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Digital Policy Hub

Digital Policy Hub – Working Paper

Dig Deep and Look Up: Applying Canada's Mining Experience to the Moon

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Key Points

- Humanity is returning to the Moon to establish a permanent presence. This will require lunar resources for life support, in situ manufacturing, propellant and infrastructure.
- Space resources are legally accessible by all, but governance questions remain about licensing, environmental assessment, cultural heritage and benefit sharing.
- Some domestic laws enable commercial ownership of space resources, despite differing views on its legality under the Outer Space Treaty (OST). This could lead to conflict, overuse and harm to lunar environments, cultural heritage or scientific goals.
- A long regulatory history of terrestrial extractive industries, as well as concurrent debates on mining the deep seabed, can offer lessons for effectively governing lunar resource activity, despite differences between these unique environments.
- Canada should position itself as a leader in space resource governance by leveraging its terrestrial mining expertise. Through institutional funding and a joint study between Natural Resources Canada (NRCan) and Global Affairs Canada (GAC), Canada can support the development of domestic and international rules for lunar resource extraction that ensure industry predictability, environmental stewardship, reconciliation and human rights.

Introduction

The Moon was formed when a Mars-sized body collided with Earth more than 4.5 billion years ago and has remained unchanged in the night sky (Vogel, n.d.). Since the Apollo missions and subsequent lunar sample missions,[1] the Moon's resources and their potential uses have been well documented (see Table 1). The Moon is also central to cultural expressions in song, fiction writing, film, as well as religious and spiritual beliefs. For many Indigenous and other peoples, the Moon is considered sacred (Noon 2024).

Outer space, often compared to the high seas or Antarctica, has historically been recognized as a global commons, and though its resources are available to all, their supply is limited.[2] Lunar activity and competition for resources are expected to increase along with planned crewed missions to the Moon. The cislunar economy is projected to reach US$170 billion by 2040 (Scatteia and Perrot 2021), and both public and private actors involved in lunar exploration intend to identify resources to support in situ needs. Military interest in the Moon has also raised tensions between China and the United States, and between the United States and Russia in the wake of the war in Ukraine (Raju 2024), which could also factor into resource rivalries.

Not surprisingly, the competition for space resources reflects resource-based geopolitics. This is most apparent in the critical minerals sector, with China attempting to establish

1 The Artemis III mission, as part of the NASA-led international program, forecasts a crewed Moon landing by mid-2027, marking the first time humans return to the Moon since 1972. China, Russia and other countries are also planning to put humans on the Moon and build a permanent lunar base in the coming two decades.

2 Elinor Ostrom (1990) provides eight strategies for managing common-pool resources, which have potential applicability to space resource extraction. Her analysis highlights that successful resource management is dependent on well-designed rules, collective decision making and locally relevant enforcement mechanisms.

control over critical minerals on Earth and on the Moon (Autry and Navarro 2024). Though outer space is to be used exclusively for peaceful purposes, article I of the 1967 OST[3] also states that the exploration and use of space is the "province of all mankind" and that there shall be "free access to all areas of celestial bodies." In theory, therefore, first movers on the Moon could secure valuable resources for their own use, such as critical minerals and water ice.

Table 1: Main Resources on the Moon and Potential Governance Implications

Resources	Potential Governance Implications
Permanently shadowed regions (PSRs)	PSRs contain water ice and other non-renewable volatiles critical for generating oxygen, hydrogen, water and propellants. The potential for competition is extremely high; policies should balance use and preservation to avoid depletion.
Radio-quiet zones (RQZs)	RQZs are needed for radio astronomy on the lunar far side and may also support localized communications and navigation. Managing this resource requires coordination.
Peaks of eternal light (PELs)	Located near the lunar poles with significantly more access to sunlight, PELs are ideal for solar panels and are close to PSRs, making them essential for energy and resource access and likely to spark competition.
Lunar lava tubes (LLTs)	LLTs offer potential habitats or storage facilities with natural radiation shielding and are valuable for scientific study and resource extraction. Like PSRs, policies should balance use and preservation to avoid depletion.
Lunar regolith	Regolith, the loose, unconsolidated layer of material on the lunar surface, has many potential uses, including for construction and radiation protection. Though regolith is generally abundant on the Moon, specific elements within the regolith, such as potassium, rare Earth elements and phosphorus, are scarcer and would be useful for power and energy systems.

Source: Adapted by the author from Kuhn, Schingler and Hubbard (2022) and Crawford (2015).

Canada's private sector is involved in lunar resource exploration through a partnership with the National Aeronautics and Space Administration (NASA).[4] While some countries such as the United States have enacted legislation permitting space resource ownership, Canada has yet to signal such a move domestically (Masson-Zwaan and Sundahl 2023) and its international contributions have been high level, with the exception of

3 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, 27 January 1967, Res 2222 (XXI) art I (entered into force 10 October 1967), online: *UNOOSA* <www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html>.

4 See www.asc-csa.gc.ca/eng/astronomy/moon-exploration/canada-role.asp.

civil society groups.[5] Despite its long history as a mining country, Canada has yet to contribute its expertise in terrestrial natural resource governance to the international conversation on space resources.

What Resources Exist on the Moon?

Though the Moon is grouped with all other celestial bodies (for example, asteroids and other planets) under the OST, its cultural significance and unique resources demand tailored governance solutions (Table 1). Lunar resource extraction proposals, while promising for space exploration goals, have raised concerns about technological feasibility, cultural heritage, interference with lunar science and environmental damage (Salmeri 2023). While the full impacts of these activities remain unknown, lunar operations will likely result in waste and generate contaminants, damage to neighbouring operations and landscape changes (Sanders et al. 2023). Despite no known signs of life on the Moon, the discovery of biosignatures during subsurface mining remains possible (Outer Space Institute 2020).

What Laws Apply to Lunar Resources?

The Moon is subject to both hard law (such as the OST, which is binding on state parties and sets enforceable obligations), as well as soft law (such as the Artemis Accords, which shapes norms and practices but lacks legally binding force).

International Law

International space law consists of obligations and expectations established in treaties, customary international law, resolutions, declarations and other relevant instruments. The OST, ratified by 115 state parties, forms the legal framework's core.[6] The treaty's principles include freedom of exploration and use (article I), non-appropriation of celestial bodies (article II) and avoiding harmful contamination or interference in carrying out space activities (article IX). Non-state actors are required to comply with the OST through the authorization and ongoing supervision of their activities by responsible states (article VI).

While early debates considered the potential prohibition of in situ resource utilization as appropriation (article II), current discussions at the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)[7] have shifted to governance and coordination (Masson-Zwaan and Sundahl 2023). Space activities must also obey other international

5 The Vancouver Recommendations on Space Mining prepared by the Outer Space Institute (2020) include international guidance for negotiating states to adopt a precautionary principle, prioritize planetary protection, ensure that lunar activities are properly monitored and encourage a mandatory benefits-sharing mechanism that includes monetary benefits.

6 The Moon Agreement (1984) has provisions relevant to resource governance but is not widely adopted, with only 17 state parties, and so has limited applicability as a legal doctrine.

7 See *Canada — Input to the Working Group on Legal Aspects of Space Resource Activities*, UNCOPUOS, 62nd Sess, UN Doc A/AC.105/C.2/2023/CRP.11 (2023), online: *UNOOSA* <www.unoosa.org/oosa/oosadoc/data/documents/2023/aac.105c.22023crp/aac.105c.22023crp.11_0.html>..

laws (article III), inviting the application of environmental law, human rights law and Indigenous rights, among others. In reality, companies and their supporting states shape international norms, prioritizing investment protection over human rights (Simons 2019).

Deep seabed mining, also a global commons, is often analogized to space mining, with both raising issues of technical feasibility, environmental impact and benefit sharing. The International Seabed Authority is slated to publish rules in 2025 that address equitable benefit sharing, environmental protection and harm prevention — though challenges remain, including governance complexity, enforcement and concerns over commercialization (Pickens et al. 2024).

Soft Law

Soft law, such as the UN resolutions[8] and non-binding instruments such as the NASA-led Artemis Accords, also shape space norms. The Artemis Accords have a growing list of signatories and assert that space resources can be extracted and appropriated in compliance with the OST.[9] China and Russia have developed guidelines for the International Lunar Research Station (ILRS), though the only published principles are "equality, openness and integrity" while they continue recruiting partners (China National Space Administration 2021).[10] The US-led and China-led regimes have not been harmonized outside limited interactions through UNCOPUOS, so it is likely that differences in interpretation of rights, obligations, safety or environmental protocols could hinder international cooperation.

Domestic Law

In the absence of a common regime for space resource management, several countries (Japan, Luxembourg, the United Arab Emirates and the United States) have unilaterally developed domestic legislation specific to space resources. These laws have three common purposes: clarifying the legality of resource extraction on celestial bodies; establishing right of ownership by operators over any resources extracted; and collecting information from operators regarding planned resource extraction (Masson-Zwaan and Sundahl 2023). In the United States, NASA has contracts with at least four companies to collect space resources, thereby establishing a precedent for private-sector space resource extraction (Lindbergh 2024).

8 A widely endorsed resolution adopted in 1996, its full title reads: Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries. The expectations of developing countries have further evolved since then with the language in the UN Sustainable Development Goals and adoption of the access to benefits rules under the UN Convention on Biological Diversity.

9 As of December 8, 2024, there are 48 signatories. See www.nasa.gov/artemis-accords/ for a current list.

10 In July 2024, China announced it is aiming to secure 50 partners for the ILRS, rivalling the United States (Jones 2024).

Issues for Lunar Resource Governance

Incentives for a Deregulated Playing Field

As humanity moves deeper into the cosmos, a dangerous idealism lurks beneath the surface. The absence of regulation reflects two animating logics: first, blind optimism that humanity will somehow behave better in space than on Earth, with little supporting evidence; and, second, a US-China race for lunar dominance, where both purport to seek safety and sustainability of operations while fiercely competing to build their respective coalitions. Without clear rules, a winner-takes-all approach could prevail. To this end, China is taking a similar approach in the South and East China Seas (O'Rourke 2018), and the United States has made clear that it believes there is "neither a need nor a practical basis to create a further elaborated international regime for space resource utilization activities."[11]

A Multilateral Forum Struggling to Keep Up

In the multilateral context, UNCOPUOS has identified high-level priorities for shaping resource governance principles:

- maintaining the centrality and compliance of the OST (including principles of non-appropriation and peaceful use);
- remaining sensitive to specific space resources and their potential benefits;
- addressing equitable, environmental and economic aspects of space resource use;
- preserving cultural heritage and the rights of Indigenous peoples;
- international coordination and licensing;
- addressing intersections with trade and investment frameworks; and
- establishing benefit sharing that aligns with the interests of developing countries. (UNCOPUOS 2023)

While this is a fulsome set of questions, the expected outcome is merely "initial recommended principles" to be adopted by 2027, which should be treated as a stepping stone to more robust regulatory controls.

Fragmented Efforts to Develop Self-Governance Standards

Efforts are under way to develop standards for lunar mining activity. The Lunar Ore Reserves Standards (LORS-101), an international initiative, draws from frameworks such as those of Australia, Canada and the United Nations, with a focus on resource value estimation. In 2023, NASA staff identified 15 areas of overlap between terrestrial mining and lunar in situ resource utilization for further study (Sanders, Kleinhenz and Boucher 2023). While a Canadian contributed to the NASA paper, and Canada's regime is referenced in LORS-101, there appears to

11 *United States — Input to the Working Group on Legal Aspects of Space Resource Activities*, UNOOSA, 62nd Sess, UN Doc A/AC.105/C.2/2023/CRP.37 (2023).

be no government involvement in either project's development or review. Both projects have a technical focus, with little recognition of sociopolitical factors outside of how social licence issues might negatively impact economic viability.

Benefit Sharing, Human and Indigenous Rights and Environmental Protection

Despite calls for equitable benefit sharing under the UN Space Benefits Declaration, rights-based concerns remain sidelined in multilateral fora and absent from national legislation. Further, activities on the Moon have already attracted rights-based concerns. For example, in 2024, a US company sent human remains to the Moon, which the Navajo Nation protested as a desecration. This activity could be seen to violate the international human right to practice culture and religion.[12] Proposals for an environmental impact assessment framework, modelled on the US National Environmental Policy Act, aim to shift focus from Earth-based impacts to assessing and mitigating the effects of off-Earth mining on celestial bodies (Kramer 2014; Dallas et al. 2021). Multilateral fora have recognized these opportunities, though they have not gained meaningful traction.

What Mining Sector Experience (in Canada and Beyond) Could Offer

Though there are many opportunities for learning from Canada's experiences, and building new capabilities in space resource mining through post-secondary programs,[13] the big takeaway from Canada's experience was summarized well by the leader of a mineral exploration company with operations in Canada and abroad: "As on Earth, my personal soap box is the same from which I would critique policy making with respect to the vision of extractive industries on the Moon — the engagement of sociopolitical issues and the identification and engagement of stakeholders occur long after the horse has left the barn."[14]

Though the terrestrial mining sector needs its own reforms, Canada's experiences in domestic and extraterritorial mining activities can inform a better approach to governing space resources, while creating a niche for a Canadian contribution to international cooperation.

Historical Parallels: Free-Entry Mining and "Freedom of Use" in Outer Space

Canada's free-entry mining claim system allows prospectors to register claims on Crown land online without visiting the area or consulting stakeholders. This approach

12 See *United Nations Declaration on the Rights of Indigenous Peoples*, GA Res 295, UNGAOR, 61st Sess, Supp No 49, UN Doc A/RES/61/295, 46 ILM 1013 (2007) [*UNDRIP*], online: *United Nations* <www.un.org/esa/socdev/unpfii/documents/DRIPS_en.pdf>. The Universal Declaration of Human Rights, the International Covenant on Civil and Political Rights (article 27) and cultural rights under UNDRIP (articles 12, 13 and 25) establish protections for spiritual and cultural rights.

13 One example is the Colorado School of Mines, which started the world's first "Space Resources Program" in 2017; see https://space.mines.edu/.

14 Interview with the author.

has faced scrutiny regarding Indigenous land rights and the Crown's duty to consult.[15] Free-entry systems, with controls such as excluding heritage or conservation areas, could be adjusted and could inform lunar licensing models, balancing the OST's freedom of use with the obligation to avoid harming other nations' interests. However, it should be noted that lunar resource mapping is still imprecise compared to terrestrial mining (Sanders et al. 2023), making it hard to identify and measure reserves, which means that it may be some time before licensing systems roll out.

Voluntary Standards and Industry Codes

Canada has several industry guidelines[16] that could provide insights for the space resource sector and inform voluntary standards such as LORS.[17] One standard, Towards Sustainable Mining (TSM), lays out a framework with 34 independently evaluated performance indicators, is publicly reported and overseen by an independent body (Mining Association of Canada 2024). This framework was the first of its kind to be introduced globally and has been adopted by 13 countries (ibid.).

Experience shows, however, that when it comes to human rights and environmental considerations, voluntary standards alone do not effectively prevent violations or provide remedies (Simons 2019). Therefore, European countries have increasingly introduced mandatory human rights due diligence laws. Canada has not yet passed such legislation, despite a proposal (Bill 262) and cases filed against extractive companies operating extraterritorially.[18] Such transnational cases create legal uncertainty and serve as a warning to avoid a deregulated approach that skews too favourably toward soft law (Simons 2023). Soft law, in the form of voluntary codes, and hard regulation can and should work in concert.

Environmental Lessons Learned

In Canada, while environmental regulation addressing the mining sector has strengthened over time, gaps remain. Recently, Canada has struggled when bankrupt extractive companies avoid their responsibility to remediate contaminated sites, leaving governments with the bill. This is starting to change: a 2019 Supreme Court of Canada ruling decided a bankrupt oil and gas company had to fulfill its environmental obligations before paying creditors.[19] In the lunar context, states are responsible for companies' environmental impacts, underpinned by article VI of the OST, and should mitigate financial concerns by requiring insurance or holding remediation funds in trust. In 2019, Canada's Impact Assessment Act broadly defined "environmental effects" to include changes to the environment, impacts on Indigenous peoples, and health, social or economic conditions.[20] The act includes projects outside Canada, meaning space activities could be in scope.

15 As seen in Ontario's Grassy Narrows First Nation case (alleging breaches of constitutional section 35 rights and UNDRIP), and British Columbia's Gitxaala Nation case, where the BC Supreme Court ordered changes to the Mineral Tenure Act (see *Gitxaala v British Columbia [Chief Gold Commissioner]*, 2023 BCSC 1680).

16 For example, the Canadian Institute of Mining, Metallurgy and Petroleum standards, the TSM and Driving Responsible Exploration.

17 The TSM provides tools and indicators to address risk management in three core areas: communities and people (for example, Indigenous relations, safety and crisis management); environmental stewardship (for example, water and mine closure); and energy efficiency. E3 Plus specifically targets exploration-stage companies, providing guidance on how to operate responsibly and voluntarily to improve practices in relation to environmental stewardship, social responsibility, community engagement, and health and safety.

18 See *Choc v Hudbay Minerals Inc,* 2013 ONSC 1414; *Garcia v Tahoe Resources Inc*, 2017 BCCA 39; and *Araya v Nevsun Resources Ltd*, 2020 SCC 5.

19 See *Orphan Well v Grant Thorton Ltd*, 2019 SCC 5.

20 *Impact Assessment Act*, SC 2019, c 28, s 81.

Relations with First Nations and Impact Benefit Agreements

Agreements between Indigenous peoples and other actors date back to early colonial times, with treaties such as the Two Row Wampum (1613) emphasizing mutual respect and non-interference. However, colonizers prioritized land and resource extraction, disregarding Indigenous laws and their relationships to the land. The struggle of Indigenous peoples to defend land and waters from extractive activities sanctioned by a sovereign viewed by many as illegitimate is long and still ongoing.[21] In some cases, impact benefit agreements (IBAs) have been tools to secure social licence to operate,[22] providing economic benefits, job opportunities and shared management rights for communities, and can inform benefit-sharing structures for space resources. Agreements mirroring IBAs can be explored where technology or personnel from non-major space players are included as part of in situ resource utilization operations.

The UNDRIP, implemented in Canada in 2021, represents a turning point in the recognition of Indigenous rights and legal orders, including in the resource context. While outer space is not explicitly named in UNDRIP, celestial bodies figure widely in Indigenous cosmology and sacred laws, in land and water navigation systems, and in harvesting protocols. This means that cultural, spiritual and traditional knowledge rights could trigger obligations under UNDRIP.[23] Indigenous peoples are raising their voices in Canada: for example, a Mi'kmaw astronomer warned of a *terra nullius* approach applied on Earth being extended to *lunar nullius* with similar negative impacts on the lunar environment, and the need to transcend colonial logics (Neilson and Ćirković 2021). By engaging with and platforming these voices, Canada can be a leader in advancing UNDRIP in its space activities and can draw insights from Indigenous legal orders to inform responsible stewardship.

Recommendations

- Commission a joint study by the Canadian government (for example, NRCan and GAC) to identify further applicability of Canada's terrestrial mining experience to lunar resources, especially where resources are scarce and competitive (for example, PSRs and PELs); present findings domestically and internationally at UNCOPUOS, and through initiatives such as LORS-101.
- Lead domestically and internationally on applying rights-based perspectives to lunar and space resources more broadly, centring Indigenous rights under UNDRIP.
- Fund the development of interdisciplinary post-secondary programs and research focused on space resources, leveraging existing institutional strengths including in mining engineering, geology, economics and law.

21 One recent example is the Wet'suwet'en Nation in British Columbia, where members long opposed the construction of a pipeline (Coastal GasLink) on their traditional territories, and Canadian authorities permitted the construction, failing to secure free, prior and informed consent. Land defenders who created blockades against an injunction order were brought to trial for criminal contempt and found guilty by the BC Supreme Court.

22 The concept of "social licence to operate" was first articulated by Canadian Jim Cooney and gained broad adoption in extractive industries, prompting a focus on social responsibility and consent, though the concept has not yet figured prominently in the space industry. It could be useful to promote such responsibility among industry actors.

23 Arguments supporting Indigenous peoples' rights in space have been advanced, including under UNDRIP articles 7, 8, 11, 12, 13, 25 and 31; see *UNDRIP*, *supra* note 10.

Conclusion

As humanity ventures to establish a permanent presence on the Moon, there is a need to balance scientific and technological progress with impact assessment, inclusion and responsible stewardship. Canada's experience in the mining sector can help position the country as a leader in international fora on space resources. While conditions on the Moon are different than on Earth, with no sovereign authority and extreme environments posing challenges for enforcement, Canada has an ethical and potentially legal imperative to support responsible resource development, including Indigenous perspectives. Standard setting that mirrors terrestrial frameworks can also provide regulatory clarity to industry, promote technology transfer, and further legislative development as the industry grows and matures in a good way.[24]

Acronyms and Abbreviations

GAC	Global Affairs Canada
IBAs	impact benefit agreements
ILRS	International Lunar Research Station
LLTs	lunar lava tubes
LORS	Lunar Ore Reserves Standards
NASA	National Aeronautics and Space Administration
NRCan	Natural Resources Canada
OST	Outer Space Treaty
PELs	peaks of eternal light
PSRs	permanently shadowed regions
RQZs	radio-quiet zones
TSM	Towards Sustainable Mining
UNCOPUOS	United Nations Committee on the Peaceful Uses of Outer Space
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples

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24 The phrase "in a good way" comes from Anishinaabe philosophy that involves aligning one's actions with values and world views in which humans are connected to all beings, both animate and inanimate.

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