law is incompatible with the Outer Space Treaty because enforcing mining rights through national courts would constitute an exercise of sovereign rights, and the legislation represents a unilateral approach that creates potential conflicts with international space law interpretations [71][40]. The United States has since announced plans to contract private companies to undertake lunar resource extraction, aligning with broader national goals for Moon missions planned within the next decade [10].

Luxembourg's Law of 20 July 2017 on the Exploration and Use of Space Resources made the Grand Duchy the first European country—and the second nation overall—to establish a dedicated legal framework for the appropriation of space resources [16][31]. Article 1 of the law states that space resources are subject to appropriation, permitting commercial companies operating under the framework to legally appropriate resources acquired from Near Earth Objects [16][32]. The law establishes a licensing and supervisory regime requiring mission operators to obtain specific authorizations for space resource utilization missions, and it mandates a "book of obligations" to enable government supervision and regulate the rights and duties of operators [32][33]. The legislation explicitly states that it does not aim to facilitate the national appropriation of outer space, the Moon, or other celestial bodies; instead, it clarifies Luxembourg's national position on the legal status of resources extracted from those bodies [31]. This focus on the appropriation of resources rather than sovereignty over celestial bodies or territories is the mechanism by which the law claims compliance with the Outer Space Treaty [33]. The Luxembourg framework follows a regulatory model similar to the U.S. Commercial Space Launch Competitiveness Act regarding the legal appropriation of space resources by commercial entities [32]. A notable divergence from the U.S. approach is that Luxembourg holds authorized operators fully liable for damages without a liability cap, a provision that may impact insurance accessibility for operators [17].

Luxembourg's legislative effort is embedded in the broader SpaceResources.lu initiative, a strategic framework through which the government committed 200 million euros to fund space exploration-related companies and establish the country as a hub for asteroid mining [8][32]. The initiative encompasses legal, regulatory, and international cooperation efforts to promote the exploration and commercial use of resources from Near Earth Objects [33]. The government has provided financial support and legal structure to untangle the complex legal issues surrounding space resource extraction and to give confidence to investors [40]. Deep Space Industries, a U.S.-based company, established a European subsidiary in Luxembourg to participate in the space resource economy, illustrating the cross-border attraction the framework was designed to generate [33]. In 2024, the United States and Luxembourg established a legal framework for joint projects to promote the exploration and use of space resources, linking the two principal national regimes [41][17]. The effectiveness of the draft law in providing legal certainty for private space mining companies has nonetheless been called into question, suggesting that the legislative effort may not fully address the needs of commercial actors [34].

Beyond the United States and Luxembourg, a growing number of jurisdictions have enacted or proposed legislation addressing space resource utilization. Japan's Space Resources Act, passed in 2021, provides a domestic framework that encourages businesses to seek permits for space mining activities and allows licensed companies to own mined space resources; the company iSpace received the first license to extract and sell space resources, such as regolith, for profit under this law ^{[6][8][39]}. The United Arab Emirates enacted Federal Law 12 of 2019, which enables the commercial exploitation of space resources as a regulatory mechanism supporting the country's ambitions in the space sector ^[8]. At the European level, the draft EU Space Act presented by the European Commission in June 2025 focuses on the operation and control of space objects, launch services, and space debris, but does not explicitly cover space mining, meaning Member States will likely retain regulatory leeway regarding mining activities ^[4]. Other nations, including Luxembourg, Japan, China, India, and Russia, are also introducing similar national legislation to legalize the appropriation of extraterrestrial resources ^[11].

Feature	United States (CSLCA 2015)	Luxembourg (Law of 20 July 2017)	Japan (Space Resources Act 2021)	UAE (Federal Law 12/2019)
Private property rights over extracted resources	Yes – possess, own, transport, use, sell [28]	Yes – appropriation of NEO resources [32]	Yes – licensed companies may own mined resources [8]	Yes – commercial exploitation enabled [8]
Sovereignty over celestial bodies disclaimed	Yes – Section 403 [28]	Yes – explicit in law text [31]	n/a	n/a
Licensing / supervisory regime	Presidential report to Congress on agency allocation [28]	Specific authorizations + "book of obligations" [33]	Permit system for operators [6]	n/a
Liability regime for operators	Not specified in findings	Full liability, no cap [17]	n/a	n/a
Stated OST compatibility rationale	Personal-property (fishing) analogy; no real-property claim [36]	Appropriation of resources ≠ appropriation of territory [33]	n/a	n/a
Financial / industrial incentives	Discourages government barriers to commercial mining [6]	200 M€ SpaceResources.lu fund [32]	n/a	n/a

The collective effect of these national statutes is to create a patchwork of domestic property-rights regimes in the absence of a unified international framework [8]. Each jurisdiction frames its legislation as compatible with the Outer Space Treaty by drawing a line between the ownership of extracted resources and the sovereignty over the celestial body from which they are taken [16] [33] [36]. The United States and Luxembourg, in particular, have articulated this

distinction in the text of their laws, while the broader question of whether such a distinction is legally sustainable under Articles I, II, and VI of the Outer Space Treaty remains contested, as the following section examines.

Interpretive Controversies and Diplomatic Disputes: Conflicting Readings of Ownership, Appropriation, and the 'Province of All Mankind'

The central legal controversy surrounding asteroid mining is whether the extraction of space resources constitutes the prohibited "national appropriation" of celestial bodies under Article II of the Outer Space Treaty, or whether it falls within the permitted "exploration and use" of outer space guaranteed by Article I. Legal scholars are divided into two principal camps on this question. One camp argues that mining necessarily requires exclusionary rights—the right to exclude others from a resource site—that violate the treaty's principles of freedom of access and non-appropriation ^{[27] [29]}. The opposing camp contends that the treaty's silence on resource extraction, combined with its prohibition of sovereignty claims over territory, does not explicitly forbid commercial mining, and that the "province of all mankind" clause in Article I is satisfied so long as the activity benefits all countries ^{[6] [27] [29]}. This interpretive fracture is compounded by the fact that the Outer Space Treaty's "province of all mankind" language differs materially from the "common heritage of mankind" formulation in UNCLOS, which required explicit amendments to permit resource development in the deep seabed ^{[6] [13]}.

The legal arguments invoked by each side turn on several distinct doctrinal questions. First, there is the question of whether the non-appropriation prohibition in Article II extends to private commercial entities or applies only to state sovereignty claims; the tension between the principle of non-appropriation and the potential for resource exploitation by non-governmental actors remains unresolved ^{[14] [25]}. Second, some scholars draw an analogy to the high seas, arguing that space resources should be treated like high-seas resources, where commercial exploitation is permitted without claiming sovereignty over the underlying territory ^[13]. Third, a distinction is drawn between in-situ resource utilisation (ISRU)—the harnessing of local natural resources at mission destinations to enhance exploration capabilities, which many legal scholars believe is not prohibited by the Outer Space Treaty—and commercial resource extraction for Earth-bound markets, which carries far greater legal risk ^[27]. Fourth, the practical property question of whether entities can hold the right to exclude others in an environment described as an Ostromian commons remains unsettled, with current discourse focused on whether customary international law is evolving to permit resource utilization despite existing treaty constraints ^{[25] [26]}.

The United States has articulated a specific interpretive position to resolve these ambiguities in favour of commercial activity. The United States maintains that its domestic legislation allowing for the commercial appropriation of space resources is consistent with its obligations under the Outer Space Treaty, relying on the interpretation that resource extraction is distinct

from national appropriation of celestial bodies ^[9]. More precisely, the United States argues that the prohibition on national appropriation applies only to resources "in place," meaning that once resources are extracted, they can be legally purchased and sold ^[23]. To entrench this reading, the United States is utilising national legislation, the Artemis Accords, and contracts with private companies to establish what it characterises as "subsequent practice" in international law ^[23]. The United States further frames space property rights as a national security priority, citing the need to reduce dependence on foreign suppliers of rare Earth elements and critical minerals ^[41].

Opposing diplomatic positions have been voiced with considerable force. Russia and China argue that the non-appropriation principle in Article II prohibits private entities from mining celestial bodies, contending that such activities would violate the principle that space exploration must be conducted for the benefit of all peoples ^[41]. Russia, through Roscosmos, has explicitly rejected the privatization of the Moon, stating that such attempts are illegal and run counter to international law ^[23]. At COPUOS, Russia argued that unilateral national legislation is invalid and that space mining contradicts the non-appropriation principle ^[17]. Greece has asserted that the legal aspects of space resource exploration and exploitation must be regulated by international law, and has suggested that existing multilateral regimes—such as the International Seabed Authority under UNCLOS, ITU frequency spectrum management, and the Antarctic Treaty—should serve as models for developing a space resource framework ^[43]. Belgium expressed concerns regarding global economic imbalances and advocated for an international approach rather than national jurisdiction ^[17]. Developing countries, including the G77+China and Indonesia, have pressed for equitable access to space resources, while nations such as Ukraine, France, and New Zealand have raised concerns regarding environmental sustainability and the prevention of contamination on celestial bodies ^[19].

The Artemis Accords, a series of bilateral agreements led by the United States to clarify issues related to the Outer Space Treaty specifically regarding the use of space resources, have become a focal point of this controversy ^[11]. Proponents argue the Accords uphold the treaty, while critics contend they violate the prohibition on national appropriation by allowing signatories to claim extracted resources from asteroids and the Moon ^[52]. The International Institute of Space Law (IISL) issued a position paper stating that the U.S. law granting property rights to mined space resources is a possible interpretation of the Outer Space Treaty and does not inherently violate it, but noted that it remains an open question whether this legal situation is satisfactory or shared by other nations ^[28]. The 1979 Moon Agreement, which declares celestial bodies to be the "common heritage of mankind" and requires an international regime for commercial exploitation, was intended to resolve these questions under a multilateral framework but lacks broad international authority because major spacefaring stakeholders, including the United States, Russia, and China, have not ratified it

[10]. Nevertheless, some scholars argue that the Moon Agreement's provisions regarding commercial mining may be binding as customary international law, a claim that would significantly constrain the permissive readings advanced by the United States [13].

A further layer of interpretive difficulty arises from the Outer Space Treaty's lack of a formal working definition of "peaceful purposes." The United States interprets this term as "non-aggressive," allowing military presence in space, while Russia interprets it as "non-military," requiring the absence of armed forces [49]. This definitional gap compounds the broader appropriation debate by leaving unclear which categories of state and private activity in space are permissible. Despite these unresolved legal questions, participants in outer space mining and resource extraction are moving forward with activities, a pattern that mirrors the early days of mining in the United States where extraction occurred before legal frameworks were fully settled [26]. Private actors such as SpaceX have been criticised for conducting activities that may establish customary norms through practice, raising concerns about the ability of private entities to effectively "make the rules" in space [5]. The cumulative effect of these divergent readings, diplomatic objections, and ongoing practice is that the legal status of property rights in outer space remains unsettled, with the central question—whether the non-appropriation principle forecloses the exclusionary rights that commercial mining requires—still open to genuine and consequential disagreement [25] [39].

Multilateral Governance Responses: UN COPUOS Deliberations, the Moon Agreement, the Liability Convention, and the Artemis Accords

The multilateral architecture governing space resource utilization is fragmented across several instruments that have, to date, produced no binding consensus on the legality of asteroid mining. The United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) remains the primary forum for discussing space resource activities, operating through its Scientific and Technical and Legal subcommittees to address issues ranging from space debris to the extraction of celestial resources [28] [37] [43]. In 2021, COPUOS's Legal Subcommittee established a Working Group on Space Resources with a five-year mandate to explore potential legal models for the exploration, exploitation, and utilization of space resources, following informal consultations that identified a gap between rapid technological advancement and the absence of a dedicated international legal framework [19] [23]. This working group is currently considering frameworks for access, ownership, and control of space resources [24]. However, COPUOS functions as a deliberative body rather than a regulatory one, and it has not produced a binding international instrument for space resource activities since the 1979 Moon Agreement [36]. Historically, its subcommittees have reached unanimity on scientific and technical questions but have struggled to reach agreement on legal questions [42]. The formation of a successful multilateral regime faces significant political barriers and collective-action problems, requiring both broad participation from spacefaring

and non-spacefaring nations and a high degree of legalization to ensure compliance and equitable benefit-sharing [24]. China and Russia have not signed on to newer international frameworks governing space activities, and this lack of participation from key global actors remains a central challenge to establishing effective governance [21][22]. In 2024, COPUOS also established the Action Team on Lunar Activities Consultation (ATLAC), tasked with facilitating expert exchanges to avoid interference during lunar exploration and addressing technical risks such as landing plumes, dust ejecta, and contamination of Permanently Shadowed Regions [45]. Analysts predict a bifurcation in which technical coordination is managed by a UN-backed mechanism like ATLAC, while actual resource extraction is governed by a patchwork of national laws and bilateral agreements rather than a unified international framework [45].

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, commonly called the Moon Agreement, is the most explicit multilateral attempt to regulate celestial resource extraction. Adopted in 1979 and promoted by the United Nations Office for Outer Space Affairs, it elaborates on the Outer Space Treaty by declaring in Article 11 that the Moon and its natural resources are the "common heritage of mankind" [3][22][44]. Article 11(3) specifically provides that natural resources "in place" may not become the property of any State, nongovernmental entity, or natural person, a distinction the Outer Space Treaty itself does not draw [35]. The Agreement mandates the establishment of an international regime to govern the exploitation of lunar natural resources once such exploitation becomes feasible, intended to ensure orderly, safe, and rational management with equitable sharing of benefits among all States Parties [44]. It further stipulates that its provisions regarding the Moon also apply to other celestial bodies within the solar system, excluding Earth, unless specific legal norms are established for those bodies [44]. The Agreement also creates a specific duty to prevent the disruption of the existing lunar environment, going beyond the Outer Space Treaty's general peaceful-purposes principle [47]. In practice, however, the Moon Agreement is widely considered unenforceable in international law. As of 2024, it has been ratified by only 17 to 18 nations, none of which are major spacefaring powers; the United States, China, and Russia are not parties [2][4][8][19][27][29][36]. The United States disagreed with the proposal for an international body to oversee and authorize space mineral extraction, and the effort failed to gain universal adoption [5][22]. Luxembourg, a leading proponent of national asteroid-mining legislation, is likewise not a party to the Agreement [31]. Among the Artemis Accords signatories, only Australia, Mexico, and Saudi Arabia are also bound by the Moon Agreement's Article 11 [39]. The Agreement is thus viewed as an impractical framework that appears to prohibit commercial space mining entirely within the solar system and lacks the wide acceptance required to resolve the legal status of such activities [6][16].

The Liability Convention, which elaborates on the responsibilities of launching States and establishes formal compensation procedures for damage inflicted by space objects, provides the existing baseline for addressing incidents arising from space resource operations [47]. It

establishes absolute liability for a launching State if damage occurs on Earth or to aircraft in flight, but applies fault-based liability for damage occurring to space objects or persons and property in space [46]. For asteroid mining and lunar operations, the Convention is poorly adapted: it currently lacks mechanisms to channel claims directly to nuclear operators or to provide for sufficient financial security, and existing frameworks may struggle to define "damage" in the context of nuclear contamination on the Moon—specifically whether it extends to loss of use, remediation costs, or economic loss where no physical injury has occurred [46]. The Convention is also ill-suited to address latent health effects or long-term environmental contamination [46]. Because the original 1960s–70s space treaties contain no direct environmental protections, the international community has developed soft-law instruments such as the Space Debris Mitigation Guidelines adopted by COPUOS in 2007, which aim to mitigate the production of new debris and ensure sustainable space access [47]. These guidelines, however, do not extend to the regulation of resource extraction itself.

The Artemis Accords, a series of non-binding bilateral pacts initiated by the United States and NASA in 2020, represent the most active multilateral effort to establish norms for space resource utilization outside the COPUOS process [20] [22] [52]. The Accords were created in response to debates within COPUOS regarding the governance of space resources and attempt to reconcile resource extraction with the Outer Space Treaty by asserting that the utilization of space resources does not constitute national appropriation under Article II [2] [5]. Section 10 of the Accords explicitly states that the extraction and utilization of space resources on the Moon, Mars, comets, and asteroids does not inherently constitute national appropriation under the Outer Space Treaty, and that legal instruments regarding space resources should remain consistent with the treaty [27] [29] [41]. Signatories agree that resource utilization can support safe and sustainable operations and may include the granting of property rights over space resources [39]. The Accords also introduce the concept of "safety zones" to provide functional protection for operational activities without establishing territorial exclusion, though these provisions are not binding for non-signatory nations, specifically including China and Russia [36] [48]. The Accords reinforce commitments to existing international space law, including the Outer Space Treaty, the Registration Convention, and the Rescue and Return Agreement, and establish operational principles such as transparency, the sharing of scientific information consistent with Article XI of the Outer Space Treaty, and the use of interoperability standards [51] [52]. They incorporate elements from the Hague International Space Resources Governance Working Group's "Building Blocks," which operate on the principle that resource extraction is permissible as long as it complies with the non-appropriation principle of Article II [35]. As of October 2024, the Accords have 45 signatories, having grown from an initial eight nations, and signing is a prerequisite for nations wishing to partner on NASA's Artemis program [53]. In-situ resource utilization (ISRU) is considered lawful under the current legal framework as interpreted through the Outer Space Treaty and the Artemis Accords, and is viewed as a method to advance space exploration [15].

△ The legal status of space mining remains contested under these instruments. Critics argue that the Artemis Accords favor United States and commercial mining interests and may subvert the role of the United Nations Office for Outer Space Affairs, and that the Accords' appropriation-centric approach diverges from existing international space law, creating potential legal ambiguities and inconsistencies with the Outer Space Treaty ^[24]^[52]. The current global space governance framework is broadly viewed as struggling to keep pace with technological advancements and the rise of non-traditional actors, with existing multilateral agreements often considered ineffective at managing modern challenges such as celestial resource use ^[37]. Luxembourg has indicated it is actively seeking to engage with other nations to establish a global legal framework for the commercial utilization of near-Earth object resources within the context of the United Nations ^[32], and Malaysia, which ratified two of the five UN space treaties and joined the Artemis Accords in October 2025, is actively engaged in international discussions on space resource governance and the long-term sustainability of outer space activities ^[43]. The net effect of the existing multilateral landscape is that no single binding instrument governs asteroid mining, and the competing readings of the Outer Space Treaty embedded in the Moon Agreement on one side and the Artemis Accords on the other remain unresolved at the international level.

Towards a Revised Legal Regime: Draft Treaties, the 'Common Heritage of Mankind' Debate, and Emerging Proposals

The absence of a dedicated international governing body or dispute-resolution mechanism for space mining has produced a patchwork of national statutes that, in the view of several scholars, risks degenerating into a "race to the bottom" on safety and environmental protections or the emergence of "flag-of-convenience" states ^[6]^[23]. The legal landscape is further complicated by a structural rift between public and private actors: commercial entities have tended to lobby for national laws that effectively supersede international treaty obligations, while state delegations at the United Nations have resisted ceding regulatory authority to private operators ^[5]. This impasse has prompted space professionals to call for a new "Multilateral Agreement on Space Resource Utilization" that would supply concrete guidelines ahead of what they anticipate will be an "asteroid-rush" ^[5].

At the heart of the reform debate sits the "common heritage of mankind" principle. The 1979 Moon Treaty, which enshrines that formulation for all celestial bodies, remains the most explicit multilateral text on the issue, yet it has failed to attract ratification from any major space-faring nation, limiting its practical force ^[40]. A different strand of the common-heritage argument draws on the BBNJ (Biodiversity Beyond National Jurisdiction) agreement: commentators have proposed that the Moon be treated analogously to the high seas, so that no state can claim sovereignty over lunar territory and resource extraction is governed by a shared international regime ^[45]. A related line of reasoning points to the UN Convention on the

Law of the Sea as a structural template, arguing that its architecture for the Area beyond national jurisdiction—combining state sovereignty over national territory with collective stewardship of the seabed—could be transposed to cislunar and asteroid contexts [\[40\]](#).

Several concrete institutional and treaty proposals have been advanced to bridge the gap between existing national legislation and a coherent international framework. The table below summarises the principal models under discussion:

Proposal	Core mechanism	Source / proponent
International registrar for priority mining rights	A multilateral registry grants first-come, first-served exploration and extraction rights	Hague International Space Resources Governance (HISRG) working group, 2019 [4]
International Seabed Authority-style regulator + Seabed Disputes Chamber-style arbitration panel	Dedicated industrial regulator and binding dispute-resolution body modelled on deep-sea mining governance	Scholars drawing on the Law of the Sea framework [2] [6]
Goals-based regulatory approach	Non-prescriptive performance targets to sidestep political disagreements over property language	Academic proposals [2]
Nonbinding United Nations standards	Soft-law guidelines adopted through COPUOS or a similar forum	Academic proposals [2]
Data-disclosure-linked mining rights	Extraction entitlements conditioned on public disclosure of exploration data	Academic proposals [2]
Lunar-centric legal regime	A specific legal regime tailored to the unique physical and operational conditions of cislunar space	Academic proposal [50]
Amendment of the Outer Space Treaty	Clarify "peaceful purposes," extend weapons prohibitions to conventional arms, and expand the treaty's spatial scope to interplanetary space and Lagrange points	Legal-expert proposals [49]

△ The common-heritage and high-seas analogies, while intellectually compelling, sit in direct tension with the property-rights language already enacted in the United States and Luxembourg (discussed in the preceding section on national legislation). Any multilateral instrument that reasserts collective stewardship over extracted resources would effectively nullify the domestic statutes under which existing commercial ventures operate, making diplomatic consensus unlikely without a transitional or grandfathering mechanism.

Beyond the structural question of who governs, reform proposals increasingly incorporate environmental safeguards. Experts have flagged the potential for overexploitation of celestial bodies and the cumulative greenhouse-gas emissions from the launch cadence that large-scale mining would require, and they recommend incorporating environmental impact assessments into new legal regimes to ensure sustainability [2]. Institutional work to synthesise these ideas is already underway: the Outer Space Institute, for example, held international workshops in 2020 to develop transdisciplinary policy recommendations on outer space mining and related challenges, aimed at guiding international space policy creation [10]. Whether any of the proposals catalogued above will mature into a binding multilateral text remains uncertain, but the convergence of academic, industry, and intergovernmental attention on the problem signals that the current interpretive vacuum is widely regarded as unsustainable.

Research Gaps

Several questions remain open because the available evidence does not resolve them.

First, whether the United States' "in place" versus extracted distinction—under which resources may be owned once removed from a celestial body but the body itself cannot be claimed—will crystallize into a rule of customary international law through sustained state practice. The United States is actively building what it characterises as "subsequent practice" through national legislation, the Artemis Accords, and private-sector contracts [23], but no body of consistent state practice from a critical number of states has yet emerged, and Russia's opposing position at COPUOS [17] makes the formation of a uniform custom uncertain.

Second, whether the Moon Agreement's Article 11 provisions—specifically the requirement that states parties reach an international agreement before engaging in commercial mining, since such activities are not yet considered "about to become feasible" [17]—could be argued to bind non-parties as customary international law. Some scholars advance this claim [13], but the evidence does not establish whether the threshold of widespread and consistent state practice required for customary-law status has been met, given that the Agreement's 17 to 18 ratifications include no major spacefaring power [2] [8].

Third, what the COPUOS Working Group on Space Resources will actually produce by the end of its five-year mandate. The Working Group is "currently considering frameworks for access, ownership, and control of space resources" [24], but no draft text, negotiating position, or timeline for a final report has been made public in the evidence reviewed. The historical pattern of COPUOS subcommittees reaching unanimity on technical questions but stalling on legal ones [42] raises the prospect that the mandate will expire without a binding outcome, but this is a prediction, not an established fact.

Fourth, whether the Artemis Accords' "safety zones" concept will evolve into a binding operational norm or remain a non-binding arrangement enforceable only among signatories. The Accords' safety-zone provisions are explicitly not binding on non-signatory nations, including China and Russia [36], and the evidence does not establish whether any signatory has yet invoked a safety zone in an operational context or whether the concept has generated any customary-law trajectory.

Fifth, the definitional gap surrounding "peaceful purposes" in the Outer Space Treaty. The United States reads the term as "non-aggressive," permitting military presence in space, while Russia reads it as "non-military" [49]. The evidence does not establish whether any forum—COPUOS, the Action Team on Lunar Activities Consultation (ATLAC), or a future treaty process—will resolve this divergence, and the related question of whether the Prevention of an Arms Race in Outer Space (PPWT) draft will be refined to address cislunar security [48] remains unanswered.

Sixth, the applicability of existing nuclear-liability instruments to incidents on the lunar surface. The Paris Convention's geographical scope is primarily terrestrial, covering damage in the territory or maritime zones of Contracting Parties, which makes its direct application to lunar installations less obvious [46]. The Liability Convention lacks mechanisms to channel claims to nuclear operators or to define "damage" in the context of nuclear contamination where no physical injury has occurred [46]. The evidence does not establish whether a dedicated lunar nuclear-liability regime will be negotiated or whether existing conventions will be interpreted to cover such scenarios.

Seventh, the practical implementation of Article IX's "due regard" obligation in the context of multiple operators at the same or proximate asteroid sites. The treaty prescribes no mechanism for establishing exclusionary zones, resolving interference disputes, or allocating extraction rights at a shared resource body [5] [47]. The evidence does not establish whether bilateral or multilateral operational protocols have been developed to address this, or whether the Hague International Space Resources Governance (HISRG) "Building Blocks" [35] will be adopted by any state or intergovernmental body.

Eighth, the economic and operational timeline within which the legal framework will be tested by actual large-scale extraction. Current operations are not economically sustainable [29], and the Shackleton Energy Company's failure to secure investment for lunar water extraction [30]

illustrates the financial risk. The evidence does not establish whether technological advances—such as reusable launch vehicles or in-situ resource utilization reducing the need to return materials to Earth ^[20]^[30]—will bring commercial viability within a defined timeframe, and therefore whether the interpretive disputes identified above will be resolved through legal negotiation or through the de facto norms established by the first operators to extract and sell celestial resources.

Ninth, the interaction between the draft EU Space Act, which focuses on space-object operation, launch services, and debris but does not explicitly cover space mining ^[4], and the national mining legislation of EU member states such as Luxembourg. The evidence does not establish whether the final EU Space Act will include resource-utilization provisions or whether member states will retain full regulatory leeway, and the 2024 United States–Luxembourg joint framework for space-resource projects ^[4] has not yet produced publicly available operational rules.

Tenth, whether the "common heritage of mankind" formulation in the Moon Agreement and the "province of all mankind" language in Article I of the Outer Space Treaty will be reconciled in a future instrument. The two phrases carry materially different legal implications—the former requiring an international regime and equitable benefit-sharing, the latter permitting free use subject to non-appropriation ^[6]^[13]—and the evidence does not establish which formulation, if either, will prevail in any successor treaty or whether the distinction will be resolved through the BBNJ or Law of the Sea analogies proposed in the academic literature ^[40]^[45].

The evidence covers the official positions of China and Russia, recent diplomatic disputes, the alignment of other national laws, the Artemis Accords and the development of customary law only shallowly. The report does not address all major spacefaring nations, enforcement and dispute-resolution mechanisms, the economic implications of the legal regimes, environmental protection or the private sector's perspective.

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Methodology

This report was generated through 4 iteration(s) of autonomous deep research, using 102 source(s) and extracting 235 finding(s).

RESEARCH CONCLUSION

i Token budget exhausted — The research used the full token budget before reaching the coverage target. The topic may require deeper investigation — consider running a follow-up with a more focused question or different sub-topics.

ITERATION LOG

Iter	Coverage	Sources	Findings	IGR*	Duration
1	0.82	34	95	2.79	58.9s
2	0.82	19	35	1.75	35.1s
3	0.82	24	58	1.81	53.4s
4	0.82	25	47	1.27	85.3s

*IGR (Information Gain Rate) = new findings per search result examined. Values near 0 indicate diminishing returns.

SOURCE DIVERSITY

- Unique domains: 49
- Domain entropy: 0.98 (0=mono-source, 1=perfectly diverse)
- Dominant domain: en.wikipedia.org (5% of sources)

Data Processing Summary

AI Model: gemma4-chat-26b, gpt-oss-120b, qwen3.6-chat-35b, qwen3.8-27b · AKI.io, Frankfurt, Germany

Search: Staan / SearXNG (EU)

Storage: Hetzner, Germany

Training: Your data is not used for model training

All data processed within the EU · GDPR-compliant · Deletable on request — privacy@ciata.io