5

Space Mining

5.1 Introduction

In the Netflix comedy series *Space Force*, China establishes a lunar base, starts mining Helium-3, and declares the Sea of Tranquility a 'territory of scientific research' off limits to other states. The United States ignores the Chinese declaration and establishes its own base nearby, and before the first season of *Space Force* ends, the astronauts from the two states proceed to destroy each other's bases. In reality, Space mining will be difficult and dangerous enough without any fighting. Yet concern over conflict is not limited to science fiction, and efforts to develop international rules for space mining are now under way.

At least 14 Space agencies have identified '*in situ* resource utilization' as a necessary capability for long-duration missions, including crewed missions to the Moon, Mars and deep Space.[1] Attention is currently focused on the potential production of rocket fuel from ice and water-bearing minerals. If rocket fuel can be sourced in Space, it will not need to be lifted, at great expense, from Earth's surface and transported throughout the solar system.

The Moon has long been the focus of Space mining studies.[2] Efforts are now under way to establish self-sustaining infrastructure and habitats in lunar orbit as well as on the surface, with eyes towards Mars. The NASA-led Artemis programme plans to use water sourced from the lunar south pole to provide fuel, radiation shielding and life support for surface and orbital operations.[3] In addition, 'regolith' – the loose layer

[1] International Space Exploration Coordination Group, 'ISECG Global Exploration Roadmap – 3rd ed' (20 January 2018), online: www.globalspaceexploration.org/wordpress/wp-content/isecg/GER_2018_small_mobile.pdf.

[2] John Billingham, William Gilbreath and Brian O'Leary, *Space Resources and Space Settlements* (Moffett Field, CA: NASA Ames Research Center, 1979).

[3] The Artemis Program incidentally aims 'to land the first woman and first person of color' on the Moon. See 'The Artemis Accords: Principles for a safe, peaceful, and prosperous

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

of rock on the surface of the Moon, or indeed of any moon, planet, or asteroid – can be mined for construction materials, and as a source of hydrogen and oxygen.[4]

China also has plans for lunar mining, and in 2020, as part of its Chang'e 5 mission, became the third state to bring samples from the Moon back to Earth.[5] The Soviet Union had done the same with its Luna programme between 1970 and 1976, preceded by the United States with Apollo between 1969 and 1972. In 2021, China and Russia signed a memorandum of understanding by which, according to a statement released by the China National Space Administration, they agreed to 'use their accumulated experience in space science research and development and use of space equipment and space technology to jointly formulate a route map for the construction of an international lunar scientific research station'.[6]

So far, all the lunar samples have been relatively small compared to the amounts envisaged with mining. But the distinction between scientific sampling and Space mining became less clear in 2020 when Jim Bridenstine, the NASA administrator during the Trump administration, announced that NASA was seeking to purchase small amounts of lunar regolith – after they had been extracted by private companies.[7] Those samples need not be returned to Earth. In the end, NASA signed contracts for future purchases with four companies.[8] As will be discussed later in this chapter, the stated purpose of these contracts was to create legally relevant 'subsequent practice' in support of an interpretation of

future' (March 2022), *NASA*, online: www.nasa.gov/specials/artemis-accords/index.html. Under the Trump administration, the goal was to land 'the first woman and the next man'.

[4] Michael B Duke, Lisa R Gaddis, G Jeffrey Taylor and Harrison H Schmitt, 'Development of the Moon' (2006) 60:1 *Reviews in Mineralogy & Geochemistry* 597.

[5] Jonathan Amos, 'China's Chang'e-5 mission returns Moon samples', *BBC News* (16 December 2020), online: www.bbc.com/news/science-environment-55323176.

[6] Steven Lee Myers, 'China and Russia agree to explore the Moon together', *New York Times* (10 March 2021), online: www.nytimes.com/2021/03/10/world/asia/china-russia-moon.html.

[7] Jeff Foust, 'NASA offers to buy lunar samples to set space resources precedent', *SpaceNews* (10 September 2020), online: spacenews.com/nasa-offers-to-buy-lunar-samples-to-set-space-resources-precedent.

[8] NASA, press release, 20-118, 'NASA selects companies to collect lunar resources for Artemis demonstrations' (3 December 2020), online: www.nasa.gov/press-release/nasa-selects-companies-to-collect-lunar-resources-for-artemis-demonstrations.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

the 1967 Outer Space Treaty (OST) that would allow for property rights in extracted resources.[9]

In the case of water ice, we know that it exists within permanently shadowed regions of the Moon, such as the floors of craters located close to the poles.[10] Its existence in such regions is made possible because the Moon's rotational axis is nearly perpendicular to the Earth's orbital plane about the Sun (the ecliptic plane). To simulate this, you can shine a flashlight on a dimpled golf ball from a short distance and spin the ball so that its 'equator' is always directly illuminated. As you will see, the dimples near the 'poles' of the ball always have a shadow. On the Moon, these shadowed regions are always very cold and capable of supporting water ice, even in the absence of an atmosphere (see Figure 5.1). The Moon's southern pole seems to have the highest concentration of water ice because there are more permanently shadowed areas.[11]

Other regions of the Moon will be attractive for different reasons. For instance, the tops of some crater rims have nearly perpetual sunshine (i.e. solar energy).[12] Thus, while there might be many areas where it is possible to extract water, some of these areas will be more desirable than others, raising the prospect of competition for optimal mining locations among different states and different companies.

The Moon is hardly the only celestial body of interest. Many asteroids contain an abundance of water and minerals that could be used to support Space operations.[13] Robotic spacecraft have already rendezvoused with and examined several such bodies. Some have even brought samples back to Earth. The Japanese Space Agency's *Hayabusa-1* returned a small amount of regolith dust from the asteroid Itokawa in

[9] 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, 610 UNTS 205 (entered into force 10 October 1967) (Outer Space Treaty).

[10] Shuai Li, Paul G Lucey, Ralph E Milliken, Paul O Hayne, Elizabeth Fisher, Jean-Pierre Williams, Dana M Hurley and Richard C Elphic, 'Direct evidence of surface exposed water ice in the lunar polar regions' (2018) 115:36 *Proceedings of the National Academy of Sciences* 8907.

[11] Ibid.

[12] Brian Dunbar, 'Moon's south pole in NASA's landing sights' (15 April 2019), *NASA*, online: www.nasa.gov/feature/moon-s-south-pole-in-nasa-s-landing-sites.

[13] Eugene Jarosewich, 'Chemical analyses of meteorites: A compilation of stony and iron meteorite analyses' (1990) 25:4 *Meteoritics* 323; K Lodders, H Palme and HP Gail, 'Abundances of the elements in the solar system', in JE Trümper, ed, *Landolt-Börnstein: Group VI Astronomy and Astrophysics* (Berlin: Springer-Verlag, 2009) vol 4B, ch 4.4, 560.

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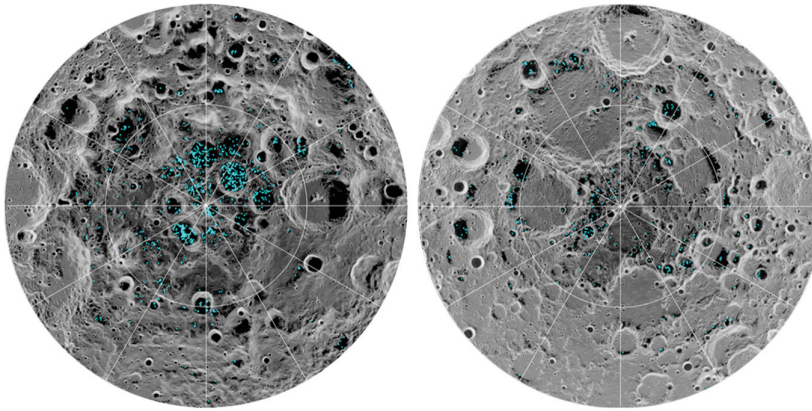

Figure 5.1 Map of the Moon's south (left) and north (right) poles, as taken by NASA's Moon Mineralogy Mapper instrument on India's *Chandrayaan-1* spacecraft. The grey colour shows temperature at the time of mapping, with cold regions shown in darker shades and hot regions in lighter ones. The cyan colour shows where water ice was detected. Credit: NASA.

2010, while *Hayabusa-2* returned a larger sample from the asteroid Ryugu in 2020. The latter sample included subsurface material that had not been degraded by eons of solar radiation. It was obtained by first firing a 'small carry-on impactor' into the asteroid to excavate a crater, and then touching down briefly to collect some of the pristine material that had been revealed. Then there is NASA's *OSIRIS-REx*, which rendezvoused with the asteroid Bennu in 2018 (see Figure 5.2). It spent 18 months flying alongside the asteroid (see Figure 5.3) before snatching a small amount of material from the surface. This sample should arrive on Earth in 2023.

In 2021, China and Russia announced a joint mission to Kamo'oalewa,[14] a 'quasi-satellite' of Earth. Kamo'oalewa is not a true moon but rather an asteroid with an eccentric orbit having a period of almost exactly one Earth year. As a result, it orbits the Sun in such a way that it never strays very far from Earth and, when viewed from here, has an apparent

[14] Andrew Jones, 'Russia joins China's mission to sample an asteroid and study a comet', *Space.com* (18 April 2021), online: www.space.com/russia-joins-china-asteroid-comet-mission.

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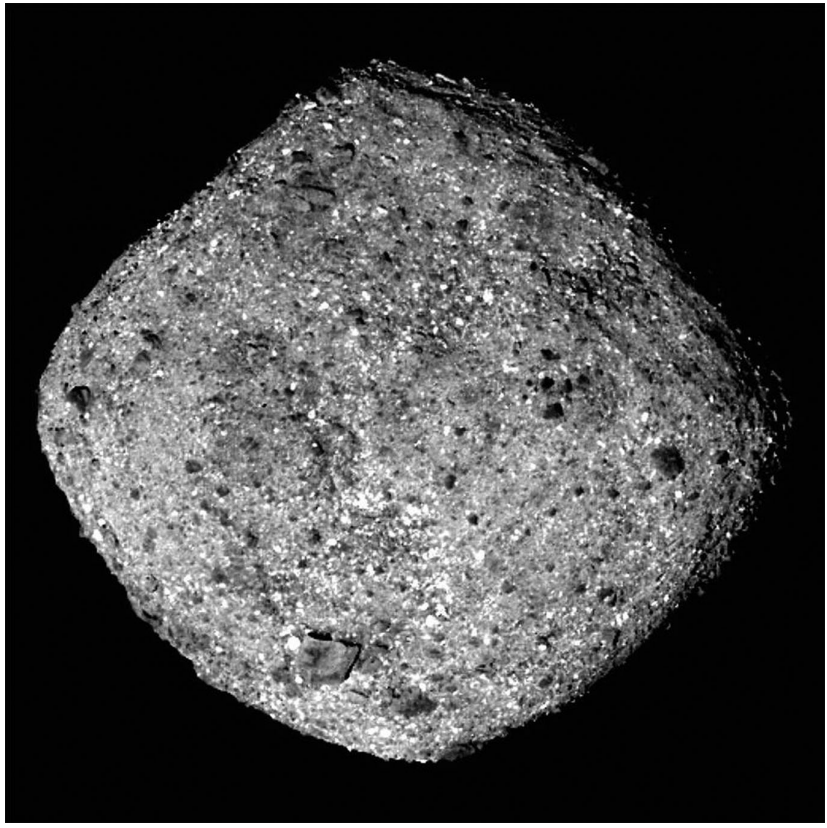

Figure 5.2 This image of Bennu was taken by the *OSIRIS-REx* spacecraft from around 80 kilometres. Credits: NASA/Goddard/University of Arizona, www.nasa.gov/press-release/nasas-osiris-rex-spacecraft-arrives-at-asteroid-bennu

'orbit' (oscillation) about our planet.[15] The robotic spacecraft, due to launch in 2024, will also attempt to retrieve a sample and return it to Earth.

The scientific interest in asteroids is clear. For example, Ryugu and Bennu are composed of some of the oldest material in the Solar System,

[15] C de la Fuente Marcos and R de la Fuenta Marcos, 'Asteroid (469219) 2016 HO3, the smallest and closest Earth quasi-satellite' (2016) 462 *Monthly Notices of the Royal Astronomical Society* 3341.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

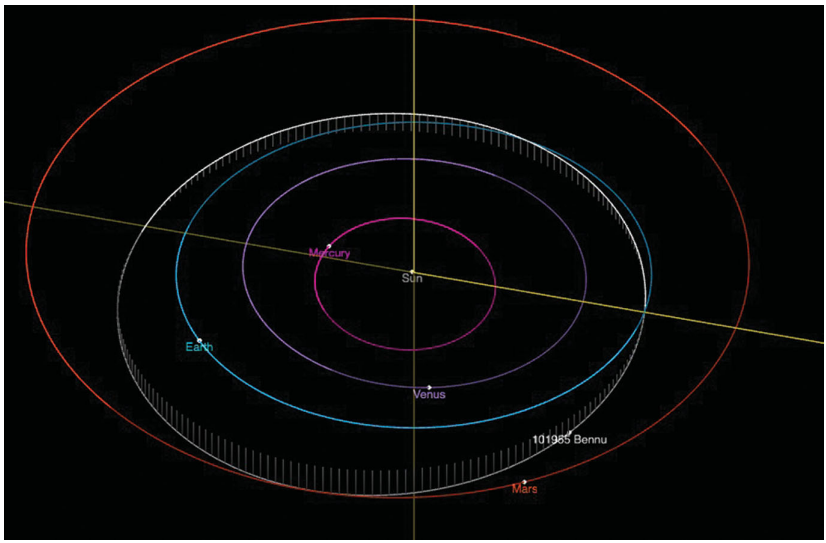

Figure 5.3 Orbital diagram showing Mercury, Venus, Earth, Mars and Bennu on 3 December 2018 when *OSIRIS-REx* arrived within 20 kilometres of Bennu. In the diagram, brighter colouring signifies when an object is above Earth's orbital plane, while the fainter lines show when an object is below. Faint grey lines emphasise the distance between Bennu's orbit (white) and Earth's orbital plane. Because Bennu's orbit is inclined, the asteroid only approaches Earth during one part of its orbit. The yellow lines are references for describing orbital angles and positions. Credit: JPL. Orbital diagram accessed at ssd.jpl.nasa.gov/sbdb.cgi?sstr=bennu.

unaltered for over 4.5 billion years.[16] Meteorites, which are fragments of asteroids that have impacted Earth, reveal that such primitive asteroids contain organic molecules, including amino acids.[17] Whether they played a role in delivering precursors of life to Earth is still an open question. It is likely that asteroids similar to Ryugu and Bennu contributed to the formation of Earth's hydrosphere, as well as to the water on the Moon.

Asteroid science is also a matter of human survival. Close studies of asteroids provide knowledge about how radiation and other perturbative forces alter their trajectories, aiding close-approach predictions and Earth

[16] Edward RD Scott, 'Chondrites and the protoplanetary disk' (2007) 35:1 *Annual Review of Earth and Planetary Sciences* 577.

[17] John R Cronin and Sandra Pizzarello, 'Amino acids in meteorites' (1983) 3:9 *Advances in Space Research* 5.

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impact warnings.[18] Bennu, for instance, is expected to pass by Earth at a distance closer than the Moon in 2135. The encounter with Earth's gravity will alter the trajectory of the 500 metre-wide asteroid as it orbits the Sun, perhaps leading to an impact risk in subsequent passes.[19] Don't panic! There are things that we can do to prevent this, with Chapter 6 of this book being devoted to the topic of 'planetary defence'.

Asteroid mining involves resource extraction beyond sampling, and while there is uncertainty as to when it might begin, there is clear momentum in that direction. NASA sees the *OSIRIS-REx* mission as a precursor to commercial operations, noting that 'asteroids like Bennu contain natural resources such as water, organics, and perhaps precious metals'.[20] Asteroids could potentially serve as deep Space fuelling stations and resource hubs. Under favourable conditions, it might also be possible to transport their resources elsewhere using low-cost, long-duration orbital manoeuvres such as solar sails and low-impulse thrusters. The potential for asteroid mining is central to plans for an off-Earth economy, with proponents of this vision including Jeff Bezos, one of the world's richest people.[21]

But while the mining of asteroids and other celestial bodies offers benefits, it will also create risks. For example, lunar mining conducted in a careful, scientifically informed manner could help us understand the Moon's history, including its record of bombardment by asteroids and comets, which in turn could help us understand Earth's history.[22] But mining that is motivated purely by resource extraction could overlook important scientific evidence or even destroy it.

A high level of care will also be required when mining asteroids, since any interference with near-Earth objects (NEOs) has the potential to create unique risks on and around Earth and the Moon. Asteroid mining

[18] NASA, news release, 'Planetary defense: The Bennu experiment' (6 December 2018), online: solarsystem.nasa.gov/news/782/planetary-defense-the-bennu-experiment.

[19] Steven R Chesley et al. 'Orbit and bulk density of the OSIRIS-REx target asteroid (101955) Bennu' (2014) 235 *Icarus* 5.

[20] Arizona Board of Regents, 'The mission' (2022), *OSIRIS-REx: Asteroid Sample Return Mission*, online: www.asteroidmission.org/objectives.

[21] Christian Davenport, 'Jeff Bezos pulls back the curtain on his plans for space', *Washington Post* (9 March 2016), online: www.washingtonpost.com/business/economy/jeff-bezos-pulls-back-the-curtain-on-his-plans-for-space/2016/03/09/a0716c7e-e5f4-11e5-a6f3-21ccdbc5f74e_story.html.

[22] William F Bottke and Marc D. Norman, 'The late heavy bombardment' (2017) 45 *Annual Review of Earth and Planetary Science* 619.

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will almost inevitably create streams of debris, which under certain conditions could contribute to the meteoroid population in significant ways. Meteoroids already pose a hazard to satellites and other spacecraft, as well as to lunar operations, none of which benefit from the protection of Earth's atmosphere. Last, and perhaps most worryingly, most physical interactions with asteroids will alter their trajectories. Under certain circumstances, this could increase the uncertainty of the asteroid's orbit and even create a new, human-caused Earth impact risk.

As this discussion of risks makes clear, widely agreed rules on Space mining are needed – to protect other Space activities, the pursuit of scientific knowledge, and perhaps even humanity itself.

5.2 Space Mining and International Law

The 1967 Outer Space Treaty (OST) is at the centre of an ongoing debate about whether property rights may be acquired over extracted Space resources. Article II reads, in full, 'Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.'[23] The United States argues that the prohibition on national appropriation applies to natural resources only when they are 'in place' and that resources, once extracted, may be purchased and sold.[24]

Other states disagree. In 2020, Dmitry Rogozin, the director general of the Russian Space Agency (Roscosmos), said, 'We will not, in any case, accept any attempts to privatize the Moon. It is illegal, it runs counter to international law.'[25] In 2021, the Indonesian delegation to the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) stated,

> Since space resources are located beyond national jurisdiction, the existing international space law and principles shall apply in their

[23] Outer Space Treaty, Art. II.

[24] Brian J Egan, 'The next fifty years of the Outer Space Treaty' (address delivered at the Galloway Symposium on Critical Issues in Space Law, Washington, DC, 7 December 2016), *US State Department*, online: 2009–2017.state.gov/s/l/releases/remarks/264963.htm.

[25] TASS Russian News Agency, 'Russia will not accept attempts to privatize the Moon, says Roscosmos CEO', *TASS* (25 May 2020), online: tass.com/science/1159969 (translated from Russian by the reporter).

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> exploration, exploitation, and utilization, including but not limited to: non-appropriation, common heritage of [hu]mankind, exclusive use for peaceful purposes, and for the benefits and interests of all countries.[26]

The Chinese delegation, for its part, joined the G77 group of developing states in stressing the need for 'International cooperation in the development of space activities . . . for the benefit and in the interest of all States taking in particular account the needs on [*sic*] developing countries'.[27]

In this section, we apply the rules of customary international law on treaty interpretation, as codified in the 1969 Vienna Convention on the Law of Treaties,[28] to the OST. We conclude that the US position is at least tenable, insofar as the treaty does not specifically address Space mining. We also explain how the United States is seeking to strengthen its position by adopting national legislation allowing Space mining companies to obtain property rights, encouraging other states to do likewise, negotiating bilateral statements (the 'Artemis Accords') in support of its view, and contracting with private companies for the purchase of lunar regolith with the explicit goal of creating legally relevant 'subsequent practice'.

But while the OST does not specifically address Space mining, all Space activities must still respect the various provisions of that treaty, including the duties of consultation and 'due regard'. This means that Space mining must be pursued in ways that guard against risks and consider the interests of all states. The United States agrees with this. The problem is that the applicable provisions of the OST are quite general, leaving room for different states to interpret them differently, develop national rules that differ from those of other states, or enforce those rules with differing degrees of rigor and consistency. Leaving the regulation of Space mining

[26] Indonesia, 'Intervention made by the delegation of the Republic of Indonesia on the Agenda Item 14: General exchange of views on potential legal models for activities in exploration, exploitation and utilization of space resources at the 60th Session of Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space' (1 June 2021), online: www.unoosa.org/documents/pdf/copuos/lsc/2021/statements/item_14_Indonesia_ver.1_1_June_AM.pdf.

[27] G77 and China, 'G-77 and China statement during the Sixtieth Session of the Legal Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space, from 31 May–11 June 2021, delivered by HE Alejandro Solano Ortiz, ambassador, permanent representative of Costa Rica' (31 May 2021), online: www.unoosa.org/documents/pdf/copuos/lsc/2021/statements/item_3_5_6a_6b_8_10_11_13_14_G77_China_ver.1_31_May_AM_LegalSC_280521.pdf.

[28] Vienna Convention on the Law of Treaties, 23 May 1969, 1155 UNTS 331 (entered into force 27 January 1980) (Vienna Convention).

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to national governments could result in a fragmentation of the governance regime, 'a race to the bottom' in terms of safety and environmental protections, or even the emergence of 'flag-of-convenience' states – with all these outcomes exacerbating the risks to Space exploration, science and the Earth itself noted above. Another possibility is that such a national approach could result in the development of rules of customary international law on Space mining that are based largely on the practice of one major spacefaring state, namely the United States, as well as the practice of companies incorporated there.

It is therefore desirable, even imperative, that states negotiate a multilateral treaty on Space mining. The good news is that a first possible step towards such negotiations has already been taken, with the creation of a Working Group on Space Resources within the Legal Subcommittee of COPUOS in 2021.

5.3 Interpreting the Outer Space Treaty

The international rules on treaty interpretation are found in the 1969 Vienna Convention on the Law of Treaties. Like most treaties, the Vienna Convention does not apply retrospectively; it therefore does not apply, as a treaty, to the 1967 OST. However, it is widely accepted as an accurate codification of the rules of customary international law on treaty interpretation,[29] which do apply to the OST. We therefore facilitate our analysis by referring to those customary rules as they appear in provisions of the Vienna Convention. This is standard practice among international lawyers. We will also, in our analysis, follow the steps of treaty interpretation in the order in which they are set out in the Vienna Convention.[30]

[29] Anthony Aust, *Modern Treaty Law and Practice*, 2nd ed (Cambridge: Cambridge University Press, 2007) 12; Richard Gardiner, 'The Vienna Convention rules on treaty interpretation', in Duncan B Hollis, ed, *The Oxford Guide to Treaties*, 2nd ed (Oxford: Oxford University Press, 2020) 459 at 477; For US acceptance that the Vienna Convention reflects customary international law, see 'Letter of transmittal of Vienna Convention on the Law of Treaties to US Senate' (22 November 1971), Senate Executive L (92nd Cong, 1st Sess), available at (1972) 11:1 *International Law Materials* 234.

[30] Steven Freeland and Ram Jakhu's interpretation of the OST begins with the negotiating history of the treaty, followed by the context, object and purpose, and meaning. Steven Freeland and Ram Jakhu, 'Article II' in Stephan Hobe, Bernhard Schmidt-Tedd and Kai-Uwe Schrog, eds., *Cologne Commentary on Space Law: Volume 1, Outer Space Treaty* (Cologne: Carl Heymanns Verlag, 2009) 44 at 59. However, Article 32 of the Vienna Convention stipulates that the negotiating history may only be used 'to confirm the

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5.3.1 *Ordinary Meaning*

Article 31 of the Vienna Convention on the Law of Treaties reads, 'A treaty shall be interpreted in good faith in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose.' The first step in our interpretation therefore concerns the 'ordinary meaning' of the terms. We begin with Article I of the OST, which reads in full,

> The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all [hu]mankind.
>
> Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.
>
> There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.[31]

On its own, ordinary meaning provides little guidance for interpreting Article I. It does not tell us whether 'use' includes the extraction of Space resources, nor whether 'use' can be exclusive to a single actor – although there are words in Article I that at least suggest otherwise, i.e. 'shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all [hu]mankind'. Nor does ordinary meaning tell us whether property rights can be acquired over extracted Space resources. Again, this last issue is the one under debate.

We turn now to Article II, where the term of greatest relevance is 'national appropriation': 'Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.'[32] There is no ordinary meaning for 'national appropriation', since the term is not used elsewhere in international law, or in day-to-day conversation.

meaning resulting from the application of article 31, or to determine the meaning when the interpretation according to article 31: (a) leaves the meaning ambiguous or obscure; or (b) leads to a result which is manifestly absurd or unreasonable.' Vienna Convention, Art. 32.

[31] Outer Space Treaty, Art. I.

[32] Outer Space Treaty, Art. II.

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We do not know whether it means title to territory, or simply the use of an object or area by one state to the exclusion of others. As a result, this first stage of interpretation – 'ordinary meaning of the terms' – does not take us very far.

5.3.2 *The Context of the Terms*

We turn to the second stage of our interpretation, namely the 'context' of the terms being interpreted. According to the Vienna Convention, context includes the text of a treaty, its preamble and its annexes. With regard to the text of the OST, there are several provisions that might inform the interpretation of Articles I and II. The first of these is Article VI, the only provision of the OST to address the issue of non-state actors:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. 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. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.[33]

'Non-governmental entities' will include international organisations, non-profit groups and private companies. But while mining is one possible profit-oriented activity that companies might pursue in Space, there are many others, including the use of satellites for communications – an activity that was already taking place at the time the OST was under negotiation and would therefore have been in the minds of the negotiators. The combination of Article VI with the possibility that Space mining could be conducted by non-governmental entities does not, on its own, make possible the acquisition of property rights. Indeed, there is nothing in Article VI that would either support or preclude this conclusion. Article VI simply makes states responsible for whichever Space activities their nationals, including private companies, undertake

[33] Outer Space Treaty, Art. IV.

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(as well as any activities of non-nationals on their territory or in spacecraft registered by them).

Then there is Article IX of the OST, which reads in full,

> In the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the moon and other celestial bodies, may request consultation concerning the activity or experiment.[34]

Article IX requires that states 'conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty'.[35] However, there is no indication as to the level of care that 'due regard' requires. Is the obligation only to avoid reasonably foreseeable harm? Or is a higher standard of care required?

Article IX also foresees that some Space activities will have the potential to cause harmful contamination or interference, and it guards against these risks with a duty of consultation. However, there is no indication as to whether a state might be required to adjust its plans because of consultations. Nor does Article IX say anything, anywhere, about property rights.

[34] Outer Space Treaty, Art. IX.
[35] Ibid.

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Article 31 of the Vienna Convention indicates that the preamble is also part of the context for the purposes of treaty interpretation. The preamble of the OST reads, in full,

> The States Parties to this Treaty,
>
> Inspired by the great prospects opening up before [hu]mankind as a result of man's entry into outer space,
>
> Recognizing the common interest of all [hu]mankind in the progress of the exploration and use of outer space for peaceful purposes,
>
> Believing that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development,
>
> Desiring to contribute to broad international co-operation in the scientific as well as the legal aspects of the exploration and use of outer space for peaceful purposes,
>
> Believing that such co-operation will contribute to the development of mutual understanding and to the strengthening of friendly relations between States and peoples,
>
> Recalling resolution 1962 (XVIII), entitled 'Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space', which was adopted unanimously by the United Nations General Assembly on 13 December 1963,
>
> Recalling resolution 1884 (XVIII), calling upon States to refrain from placing in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction or from installing such weapons on celestial bodies, which was adopted unanimously by the United Nations General Assembly on 17 October 1963,
>
> Taking account of United Nations General Assembly resolution 110 (II) of 3 November 1947, which condemned propaganda designed or likely to provoke or encourage any threat to the peace, breach of the peace or act of aggression, and considering that the aforementioned resolution is applicable to outer space,
>
> Convinced that a Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, will further the Purposes and Principles of the Charter of the United Nations,
>
> Have agreed on the following . . .[36]

We see nothing in the preamble of the OST that supports or precludes the acquisition of property rights over extracted resources. The negotiators believed that the exploration and use of Space should benefit all peoples, but property rights are not necessarily incompatible with this belief.

[36] Outer Space Treaty, preamble.

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5.3.3 *Object and Purpose*

The third step in a treaty interpretation is to examine whether the 'object and purpose' of the treaty cast any 'light' on the ordinary meaning of its terms. The most important evidence of a treaty's object and purpose is usually found in its preamble, which is reproduced directly above. It is clear from the preamble that the overall object and purpose of the OST is the promotion of peace and international co-operation in Space – something which property rights might, depending on the circumstances, either strengthen or weaken. In other words, the object and purpose provide no guidance to our interpretation.

5.3.4 *Subsequent Agreement*

We must now consider any 'subsequent agreement' or 'subsequent practice' establishing 'the agreement of the parties regarding' the interpretation of the OST, with Article 31(3)(a) and (b) of the Vienna Convention on the Law of Treaties reading,

> There shall be taken into account, together with the context:
>
> (a) any subsequent agreement between the parties regarding the interpretation of the treaty or the application of its provisions;
> (b) any subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation . . .[37]

One possible subsequent agreement of relevance is the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies ('Moon Agreement'),[38] which Steven Freeland and Ram Jakhu argue provides some support for an interpretation of Article II OST in favour of the 'exploitation' of extracted resources not constituting 'national appropriation':

> the terms of the MOON [the 1979 Moon Agreement] suggest that the exploitation of the natural resources of the moon (and other celestial bodies within the solar system) does *not* constitute a means of appropriation. Article 11(2) of the MOON replicates the prohibitions contained in Article II of the Outer Space Treaty. Yet, one of the principal objects and

[37] Vienna Convention, Art. 31(3)(a)–(b).
[38] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 5 December 1979, 1363 UNTS 13 (entered into force 11 July 1984) (Moon Agreement).

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> purposes of the MOON is to promote the "exploitation" of the natural resources of the moon, through the current provisions of the Agreement and eventual establishment of an international regime.
>
> It is clear, therefore, that the prohibition of natural appropriation in Article 11(2) of the MOON does not in and of itself restrict the exploitation of natural resources, which will also involve removal of such resources from their "place" on the moon.[39]

However, the most relevant aspect of the Moon Agreement regarding the issue of resource exploitation would seem to be the deferral of negotiations on the issue until some later date. In our view, this deferral suggests not the existence of 'any agreement between the parties regarding the interpretation of the treaty or the application of its provisions', but rather an absence thereof. We therefore conclude that the Moon Agreement is of no assistance to our interpretation of the OST.

5.3.5 *Subsequent Practice*

We turn now to 'any subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation'. Since Space mining as such has not yet taken place, there is very little to look at here – apart from the fate of a few lunar samples. In 1993, Sotheby's auctioned three moon rocks for $442,500.[40] The rocks had been collected by the Soviet Union's robotic Luna-16 mission in 1970 and given to the widow of Sergei Pavlovich Korolev, the former director of the Soviet Space programme, in his honour.[41] Two decades later, they somehow found their way to Sotheby's. The same rocks were auctioned again in 2018, this time for $855,000. However, there is no indication that the Soviet or Russian governments approved these sales, making them of little value as 'subsequent practice' establishing the 'agreement of the parties' regarding the interpretation of the OST.

In 2012, the US Congress granted former crew members of the Mercury, Gemini and Apollo programmes full ownership rights over equipment and spacecraft parts they had saved as souvenirs. However, the legislation specifically excluded 'lunar rocks and other lunar

[39] Freeland and Jakhu, op. cit. at 70, original emphasis.

[40] Douglas Martin, 'Space artifacts of Soviets soar at a $7 million auction', *New York Times* (12 December 1993), online: www.nytimes.com/1993/12/12/nyregion/space-artifacts-of-soviets-soar-at-a-7-million-auction.html.

[41] Agence France-Presse, 'Moon rocks sell for $855,000 in New York: Sotheby's', *Phys.org* (29 November 2018), online: phys.org/news/2018-11-moon-york-sotheby.html.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

material'.[42] As an action taken by a national government, this exclusion would seem to be relevant as subsequent practice, but it is an isolated case. Five years later, in 2017, a bag containing a few particles of Moon dust was auctioned at Sotheby's for $1.8 million.[43] The bag, used by Neil Armstrong to collect lunar samples in 1969, was lent by NASA to a Space museum in Kansas. The bag then went missing and, years later, was misidentified and sold for just $995. When NASA found out what had happened, it challenged the purchaser's ownership, which led to litigation, a ruling against NASA, and ultimately the $1.8 million sale. It all makes for a great story, but there is no relevant subsequent practice here. NASA was not arguing that it did or did not have property rights over the lunar dust. It was simply arguing that the bag had been illegally acquired.

5.3.6 *Negotiating Records*

Our analysis above leads to the conclusion that the issue of property rights is not addressed in the OST. Having reached this stage, we can now review the negotiating record of the treaty to confirm our interpretation but not to overturn it, as Article 32 of the Vienna Convention explains:

> Recourse may be had to supplementary means of interpretation, including the preparatory work of the treaty and the circumstances of its conclusion, in order to confirm the meaning resulting from the application of article 31, or to determine the meaning when the interpretation according to article 31:
>
> (a) leaves the meaning ambiguous or obscure; or
> (b) leads to a result which is manifestly absurd or unreasonable.[44]

There was very little debate on Article II during the negotiation of the OST, probably because the provision was adopted almost verbatim from Article 3 of the 1963 United Nations General Assembly 'Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space', which reads, 'Outer space and celestial bodies are

[42] An Act to Confirm Full Ownership Rights for Certain United States Astronauts to Artifacts from the Astronauts' Space Missions, Public L No 112–185, 126 Stat 1425 (2012), online: www.congress.gov/112/plaws/publ185/PLAW-112publ185.pdf.

[43] Jacey Fortin, 'Bag with Moon dust in it fetches $1.8 million from a mystery buyer', *New York Times* (21 July 2017), online: www.nytimes.com/2017/07/21/us/moon-bag-auction-sothebys.html.

[44] Vienna Convention, Art. 32.

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not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.'[45]

The only change made to this text in the 1967 OST was the insertion of the words 'including the moon and other celestial bodies' after the term 'outer space', in recognition of the fact that all celestial bodies – including potentially mineral-rich asteroids – are part of Space and not distinct from it. The same change was made in Article I of the OST. As a result, the Moon, asteroids and other planets are all subject to the freedom of 'exploration and use' and other provisions of the treaty, in addition to the prohibition on national appropriation.

Despite the near absence of debate, an examination of the negotiating records (*travaux préparatoires*) reveals several interventions of relevance.[46] During a meeting of COPUOS on 13 July 1966, an Austrian delegate expressed the view that a proper differentiation was required between 'non-appropriation' and 'use'. He suggested that the text 'should go further and should regulate not only the exploration of the moon and other celestial bodies but also their use; that would obviate any contradiction between the terms "non-appropriation" and "use".'[47]

On 4 August 1966, a Belgian delegate said that he had 'taken note of the interpretation of the term "non-appropriation" advanced by several delegations – apparently without contradiction – as covering both the establishment of sovereignty and the creation of titles to property in private law.'[48]

[45] *Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space*, GA Res 1962 (XVIII), UNGAOR, 18th Sess, 1280th Plen Mtg, UN Doc A/RES/1962(XVIII) (1963). Resolution 1962 itself built on Resolution 1721 (XVI), adopted two years earlier, by providing examples of how the prohibited 'national appropriation' might occur, i.e. 'by claim of sovereignty, by means of use or occupation, or by any other means'. *International Cooperation in the Peaceful Uses of Outer Space*, GA Res 1721 (XVI), UNGAOR, 16th Sess, 1085th Plen Mtg, UN Doc A/RES/1721(XVI) (1961).

[46] The *travaux préparatoires* are at United Nations Office for Outer Space Affairs, 'Travaux Préparatoires – Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies' (2022), online: www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/travaux-preparatoires/outerspacetreaty.html.

[47] Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, *Summary Record of the 58th Meeting*, UNGAOR, 5th Sess, 58th Mtg, UN Doc A/AC.105/C.2/SR.58 (13 July 1966) at 3.

[48] Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, *Summary Record of the 71st Meeting*, UNGAOR, 5th Sess, 71st Mtg, UN Doc A/AC.105/C.2/SR.71 (4 August 1966) at 10.

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Ultimately, negotiations on the issue of 'extracting minerals' were deferred to some indefinite future date (i.e. after the conclusion of the OST), as the following exchange between French and Soviet delegates on 20 October 1966 made clear:

> Mr. Deleau (France) 'observed that it was most important to clarify the scope of the treaty. It was quite clear that the treaty was to apply both to the celestial bodies and to outer space, but what type of activity was it to regulate? The texts referred to exploration and "use". Did the latter term imply use for exploration purposes, such as the launching of satellites, or did it mean "use" in the sense of exploitation, which would involve far more complex issues? Space, of course, was already being used for meteorological research and telecommunications, but in the case of celestial bodies it was hard at present to conceive of utilizing the moon, say, for the extraction of minerals. It was important for all States, and not only those engaged in space exploration, to know exactly what was meant by the term "use". The word was, of course, to be found in the declaration of Principles, but the latter was by no means exhaustive and should not preclude further textual improvements'.[49]
>
> . . .
>
> In response to Mr. Deleau's comments on the Draft treaties submitted by the USSR and US, Mr. Morozov (USSR) had 'felt that the Soviet text covered the very interesting point raised by the representative of France. It was not possible to say everything in one article and he believed that adequate clarification was to be found in article II of the USSR draft, which specified that outer space and celestial bodies should not be subject to national appropriation by means of use or occupation, or by any other means. In other words, no human activity on the moon or any other celestial body could be taken as justification for national appropriation. Needless to say, a treaty could deal only with the problems arising at the current stage of human evolution, and future developments would give rise to new problems requiring subsequent solution. But it would be unwise to look too far ahead and to attempt to prescribe rules for situations on which it was impossible to form adequate judgement at the present stage . . .'[50]

As a conclusion to this section, we note that a full and systematic treaty interpretation, carried out in accordance with the customary international law codified in Articles 31 and 32 of the Vienna Convention on the Law of Treaties, supports the view that the OST does not address – and was not

[49] Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, *Summary Record of the 63rd Meeting*, UNGAOR, 5th Sess, 63rd Mtg, UN Doc A/AC.105/C.2/SR.63 (20 October 1966) at 8-9.

[50] Ibid. at 11.

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intended to address – the issue of property rights over extracted Space resources. Rather, the issue was left until later, when Space mining had become a real prospect and the challenges involved were better understood.

A decade later, the initiation of negotiations leading to the 1979 Moon Agreement provided further confirmation that this was the intended approach. The preamble to the Moon Agreement acknowledges the 'benefits which may be derived from the exploitation of the natural resources of the moon and other celestial bodies' and the 'need to define and develop the provisions' of the four main Space treaties (the OST,[51] the Rescue Agreement,[52] the Liability Convention[53] and the Registration Convention[54]) 'having regard to further progress in the exploration and use of outer space'.

Indeed, the proposal that led to the negotiations, submitted to COPUOS by a representative from Argentina, Dr Aldo Armando Cocca, argued that the OST was deficient because it did not specifically regulate the use of the Moon's natural resources.[55]

The need for negotiations on Space mining was accepted by all the members of COPUOS, which operates on consensus, as well as all the members of the UN General Assembly, which adopted the Moon Agreement without a vote (i.e. by consensus) in 1979.[56] The fact that only 18 states subsequently ratified the Moon Agreement does not detract from this point, since decisions to refrain from ratifying usually concern the specific provisions of a treaty and not the general need for a treaty on the subject matter in question.

[51] Outer Space Treaty.

[52] Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, 22 April 1968, 672 UNTS 119 (entered into force 3 December 1968) (Rescue Agreement).

[53] Convention on International Liability for Damage Caused by Space Objects, 29 March 1972, 961 UNTS 187 (entered into force 1 September 1972) (Liability Convention).

[54] Convention on Registration of Objects Launched into Outer Space, 12 November 1974, 1023 UNTS 15 (entered into force 15 September 1976) (Registration Convention).

[55] James R Wilson, 'Regulation of the outer space environment through international accord: The 1979 Moon Treaty' (1990) 2:2 *Fordham Environmental Law Review* 173 at 176.

[56] *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, GA Res 34/68, UNGAOR, 34th Sess, 89th Plen Mtg, UN Doc A/RES/34/68 (5 December 1979), online: www.unoosa.org/oosa/oosadoc/data/resolutions/1979/general_assembly_34th_session/res_3468.html.

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As mentioned above, the Moon Agreement itself does not provide a detailed set of rules for Space mining. Instead, it declares the Moon and other celestial bodies the 'common heritage of [hu]mankind' and provides a mechanism for initiating a multilateral negotiation on an 'international regime . . . to govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible' (Article 11 (5)). According to Article 18, such a negotiating conference can be called 'at the request of one third of the States Parties to the Agreement and with the concurrence of the majority of the States Parties'.

Although the Moon Agreement was clearly intended to open the door to Space mining, the United States began opposing the new treaty shortly after its adoption,[57] as well as any other efforts to address the issue through multilateral negotiations. It adopted an alternative strategy of creating more 'subsequent practice' in favour of its position, which is that the OST does not preclude property rights over extracted resources, and that in the absence of international rules on the conduct of Space mining, these activities may be regulated solely through national laws. Again, the US position is not untenable, but this is hardly the end of the matter.

Our concerns are not with the US interpretation of the OST, but with the assumption that regulating Space mining solely through national laws is an appropriate approach, given the existence of serious risks, global interests and the possible emergence of flag-of-convenience states. We are also concerned that the United States and companies incorporated there could be uniquely positioned to shape the development of rules of customary international law on the conduct of Space mining, rules that could be heavily influenced by corporate interests and would be binding on most, if not all, states.

[57] The Moon Agreement is derided by the US mostly because it includes the term 'common heritage of [hu]mankind'. But the term is not unusual. It features centrally in the UN Convention on the Law of the Sea (UNCLOS), the so-called 'Constitution of the Oceans', which includes a detailed regime for deep seabed mining. United Nations Convention on the Law of the Sea, 10 December 1982, 1833 UNTS 3 Art. 136 (entered into force 16 November 1994) (UNCLOS). In 1987, the 'Brundtland report' of the World Commission on Environment and Development identified Space as 'a global commons and part of the common heritage of [hu]mankind'. Gro H Brundtland, 'Report of the World Commission on Environmental Development: Our Common Future' (1987), *United Nations*, online: sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf.

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5.4 Recent Efforts by the United States to Advance Its Position

Subsequent practice for the purposes of treaty interpretation includes not just physical acts, but also official statements, as well as the adoption of national law and regulations. The United States has long maintained that the OST 'does not preclude private ownership of resources extracted from a celestial body'.[58] In 1979, Secretary of State Cyrus Vance told the Senate Foreign Relations Committee that the 'non-appropriation' principle applies to the natural resources of celestial bodies only when such resources are 'in place' and does not limit 'ownership to be exercised by States or private entities over those natural resources which have been removed from their "place" on or below the surface of the moon or other celestial bodies.'[59] However, it still came as a surprise to many when, in 2015, the US government adopted national legislation in support of commercial Space mining despite the absence of widely agreed international rules.

5.4.1 Commercial Space Launch Competitiveness Act

Sponsored by Republican Senators Ted Cruz and Marco Rubio and signed by Democratic president Barack Obama, the 2015 Commercial Space Launch Competitiveness Act gives US citizens and companies the right to 'possess, own, transport, use, and sell [any] asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States'.[60] The legislation thus claims to be consistent with international law, though it does not necessarily take the interests of all countries into account.

The Commercial Space Launch Competitiveness Act was designed to bolster the United States' preferred interpretation of the OST and support US companies such as Planetary Resources, which, while now defunct, lobbied hard for this legislation.[61] As Brian Israel, one of the State Department lawyers involved in the legislation, later argued,

[58] Egan, op. cit.
[59] Quoted in ibid.
[60] US Commercial Space Launch Competitiveness Act, Pub L No 114-90, 124 Stat 2806, 2820 (2015). See Mike Wall, 'New space mining legislation is "history in the making"', *Space.com* (20 November 2015), online: www.space.com/31177-space-mining-commercial-spaceflight-congress.html.
[61] ProPublica, 'Lobbying by Planetary Resources, Inc – January 15, 2015 to March 31, 2017' (2017), *ProPublica*, online: projects.propublica.org/represent/lobbying/300931519.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

'Absent international consensus on what the rule is, national legislatures are in the position of weighing in on one side or another of an unresolved interpretive debate'.[62]

Sometimes, national legislation can indeed help to clarify the interpretation of a treaty provision. Again, Article 31(3)(b) of the Vienna Convention on the Law of Treaties reads,

> There shall be taken into account, together with the context: . . .
>
> (b) any subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation . . .[63]

However, no single state can develop international law on its own. For this reason, it helps the US interpretive effort that three countries have demonstrated support for its position by adopting similar domestic laws. In 2017, Luxembourg adopted legislation on commercial Space mining and offered subsidies to Space mining companies that incorporate there.[64] In 2019, the United Arab Emirates (UAE) adopted a law that foresees commercial Space mining, while postponing the creation of a licensing regime.[65] In 2021, Japan adopted a 'Law Concerning the Promotion of Business Activities Related to the Exploration and Development of Space Resources', under which Japanese companies may seek permission from the Japanese government to extract and use Space resources.[66]

One can understand why these states have become 'first movers' on this new economic frontier. The United States is the centre of 'NewSpace', with thousands of large and small companies focused on developing and generating profit from new technologies and applications. Luxembourg

[62] Brian R Israel, 'Space resources in the evolutionary course of space lawmaking' (2019) 113 *AJIL Unbound* 114 at 116.

[63] Vienna Convention, Art. 32(3)(b).

[64] Luxembourg, Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace (20 July 2017), *Journal officiel du grand-duché de Luxembourg*, online: legilux.public.lu/eli/etat/leg/loi/2017/07/20/a674/jo/fr (with unofficial English translation). See Haroon Siddique, 'Luxembourg aims to be big player in possible asteroid mining', *The Guardian* (3 February 2016), online: www.theguardian.com/science/2016/feb/03/luxembourg-aims-to-be-big-player-in-possible-asteroid-mining.

[65] United Arab Emirates, Federal Law No. (12) of 2019 on the Regulation of the Space Sector (19 December 2019), *Ministry of Justice*, online: www.moj.gov.ae/assets/2020/Federal%20Law%20No%2012%20of%202019%20on%20THE%20REGULATION%20OF%20THE%20SPACE%20SECTOR.pdf.aspx.

[66] Jeff Foust, 'Japan passes space resources law', *SpaceNews* (17 June 2021), online: spacenews.com/japan-passes-space-resources-law.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

has long provided a comfortable corporate home to the two largest operators of geosynchronous communications satellites, while the UAE is seeking to diversify its oil-based economy. It already operates three Earth observation satellites as well as a scientific probe named *Hope* that orbits Mars and collects data on that planet's atmosphere. The Japanese government, for its part, has long engaged in Space exploration, including on the International Space Station, and is now seeking to develop a globally competitive Space industry. One Japanese company, ispace, welcomed the new law with an ambitious statement of intent: 'This means that companies of Japanese nationality may operate continuously in a fixed location on the Moon for the purposes of mining or extraction, storage, processing, and other operations necessary for the development of space resources, as well as to freely use space resources.'[67] By adopting national legislation, all four states aim to provide companies and investors with some of the certainty they need to develop the expensive technologies and infrastructure required for Space mining.

However, Article 31(3)(b) of the Vienna Convention on the Law of Treaties includes the words 'which establishes the agreement of the parties'. Four states cannot, on their own, establish the agreement of the parties regarding the interpretation of a treaty, like the OST, that has been ratified by 110 states. Moreover, as with state practice in customary international law, 'subsequent practice' in treaty interpretation also includes the reactions of the other parties. How many states have expressed support for the US position? How many have expressed concerns, for instance, during meetings of COPUOS? How many have indicated a preference for a widely multilateral rather than unilateral or bilateral approach to the issue of Space mining? Although the United States, Luxembourg, the UAE and Japan have adopted legislation, what matters, more than these four instances of subsequent practice, is how the rest of the parties to the OST respond.

Again, it is important to recognise that the Commercial Space Launch Competitiveness Act is part of a deliberate effort to advance a particular interpretation of the OST. As Philip De Man cogently explains,

> Prominent spacefaring States are increasingly resorting to the adoption of domestic legislation that implements their international obligations according to an interpretation that best serves their own interests. This

[67] ispace, 'ispace applauds Japan's passage of space resources law' (15 June 2021), online: *ispace* ispace-inc.com/wp-content/uploads/2021/06/Release_SpaceMiningAct.pdf.

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> approach is obviously preferred over protracted multilateral negotiation processes that, apart from being cumbersome, risk upsetting the basic balance of the existing space law regime that favours spacefaring States in the first place.[68]

De Man also explains how a power imbalance between spacefaring states on the one hand, and non-spacefaring states on the other, raises a serious issue as to how we treat 'subsequent practice in the application of the treaty'. We can draw a parallel here with the role of power in the development and change of customary international law. Indeed, one of the authors of this book has argued that the actions and statements of less powerful states should be accorded disproportionate weight as state practice and evidence of *opinio juris* – the subjective element of customary international law – because taking positions in opposition to powerful states can entail 'costs' and doing so therefore indicates strong commitments to those positions.[69]

Further to this, De Man makes the important point that the OST is not a regular treaty. Instead, the OST and the other multilateral Space treaties contain 'fundamental principles' that 'concern all States, and indeed the whole of humanity'.[70] For this reason, De Man argues,

> the fundamental importance of the principles of the Outer Space Treaty as rules that guide the use and exploration of outer space by all States for the betterment of all [hu]mankind, warrants a particularly rigorous assessment of the conditions for subsequent practice to be taken into account for these principles. This consideration should hold in particular when the available practice is limited to conduct performed by a handful of States, whereas the treaty obligation at hand aims to safeguard the equality of all States in and through the performance of such practice.[71]

De Man finds support for his position in the first report of the United Nations International Law Commission's Working Group on Subsequent Agreements and Practice in Relation to the Interpretation of Treaties. According to the working group, 'the interpretation of treaties which establish rights for other States or actors is less susceptible to "authentic"

[68] Philip De Man, 'State practice, domestic legislation and the interpretation of fundamental principles of international space law' (2017) 42 *Space Policy* 92 at 93.
[69] Michael Byers, *Custom, Power and the Power of Rules* (Cambridge: Cambridge University Press, 1999) at 156–57.
[70] De Man, op. cit. at 98.
[71] Ibid. at 100.

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interpretation by their parties'.[72] De Man goes so far as to argue that the second paragraph of Article I, and Article II, of the OST create obligations *erga omnes*, i.e. obligations owed 'towards the international community as a whole',[73] a category of rules that is well recognised in international law.[74]

To be clear, De Man is not arguing that the parties to the OST are unable to collectively modify its provisions, either formally through negotiations or informally through subsequent practice. His argument, instead, is that the subsequent practice of a small subset of the parties should not and cannot be treated as sufficient. The merit in this argument becomes apparent if we read the two provisions carefully again.

Article I, second paragraph:

> Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.[75]

Article II:

> Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.[76]

The second paragraph of Article I recognises rights held by 'all States . . . on a basis of equality', while Article II maintains the internationalised character of Space against any effort to assert title, including by actions of

[72] International Law Commission, *First Report on Subsequent Agreements and Subsequent Practice in Relation to Treaty Interpretation*, UNGAOR, 65th Sess, UN Doc A/CN.4/660 (19 March 2013) at 14, fn 76.

[73] De Man, op. cit. at 101.

[74] *Barcelona Traction, Light and Power Company, Limited* (*Belgium* v. *Spain*), [1970] ICJ Rep 3 1970 at 32, para. 33; Michael Byers, 'Conceptualising the relationship between jus cogens and erga omnes rules' (1997) 66:2–3 *Nordic Journal of International Law* 211. The International Law Commission's 2001 'Draft Articles on Responsibility of States for Internationally Wrongful Acts, with Commentaries' make frequent reference to these 'obligations owed to the international community as a whole'. See International Law Commission, *Draft Articles on Responsibility of States for Internationally Wrongful Acts, with Commentaries*, UNGAOR, 56th Sess, Supp No 10, UN Doc A/56/10 (2001), online: legal.un.org/ilc/documentation/english/reports/a_56_10.pdf. These draft articles were commended to governments by the UN General Assembly in its resolution *Responsibility of States for Internationally Wrongful Acts*, GA Res 56/83, UNGAOR, 56th Sess, 85th Plen Mtg, UN Doc A/RES/56/83 (2001).

[75] Outer Space Treaty, Art. I, para. 2.

[76] Outer Space Treaty, Art. II.

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a kind – 'use and occupation' – that could only be taken by powerful spacefaring states. All this leads De Man to conclude,

> The increasing importance of subsequent State practice as an interpretative tool to determine the current meaning of treaty provisions reflects a development in general international law with salient repercussions in international space law. The aim and content of the UN space treaties in combination with a marked shift in law-making dynamics from the multilateral to the domestic level renders a number of fundamental treaty principles particularly receptive to selective interpretation through subsequent practice by certain States.
>
> When national legislation is being pursued at the same time that proceedings at the intergovernmental level are losing their teeth, the danger for informal modification through State conduct becomes real. And when such practice can only be performed by a limited number of States, whereas the fundamental rules subject to interpretation stress the equal freedom of all States to carry out spacefaring activities in an inclusive environment, courts and States should be particularly wary of attaching authoritative importance to domestic space legislation as an interpretative tool.[77]

Although the United States' position on the OST and Space mining is not untenable, and while it is seeking to strengthen its position and develop new rules of customary international law through its own practice and those of a small group of like-minded states, it is important to remember that a much larger number of states disagree, including the G77, China and Russia. It is possible that two camps will emerge on the issue of Space mining and international law in the future: the United States and its allies on one side, and Russia, China and the Global South on the other. Such a divide would both weaken the OST and preclude the development of new customary international law. In the circumstances, the only globally responsible way forward is to negotiate a new multilateral treaty on Space mining. Brian Israel, indeed, anticipates such a negotiation – at some future point:

> It is foreseeable that space-resource utilization will again become the subject of major multilateral lawmaking, at such time as a critical mass of spacefaring states recognize a practical need and a practical basis for such lawmaking … Such international lawmaking may also have the effect of straightening out the kinks in the regime as states revise their national laws for consistency with a new international agreement.[78]

[77] De Man, op. cit. at 101.
[78] Israel, op. cit. at 118.

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The Commercial Space Launch Competitiveness Act has served an important, if unintended, purpose by drawing attention to these matters and mobilising voices in favor of a multilateral approach. Several expert groups and non-governmental organisations, representing a wide variety of stakeholders, have responded by proposing principles and frameworks for the multilateral governance of Space resources. For example, in November 2019, The Hague International Space Resources Governance Working Group adopted twenty 'Building Blocks for the Development of an International Framework on Space Resource Activities'.[79] This document advocates the establishment of an international framework which is consistent with international law, contributes to sustainable development, promotes and secures 'the orderly and safe utilization' of Space resources, and takes into 'particular account' the needs of developing states and science. In April 2020, the Outer Space Institute adopted the 'Vancouver Recommendations on Space Mining', which promote negotiations on a multilateral agreement that are open to all states.[80] It was in the context of these calls for multilateral negotiations that the United States decided to push harder, both for its preferred interpretation of the OST, and for new rules and practices developed among a small group of like-minded states.

5.4.2 *Executive Order and Artemis Accords*

In April 2020, President Donald Trump signed an 'Executive Order on Encouraging International Support for the Recovery and Use of Space Resources' (see Figure 5.4).[81] The executive order (EO) reiterated that it is 'the policy of the United States to encourage international support for the public and private recovery and use of resources in outer space, consistent with applicable law'. However, the EO went further than

[79] The Hague International Space Resources Governance Working Group, 'Building blocks for the development of an international framework on space resource activities' (12 November 2019), *Leiden University*, online: www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht–en-ruimterecht/space-resources/bb-thissrwg–cover.pdf.

[80] Outer Space Institute (OSI), 'Vancouver recommendations on space mining' (20 April 2020), *OSI*, online: www.outerspaceinstitute.ca/docs/Vancouver_Recommendations_on_Space_Mining.pdf.

[81] Mike Wall, 'Trump signs executive order to support moon mining, tap asteroid resource', *Space.com* (6 April 2020), online: www.space.com/trump-moon-mining-space-resources-executive-order.html.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

Figure 5.4 From left to right: NASA Administrator Jim Bridenstine, President Donald Trump, VP Mike Pence and Second Lady Karen Pence watch a SpaceX Falcon 9 rocket launch NASA astronauts Robert Behnken and Douglas Hurley on 30 May 2020. Credit: NASA (www.flickr.com/photos/nasahqphoto/49956153337/in/photostream).

the 2015 Commercial Space Launch Competitiveness Act by explicitly rejecting that Space is a 'global commons' and dismissing the 1979 Moon Agreement as irrelevant because it has not been ratified by major spacefaring states. The EO also instructed the US State Department to take 'all appropriate actions to encourage international support for the public and private recovery and use of resources in outer space'.[82]

[82] Ibid.

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Just one month later, in May 2020, NASA announced the core principles of the 'Artemis Accords', which it said would 'establish a common set of principles to govern the civil exploration and use of outer space'.[83] Then, in October of 2020, the full text of the Artemis Accords was released.[84]

The Trump administration clearly wanted the Artemis Accords to provide strong support for the US position that the OST does not preclude property rights over extracted resources, and that in the absence of international rules on the conduct of Space mining, these activities may be regulated solely through national laws. NASA negotiated bilaterally with NASA partner states, with these being the states most likely to support the US position. Yet the Artemis Accords as ultimately adopted carry less weight, as subsequent practice, than NASA might have hoped. Although Australia, Canada, Italy, Japan, Luxembourg, the UAE and the UK all signed the document in an online ceremony at the International Astronautical Congress in October 2020, the text explicitly states that the Artemis Accords 'represent a political commitment'. In other words, they do not constitute a multilateral treaty or even a series of bilateral treaties. For this reason, the Artemis Accords are not that significant as 'subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation', or as state practice and evidence of *opinio juris* for the purposes of customary international law.

The text of the Artemis Accords also includes a sentence in Section 10 (2) that reads,

> 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.[85]

The language used in this sentence differs from that used in the 'Artemis Principles' as released by NASA in May 2020, before the negotiations with NASA partner states began. There, NASA simply asserted, 'The

[83] Jeff Foust, 'NASA announces Artemis Accords for international cooperation in lunar exploration', *SpaceNews* (15 May 2020), online: spacenews.com/nasa-announces-artemis-accords-for-international-cooperation-in-lunar-exploration.

[84] The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes (13 October 2020), *NASA*, online: www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf.

[85] Artemis Accords, s 10(2).

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

Artemis Accords reinforce that space resource extraction and utilization can and will be conducted under the auspices of the Outer Space Treaty, with specific emphasis on Articles II, VI, and XI.' Although NASA was likely pushing for a similar statement that Space mining does not constitute 'national appropriation', the insertion of the word 'inherently' into Section 10(2) of the final text of the Artemis Accords introduces an element of ambiguity that the US negotiators would not have sought. Is Space mining sometimes 'national appropriation' and sometimes not? Was Space mining originally not 'national appropriation', but capable of becoming understood as 'national appropriation' as understandings and interests change? Can a term such as 'national appropriation', which has no 'ordinary meaning' because it is not used outside the Outer Space Treaty, 'inherently' mean anything? The appearance of this term in the final text of the Artemis Accords most likely represents a negotiated compromise, and specifically a 'constructive ambiguity' designed to accommodate different views by fudging the terminology.[86] The result, however, is to further reduce the weight of the Artemis Accords as subsequent practice, state practice and evidence of *opinio juris*.

Despite this ambiguity and their status as a 'political commitment', the Artemis Accords still had the effect of undermining the long and stable relationship of Space co-operation between Russia and the United States. The May 2020 announcement of the core principles of the Artemis Accords was quickly condemned by Dmitry Rogozin, the director general of Roscosmos, on Twitter: 'The principle of the invasion is the same, be it the moon or Iraq. Create a coalition of the willing and then, without the UN or even Nato, move forward to the goal. But this will only result in a new Afghanistan or Iraq.'[87] Two weeks later, in a radio interview, Rogozin spoke directly to the international law issue: 'We will not, in any case, accept any attempts to privatize the Moon. It is illegal, it runs counter to international law.'[88]

[86] The term 'constructive ambiguity' is generally attributed to Henry Kissinger. See GR Berridge and Lorna Lloyd, *Dictionary of Diplomacy*, 3rd ed (Basingstoke: Palgrave Macmillan, 2012) at 73. For more on this negotiating and drafting strategy, see Michael Byers, 'Still agreeing to disagree: International security and constructive ambiguity' (2020) 8:1 *Journal on the Use of Force and International Law* 91.

[87] Marc Bennetts, 'US plan for moon mining is like Iraq invasion, says Russia', *The Times* (10 May 2020), online: www.thetimes.co.uk/article/us-plan-for-moon-mining-is-like-iraq-invasion-says-russia-sqgvpvqvt (translated from Russian by the reporter).

[88] TASS Russian News Agency, op. cit.

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China, for its part, did not offer an official response, although commentary in its state-run media described the Artemis Accords as a product of a Cold War mentality, focused on exerting dominance, and continuing the legacy of colonisation.[89] There is no indication or expectation that China might participate in the US-led effort to develop a governance regime for Space mining through practice and bilateral instruments.

As for the states of the Global South, most of them likely shared the view – expressed officially by Rogozin and unofficially by the Chinese state-run media – that the Artemis Accords were just another exercise of American hegemony, this time led by the proudly unilateralist and undiplomatic Donald Trump. As we will see below, many of these states later took part in a 'G77 and China' statement strongly supporting the creation of a Working Group on Space Resources at COPUOS, a possible first step towards multilateral negotiations.

The United States is, however, continuing its effort to advance its preferred interpretation of the OST, and to build on it by creating rules and practices for Space mining through agreements and other 'state practice' co-ordinated among a small group of like-minded states. Thirteen additional states – Brazil, New Zealand, South Korea, Ukraine, Poland, Israel, Mexico, Romania, Bahrain, Colombia, Singapore, France and Saudi Arabia – have signed the Artemis Accords since October 2020. However, the most significant further step in the US effort involves a call for proposals, issued to the Space industry, for the extraction and sale of lunar regolith to NASA.

5.4.3 *NASA Contracting to Purchase Lunar Regolith*

In September 2020, NASA announced that it was seeking proposals from private companies to extract small amounts of regolith from the surface of the Moon and sell them to NASA. Any selected company would be required to collect between 50 and 500 grams and provide imagery of the material and data concerning its location. NASA would then buy the material, through an 'in-place ownership transfer', without the company

[89] Elliot Ji, Michael B Cerny and Raphael J Piliero, 'What does China think about NASA's Artemis Accords?', *The Diplomat* (17 September 2020), online: thediplomat.com/2020/09/what-does-china-think-about-nasas-artemis-accords.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

having to return the sample to Earth. NASA might then retrieve the material at some unspecified future time.[90] Or it might not.

None of this was about the regolith itself. NASA Administrator Jim Bridenstine admitted that the planned purchases were aimed at creating more subsequent practice in favour of the US interpretation of the OST: 'What we're trying to do is make sure that there is a norm of behavior that says that resources can be extracted and that we're doing it in a way that is in compliance with the Outer Space Treaty'.[91] The admission was remarkable for its candour: government officials are rarely transparent about efforts to change international law through actions rather than negotiations, perhaps because it draws attention to their efforts and can generate pushback from other state and non-state actors.

In December 2020, NASA signed contracts with four companies: Lunar Outpost and Masten Space Systems from the United States, and the Japanese company ispace and its Luxembourg-based subsidiary ispace Europe.[92] It aims to complete the purchases of regolith by 2024.

5.5 Risks of the US Approach

Former NASA Administrator Jim Bridenstine drew an analogy between Space mining and high-seas fishing, where a fish cannot be owned while in the ocean but can be owned as soon as it is caught.[93] The analogy is apt to the degree that it concerns the acquisition of ownership of something from an 'area beyond national jurisdiction'. Yet it does not lead to the conclusion that the exploitation of resources in such areas should be allowed and supported by national governments in the absence of a multilateral agreement providing specific rules for operators to follow.

Fishing without science-based regulation often leads to overexploitation and even destruction of stocks. For this reason, high-seas fisheries are now usually subject to international regulation, for instance under the 1995 United Nations Agreement on Straddling Fish Stocks and Highly

[90] NASA Shared Services Center, 'Request for quotation (RFQ) 80NSSC20737332Q, purchase of lunar regolith and/or rock materials from contractor' (10 September 2020), *System for Award Management*, online: sam.gov/opp/77726177617a45d0a196e23a587d7c14/view.

[91] Foust, 'NASA offers to buy lunar samples to set space resources precedent', op. cit.

[92] NASA, op. cit.

[93] Edward Helmore, 'NASA is looking for private companies to help mine the moon', *The Guardian* (11 September 2020), online: www.theguardian.com/science/2020/sep/11/nasa-moon-mining-private-companies.

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Migratory Fish Stocks,[94] under regional treaties such as the 2018 International Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean,[95] and under numerous 'regional fisheries management organizations'.[96] These treaties often result in science-based quotas and sometimes moratoria. Other areas beyond national jurisdiction, such as the deep seabed and Antarctica, are also governed through specific multilateral agreements.[97] We are not arguing that these regimes are perfect; our point, simply, is that they exist – and that many states, including the United States and the Soviet Union, co-operated in their creation.

Space mining, if it occurs, will have to respect the interests of all states. Even the United States accepts this position, stressing the continued application of the duty to consult (Article IX OST) to any proposed Space mining activity. But while some shared interests are uncontroversial – for instance, avoiding the loss of science opportunities, the lofting of dust into lunar orbits, or the inadvertent redirecting of asteroids into Earth impact trajectories – the need for widely agreed safety and environmental standards for Space mining remains. Leaving the regulation of Space mining to individual states is unlikely to deliver the necessary protections. It also risks a regulatory race to the bottom and even the emergence of flag-of-convenience states, as governments compete to attract investments and technologies.[98]

[94] United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, 4 August 1995, 2167 UNTS 3 (entered into force 11 December 2001).

[95] Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, 3 October 2018, Can TS 2021 No (entered into force 25 June 2021). China, Russia and the United States are among the eight parties to the treaty.

[96] See e.g. 'Northwest Atlantic Fisheries Organization' (2022), online: www.nafo.int; 'Western & Central Pacific Fisheries Commission' (2022), online: www.wcpfc.int/home; 'Indian Ocean Tuna Commission' (2022), online: www.iotc.org.

[97] See UNCLOS, Part XI; also the 'International Seabed Authority' (2022), online: www.isa.org.jm/home; and the Antarctic Treaty, 1 December 1959, 402 UNTS 71 (entered into force 23 June 1961); also the Secretariat of the Antarctic Treaty, 'The Antarctic Treaty' (2022), online: www.ats.aq/e/antarctictreaty.html.

[98] So far, the world has been lucky on the latter front, with the availability of large government contracts incentivising Space companies to remain incorporated and active in the United States. But wealthy actors have options: Elon Musk recently moved his home and some of SpaceX and Tesla's operations from California to Texas, apparently because of its more favourable tax and regulatory regime. Bloomberg and Dana Hull, 'Why Elon Musk moved to Texas – and what he really thinks of California', *Fortune* (8 December 2020), online: fortune.com/2020/12/08/elon-musk-moving-to-texas-from-california.

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5.5.1 Loss of Science Opportunities

Done well, Space mining could provide new science opportunities and unprecedented sampling of celestial bodies. For example, asteroids contain some of the oldest materials in the solar system, some of which have experienced little thermal processing since their incorporation into parent bodies. The Moon's ice deposits are a partial record of volatile delivery to Earth.

Done poorly, Space mining would hinder science. For example, water and oxygen could in the future be extracted from astromaterials by pyrolysis.[99] If systematic scientific sampling does not occur prior to their alteration or consumption, valuable information about the solar system could be lost, including information locked into cosmochemical or mineralogical signatures. A clear analogy exists on Earth where, in many jurisdictions, mining and construction companies are made to wait while archaeologists and biologists survey sites slated for development. A Space mining company's own analysis will be designed to maximise resource yields and not science opportunities. These risks would only be exacerbated by inconsistent practices of the kind likely to result from national regulations that are not co-ordinated under some kind of multilateral regime.

5.5.2 Planetary Protection

Some of the first efforts at private Space exploration have manifested an incautious approach to risk avoidance. In 2019, the Israeli non-profit SpaceIL crashed a robotic lander on the Moon. Unbeknown to SpaceIL, its partner – the Arch Mission Foundation – had placed thousands of tardigrades on board.[100] Tardigrades, commonly referred to as 'water bears' or 'moss piglets', are tiny (0.5 millimetre) eight-legged animals that are able to survive extreme temperatures, pressures and radiation, and even the vacuum of Space. In this instance, the act of putting life on the Moon is not the concern, thanks to the harsh environment on the lunar surface. Rather, the concern is that a non-governmental entity has

[99] Lukas Schlüter and Aidan Cowley, 'Review of techniques for in-situ oxygen extraction on the moon' (2020) 181 *Planetary and Space Science* 104753.

[100] Keren Shahar and Dov Greenbaum, 'Lessons in space regulations from the lunar tardigrades of the Beresheet hard landing' (2020) 4 *Nature Astronomy* 208.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

already smuggled lifeforms onto a spacecraft destined for another celestial body.

In 2018, SpaceX launched a Tesla automobile on an orbit that extends past Mars. Although no impact with Mars is expected,[101] there was an initial lack of clarity on the mission profile and the potential for the unsterilised payload to encounter the Red Planet.[102] Unlike the Moon, the environment on Mars may allow certain forms of life to survive and become established. Careful precautions are therefore needed and should always involve full transparency and co-operation.

These examples of private risk-taking suggest that Space mining companies might take shortcuts too if not carefully regulated according to widely agreed rules. For example, they might choose not to fully sterilise equipment sent to Mars or other celestial bodies having conditions potentially favorable to life, thus contravening the international guidelines on planetary protection produced by the Committee on Space Research (COSPAR) and studiously followed by national Space agencies.[103] One could even imagine a company disregarding the guidelines in order to experiment by introducing lifeforms to an alien environment, as occurred with rabbits in Australia, starlings in the United States and Canada Geese in the United Kingdom and New Zealand. It is, in addition, very easy to imagine Space mining companies failing to take the measures necessary to contain potentially dangerous dust and debris.

5.5.3 *Dust and Debris Streams*

Lunar dust, which is very fine and highly abrasive, is a known challenge to operations on the Moon. Any surface activity could exacerbate lunar dust migration, including by lofting dust onto trajectories that cross lunar

[101] Hanno Rein, Daniel Tamayo and David Vokrouhlický, 'The random walk of cars and their collision probabilities with planets' (2018) 5:2 *Aerospace* 57.

[102] Committee on the Review of Planetary Protection Policy Development Processes, *Review and Assessment of Planetary Protection Policy Development Process* (Washington DC: The National Academies Press, 2018).

[103] G Kminek, C Conley, V Hipkin and H Yano, 'COSPAR's Planetary Protection Policy' (December 2017), *Committee on Space Research (COSPAR)*, online: cosparhq.cnes.fr/assets/uploads/2019/12/PPPolicyDecember-2017.pdf. For more on COSPAR, which operates at arm's length from many governments, see COSPAR, 'About' (20 May 2019), *COSPAR*, online: cosparhq.cnes.fr/about.

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orbits, such as that of NASA's planned Lunar Gateway.[104] Moreover, without co-operation from all actors, the limited number of useful lunar orbits could quickly become filled with Space debris, interfering with humanity's access to the Moon.

On asteroids, limited gravity and low escape speeds will make it difficult to prevent the loss of surface material. Even if full enclosures are used, waste material might be purposefully jettisoned to reduce costs. Mining could also lead to uncontrolled outbursts of material due to volatile sublimation following the removal of surface layers or other processes.

Space mining will initially focus on the Moon and near-Earth asteroids, because of their accessibility. Asteroids on Earth-crossing orbits will be among the easiest to reach. Under certain conditions, the debris streams resulting from asteroid mining could contribute to the near-Earth meteoroid population and therefore threaten not only lunar operations but the thousands of satellites in Earth's orbit that support essential civilian and military activities, ranging from banking, agriculture and aviation to search and rescue and reconnaissance.[105] Even the dust from the Moon, if expelled at much higher than natural rates, could cause noticeable changes to the cis-lunar environment (which, as we explain in Chapter 7, is the region of Space between an altitude of 35,786 kilometres – where Earth's geosynchronous orbit is located – and the area around the Moon).

Space missions already provide some evidence of such risks, although so far these remain at negligible levels. As mentioned, a small impactor was used to make a crater on Ryugu in 2019, during Japan's *Hayabusa-2* mission.[106] Some of the anthropogenic meteoroids resulting from the impact could begin reaching Earth in 2033 during Ryugu's next close

[104] Philip T Metzger, 'Dust transport and its effects due to landing spacecraft' (paper delivered at the Impact of Lunar Dust on Human Exploration conference, Houston, 11–13 February 2020, Houston, LPI Contrib No 2141), online: www.hou.usra.edu/meetings/lunardust2020/pdf/5040.pdf.

[105] Logan Fladeland, Aaron C Boley and Michael Byers, 'Meteoroid stream formation due to the extraction of space resources from asteroids' (paper delivered at the First International Orbital Debris Conference, 9–12 December 2019, Sugar Land, TX), online: arxiv.org/pdf/1911.12840.pdf.

[106] Masahiko Arakawa et al., 'An artificial impact on the Asteroid (162173) Ryugu formed a crater in the gravity-dominated regime' (2020) 368:6486 *Science* 67.

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approach to our planet.[107] In September 2022, NASA tested its ability to deflect an asteroid by striking (65803) Didymos B (Dimorphos) with the Double Asteroid Redirection Test (DART) spacecraft. This impact will also have produced anthropogenic meteoroids, with the possibility in this case of immediate delivery to Earth.[108] Again, while these risks are far less than those posed by existing meteoroids, they demonstrate that human actions can indeed change the near-Earth environment.

Nor are operational hazards the only consideration. For example, while dust launched into cis-lunar Space from the Moon might be too fine or too low in spatial density to pose a serious risk to spacecraft, at least compared to other hazards, it could, if launched in sufficient quantities, have implications for the brightness of Earth's sky and therefore for astronomy due to scattered light. Since we are just now beginning to understand how dust is naturally distributed in cis-lunar Space,[109] we are not yet at the point of considering its effects on sky brightness. But light pollution from satellites has emerged as a major concern, followed (most recently) by an awareness that light reflecting off orbital debris might also affect astronomy.[110]

5.5.4 *Asteroid Trajectory Changes*

Some of the risks associated with Space mining are small in terms of statistical risk but very high in consequence. As Chapter 6 explains, over the next decade we can expect about 50 asteroids with diameters greater than 100 metres to pass within ten lunar distances of Earth, a handful of which are in the 1,000-metre size range.[111] The positions and orbits of these asteroids are relatively well established and none of them poses any risk to us in this current century. However, these asteroids that approach

[107] M Kováčová, R Nagy, L Kornoš and J Tóth, '101955 Bennu and 162173 Ryugu: Dynamical modelling of ejected particles to the Earth' (2020) 185 *Planetary and Space Science* 104897.

[108] Paul Wiegert, 'On the delivery of DART-ejected material from Asteroid (65803) Didymos to Earth' (2019) 1:3 *Planetary Science Journal* 1.

[109] Charles Q Choi, 'Signs of Earth's weird, elusive "dust moons" finally spotted', *Space.com* (31 October 2018), online: www.space.com/42293-earth-orbiting-dust-clouds-confirmed.html.

[110] Miroslav Kocifaj, Frantisek Kundracik, John C Barentine and Salvador Bará, 'The proliferation of space objects is a rapidly increasing source of artificial night sky brightness' (2021) 504:1 *Monthly Notices of the Royal Astronomical Society: Letters* L40.

[111] Center for Near Earth Object Studies, 'NEO Earth close approaches' (May 2022), online: *NASA* cneos.jpl.nasa.gov/ca.

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closest to Earth are also the ones most likely to be selected for Space mining. Since removing mass from an asteroid will almost inevitably change its trajectory, any mining operations that are not fully informed by science could potentially lead to an Earth impact emergency. Do we trust profit-oriented companies, which seek to reduce costs wherever possible, to conduct the careful scientific assessments and calculations needed to guard against this low-risk, very-high-consequence outcome? Do we trust national regulators from individual states to maintain up-to-date requirements based upon the best available science and the precautionary principle, and to monitor and enforce compliance? What about flag-of-convenience states that may see economic advantage in having more relaxed standards or less rigorous enforcement? Clearly, multilateral rules and oversight are required.

5.5.5 *Space Companies as Actors in International Law-Making?*

The accessibility of Space is increasing as a growing number of actors develop or purchase the technologies needed to launch and operate satellites and other spacecraft. Alongside the growth in spacefaring states is an even faster growth in the number of Space companies. The result, one might think, could be a certain democratisation of the Space environment.

However, most of the growth in Space companies is centred in one country.[112] This concentration of growth raises the possibility that the United States, as the launch and licensing state for most commercial Space activities, could be uniquely positioned to steer actual mining practice in support of its diplomatic efforts to secure broad acceptance among states that commercial Space mining is permissible under the OST. Such practice could further contribute to the development of customary international law standards for the conduct of mining operations.

This steering could happen in one of two ways, or even both. First, international Space law uniquely makes states responsible for the activities of companies incorporated within them. This feature might allow those activities to count both as 'subsequent practice' for the purposes of treaty interpretation, and as 'state practice', and even evidence of

[112] James Clay Moltz explains how the rapid growth in Space companies ('NewSpace'), and associated technological developments, are the principal factors keeping the United States ahead of China in the Space domain. James Clay Moltz, 'The changing dynamics of twenty-first-century space power' (2019) 12:1 *Journal of Strategic Security* 15.

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opinio juris, for the purposes of customary international law. This is due to Article VI of the OST, which is reproduced in full above, and only partly here:

> States Parties to the Treaty shall bear international responsibility for national activities in outer space ... whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty.[113]

The activities of most Space mining companies will comply from the outset with the laws, regulations and policy preferences of their state of incorporation, which again is likely to be the United States. In such a situation, one could – because of Article VI – understand the activities of the company as akin to those of an agent acting on behalf of the state. We note that a state can be legally accountable for the actions of actual agents, e.g. SpaceX when carrying NASA astronauts to the ISS under contract with that national Space agency, under the general rules of customary international law on state responsibility,[114] in parallel to (or even outside the scope of) Article VI.

In other situations, the laws, regulations and policy preferences of the state of incorporation might not yet be fully developed, in which case the activities of the company will either be met with acquiescence or prompt the state into adopting new rules or clarifying existing ones.[115] In the case of acquiescence, the activities of the company could be considered subsequent practice and state practice, since the state is thereby implicitly endorsing them. Activities that prompt the state to develop or reform its laws, in contrast, should not be so considered, because the state is responding in a manner that indicates a lack of endorsement. Instead, it is the adoption of new rules or the clarification of existing rules that is the relevant subsequent practice and state practice here. It may also

[113] Outer Space Treaty, Art. VI.

[114] International Law Commission, 'Draft Articles on the Responsibility of States for Internationally Wrongful Acts', op. cit., Art. 5.

[115] See Melissa J Durkee, 'Interstitial space law' (2019) 97:2 *Washington University Law Review* 423 at 428: 'Because private missions are defined by the Outer Space treaty as "national" missions, which are attributed to the home nation and for which home nations are responsible, these private acts can also be attributed to those nations for the purposes of customary law formation and treaty interpretation. This is because when a corporation whose activity is attributed to the state publicly asserts a legal rule and acts on it, and a nation does nothing, that nation implicitly accepts the corporate rule' (footnotes omitted).

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provide evidence of *opinio juris* because it suggests a sense of obligation on the part of the state to bring its domestic law into compliance with developments in international law.

The second way that US steering could happen is that other states or foreign companies wishing to engage in Space mining might have little choice but to hire US companies, or to enter into joint ventures with them, in order to access technology or operational experience. As a result, their Space mining activities will then follow the laws and regulations of the United States.

There is a historical precedent for this. In the 1945 Truman Proclamation, the US government asserted that every coastal state has exclusive jurisdiction over the resources of the continental shelf off its coastline.[116] The claim, which was framed to be available to every coastal state, was soon repeated by many of them, leading to the rapid development of a new rule of customary international law and, just 13 years later, to its codification in the 1958 Convention on the Continental Shelf.[117] However, the reciprocally available character of the claim did more than attract the support of other states; it also worked to the advantage of US oil companies, which at the time were among the very few companies with offshore drilling technologies. As a result, most other coastal states could only exercise their newly recognised rights by partnering with a US oil company.[118] This situation also worked to the benefit of the US government, as overseas profits flowed home, and as US regulators found themselves regulating offshore drilling worldwide – via their regulatory powers over the US companies.

One can see a similar development currently in low Earth orbit (LEO), where SpaceX is occupying entire orbital shells under licences issued by

[116] 'Proclamation by the president with respect to the natural resources of the subsoil and sea bed of the continental shelf' (25 September 1945), reproduced in (1946) 40:S1 *American Journal of International Law* 45.

[117] Convention on the Continental Shelf, 29 April 1958, 499 UNTS 311 (entered into force 10 June 1964). On the Truman Proclamation's effects on customary international law, see Zdenek Slouka, *International Custom and the Continental Shelf* (The Hague: Martinus Nijhoff, 1968); James Crawford and Thomas Viles (1994) 'International law on a given day', in Konrad Ginther et al., eds., *Völkerrecht zwischen normativem Anspruch und politischer Realität: Festschrift für Karl Zemanek* (Berlin: Duncker and Humblot, 1994) 45.

[118] Even developed states had little choice but to co-operate with the US oil industry. As late as 1981, US companies were responsible for 50 per cent of production in the North Sea. See William H Millard, 'The legal environment of the British oil industry' (1982) 18:3 *Tulsa Law Review* 394.

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the United States' Federal Communications Commission (FCC) as it builds a mega-constellation of up to 40,000 satellites. As a result, the FCC has become the most important regulator in LEO, notwithstanding the international character of that zone. The various challenges associated with mega-constellations are discussed in Chapters 2 and 3.

There are, however, two factors that could impede the influence of the United States and US companies on the development of new rules for Space mining. The first is the incredible mobility of high-tech companies, which can be attracted to states with generous subsidies, lower taxes or more relaxed regulatory regimes. The second factor is China, which has recently developed into a major spacefaring state.

5.5.6 *Fragmentation of the Space Law Regime*

As mentioned, the interpretation of the OST preferred by the United States risks a race to the bottom and even the emergence of flag-of-convenience states. Allowing Space mining to take place under national regulations – subject, at the international level, only to an undefined duty to consult – would enable states that wished to attract mining companies to do so by offering minimal regulation and lax enforcement.

There are examples here on Earth that support our concerns. For example, three-quarters of the world's terrestrial mining companies are incorporated in Canada, which exercises relatively little oversight of their operations in the Global South.[119] Inconsistencies among different national laws and regulations, along with weak enforcement, have led to human rights abuses, environmental damage and adverse health impacts. Meanwhile, in the maritime domain, flag-of-convenience states provide shipping companies with registrations for their vessels, as is required by international law, but do so with minimal regulation and lax enforcement. Not surprisingly, ships with flags of convenience have poor safety records.[120] In Space, as we explain in Chapter 2, national regulation of corporate activities with little international involvement has already resulted in a debris crisis in LEO.

Established US companies such as SpaceX are unlikely to change their place of incorporation anytime soon, because of the frequent and often

[119] See e.g. Todd Gordon and Jeffery R Webber, 'Imperialism and resistance: Canadian mining companies in Latin America' (2008) 29:1 *Third World Quarterly* 63.

[120] Alexandra Mandaraka-Sheppard, *Modern Maritime Law: Volume 2, Managing Risks and Liabilities*, 3rd ed (Abingdon: Informa Law from Routledge, 2013).

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

very large contracts they receive from NASA and the US Space Force. But the fact that Japan's ispace has established a subsidiary in Luxembourg suggests that other Space companies are willing to 'move' elsewhere in pursuit of subsidies, tax breaks or favourable regulations. It is also interesting that this Luxembourg subsidiary, ispace Europe, was one of the four recipients of a NASA contract for the extraction and sale of lunar regolith, since this suggests a certain lack of concern about 'regulatory flight' on the part of the US government. However, awarding this one contract to a foreign company might also have been a calculated move to involve another country in what, according to the then NASA administrator, was nothing more than an effort to create a legal precedent.[121]

Tax breaks and favourable regulation is one thing; little to no oversight is another. It is not difficult to imagine a national government seeking revenue through fees for incorporating Space companies or for registering spacecraft without making any serious effort to develop and enforce national laws and regulations. As we explain in Chapter 2, for example, Rwanda might be behaving as a flag-of-convenience state for the purposes of filings for radio spectrum at the International Telecommunication Union. We thus must ask whether a flag-of-convenience state would be acquiescing to all activities of one of its 'national' companies by failing to develop or enforce meaningful national laws for Space mining companies incorporated there. And would this then make the activities of that company subsequent practice for the purposes of treaty interpretation, and state practice and evidence of *opinio juris* for the purposes of customary international law? The answer, unfortunately, could well be 'yes'.

Then there is China, which has recently emerged as a major spacefaring state and is unlikely to support or accept new rules that have been crafted to suit US interests. China has ratified the Outer Space Treaty, is an active participant at COPUOS, and co-operates with the United States and other Western countries in Space-based search and rescue (COSPAS-SARSAT)[122] and disaster relief (the Disasters Charter).[123] But

[121] See discussion at *supra* note 91.

[122] See COSPAS-SARSAT, 'International Cospas-Sarsat Programme' (2014), online: www.cospas-sarsat.int/en/about-us/about-the-programme.

[123] See 'International charter space and major disasters' (2022), online: disasterscharter.org; For the text of this 'Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters', Rev 3 (25 April 2000), see *International Charter Space and Major Disasters*, online: disasterscharter.org/web/guest/text-of-the-charter.

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its considerable political and economic power, fast-growing Space capabilities and increasingly assertive approach to foreign relations all suggest that China will either go it alone on Space mining or – perhaps more likely – seek to create its own group of like-minded states. The latter approach would be consistent with China's creation of the Belt and Road Initiative and the Asian Infrastructure Investment Bank, as well as its open invitation to host foreign astronauts on its new Tiangong Space station. A Chinese-led bloc of spacefaring states would likely develop its own practices and procedures, different from the US-led approach under the Artemis Accords, with even subtle differences – such as on safety zones – being potentially important.

One thing is certain. In the absence of a multilateral process for governing Space mining, the approach taken by the United States risks the development of different, inconsistent and perhaps even conflicting rules and practices. This could, in turn, destabilise the entire existing Space governance regime, to the long-term detriment of international peace and security. By marginalising input from developing and non-spacefaring states, it could also replicate, perpetuate and even exaggerate current economic and political inequities as humanity moves into Space.

5.5.7 Safety Zones and Long-Term Stewardship

'Safety zones' are used around oil platforms operating in exclusive economic zones (EEZs) to prevent accidents involving ships. Under Article 60 of the 1982 United Nations Convention on the Law of the Sea (UNCLOS), a coastal state 'may, where necessary, establish reasonable safety zones' around oil platforms and similar installations.[124] These safety zones may not extend more than 500 metres from the structure, and other states must be provided with 'due notice' of their extent. It remains unsettled whether a coastal state may create a safety zone around an oil platform on the extended continental shelf (i.e. beyond the 200-nautical-mile EEZ) or around a ship in motion, such as a ship conducting a seismic survey in support of oil and gas exploration.[125]

In the Artemis Accords, signatories express their intent to use 'safety zones' around Space mining operations to provide notification of their activities and to co-ordinate with other actors to avoid 'harmful

[124] UNCLOS, Art. 60.

[125] See Joanna Mossop, 'Protests against oil exploration at sea: Lessons from the Arctic Sunrise arbitration' (2016) 31:1 *International Journal of Marine and Coastal Law* 60.

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interference'.[126] Arguably, this notification is necessary to allow full implementation of the consultation, due regard, and notification obligations in Articles IX and XI of the OST.[127] The signatories say they will 'respect the principle of free access to all areas of celestial bodies and all other provisions of the Outer Space Treaty in their use of safety zones', which 'will ultimately be temporary, ending when the relevant operation ceases'.[128]

These assurances are appropriate, but they are expressed within a non-binding instrument that was negotiated among a small group of like-minded states. This leaves the door open to selective application, abuse or at least contestation regarding any safety zone that is established. There is also a question of how China and other non-Artemis Accord spacefaring states might regard the rights of others in any safety zones that they themselves might choose to establish – now that the United States has opened this door. On the oceans, the behaviour of coastal states concerning safety zones has given rise to several disputes, most notably between the Netherlands and Russia, when a Greenpeace ship and its crew were detained for months after protesting offshore oil drilling in the Russian EEZ.[129] Moreover, it is not clear that safety zones, as envisaged, are any better than the general duty to consult. Consultation could provide the desired notification of planned activities on the Moon and other celestial bodies without creating any boundaries, even if those boundaries are only non-binding and temporary.

The US effort to persuade other states to sign the Artemis Accords has undoubtedly been facilitated by the following provision: 'The Signatories intend to use their experience under the Accords to contribute to multilateral efforts to further develop international practices, criteria, and rules applicable to the definition and determination of safety zones and harmful interference.'[130] However, the United States might not be

[126] Artemis Accords, s 11. Safety zones were recommended in the final report of The Hague International Space Resources Governance Working Group, op. cit. See also Tanja Masson-Zwaan and Mark J Sundahl, 'The lunar legal landscape: Challenges and opportunities' (2021) 46 *Air and Space Law* 29.

[127] Lucas Mallowan, Lucien Rapp and Maria Topka, 'Reinventing treaty compliant "safety zones" in the context of space sustainability' (2021) 8:2 *Journal of Space Safety Engineering* 155.

[128] Artemis Accords, s 11(7)(b).

[129] *Arctic Sunrise Arbitration* (*The Netherlands* v. *Russia*) (Award on Merits), Permanent Court of Arbitration, Case No 2014-02 (14 August 2014), online www.pcacases.com/web/view/21.

[130] Artemis Accords, s 11(6).

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disappointed if the envisaged multilateral law-making efforts are postponed, fail or never take place. As we explained above, the United States and US companies are uniquely positioned to influence the development of customary international law concerning the conduct of Space mining, including through actual mining and safety zones. It is also possible that this influence might be bolstered by the Artemis Accords' provisions on safety zones, not as treaty provisions, but as a weak form of state practice on the part of the signatories.

Of course, US-led efforts to 'develop international practices, criteria, and rules' for safety zones could also fail at the level of customary international law. Everything depends on the responses of other states, including non-spacefaring and developing states. Again, no single state or small group of states can make or change international law on its own, no matter how powerful and technologically capable they may be.

None of what is happening here is unusual in international law-making, including the fact that a powerful state is seeking to establish the framework within which state practice and any eventual multilateral negotiations will take place. Powerful states generally try to shape international law in their interests, rather than brazenly violating or simply ignoring the rules.[131] The postponement of negotiations until rules and practices can be shaped by a small group of like-minded states is one of the tried-and-tested strategies of hegemonic law-making. For this reason, less powerful states, including non-spacefaring and developing states, may wish to weigh in on this matter sooner rather than later.

There are long-term, global interests at stake. As prefigured in the Artemis Accords, safety zones could – depending on how they are applied in practice – provide a Space actor with some of the benefits of territory, while relieving it of long-term obligations of stewardship. It is easy to find analogies on Earth that support these concerns, including 'orphan' oil wells and abandoned mining tailings.[132] Moreover, since resource exploration and extraction could take considerable time in Space, a safety zone might remain in place for decades or even centuries, blurring any distinction between temporary use and de facto occupation.

[131] See generally Michael Byers and Georg Nolte, eds., *United States Hegemony and the Foundations of International Law* (Cambridge: Cambridge University Press, 2003).

[132] Robert Fife et al., 'Ottawa provides $2.4-billion to get oil and gas workers back on the job', *Globe and Mail* (17 April 2020), online: www.theglobeandmail.com/politics/article-ottawa-announces-17-billion-to-clean-up-orphan-oil-wells-in-western.

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We agree that safety zones could reduce the risk of certain kinds of accident by ensuring that Space actors do not encroach on each other's operations. Geographic separation could be particularly important in low-gravity situations were dust and debris are easily dispersed. Our concern about the US-led push for an acceptance of safety zones does not deny their potential benefits, or that something like safety zones will be needed in some circumstances. Rather, our concern is that the development of safety zones, and standards for them, could be skewed in favour of powerful spacefaring states and companies from those states, enabling arbitrary boundaries, limits on access or other forms of unnecessary self-privileging. For this reason, safety zones, and Space mining operations in general, should be governed by rules informed by longer-term interests and diverse perspectives—including those of states in the Global South.

Current debates on international law and Space mining can benefit from the experience gained during the development of globally applicable rules on deep seabed mining. During the negotiation of UNCLOS, the United States demanded that private companies have access to deep seabed resources beyond the continental shelf. Most other states wished the deep seabed to be recognised as 'the common heritage of [hu]-mankind',[133] with mining subject to international regulation and oversight. The latter view prevailed, mostly due to co-ordinated negotiating by developing states.[134] This is not the place to defend how that exercise in multilateralism is playing out; we simply point to it as an opportunity for learning.[135] We also note that the United States' failure to ratify UNCLOS has not posed a barrier to the treaty's success: 168 other states have ratified the treaty and, since 1983, the United States has accepted that many of its provisions reflect customary international law.[136]

[133] UNCLOS, Art. 136.

[134] Gorana Draguljić, 'Power in numbers: The developing world and the construction of global commons institutions' (2020) 41:12 *Third World Quarterly* 1973; Surabhi Ranganathan, 'The common heritage of mankind: Annotations on a battle', in Jochen von Bernstorff and Philipp Dann, eds., *The Battle for International Law* (Oxford: Oxford University Press, 2019) 35.

[135] For an overview of the latest developments, see Pradeep A Singh, 'The two-year deadline to complete the International Seabed Authority's Mining Code: Key outstanding matters that still need to be resolved' (2021) 134 *Marine Policy* 104804.

[136] Ronald Reagan, 'Statement on United States Ocean Policy', 1 Pub Papers 378 (10 March 1983), online: www.reaganlibrary.gov/archives/speech/statement-united-states-oceans-policy: '[UNCLOS] contains provisions with respect to traditional uses of the oceans

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5.6 The Working Group on Space Resources

In August 2020, more than 140 non-governmental experts, including three Nobel Laureates, signed an 'International Open Letter on Space Mining' addressed to the president of the United Nations General Assembly.[137] The concluding paragraph of the letter read,

> It is our opinion that the speed and scale of developments relating to the exploration, exploitation and utilization of space resources require more affirmative and urgent action. The undersigned therefore urge States to present for adoption at the United Nations General Assembly, a resolution which would request UNCOPUOS to negotiate, with all deliberate speed, a draft multilateral agreement on space resource exploration, exploitation and utilization for consideration by the General Assembly.[138]

In May 2021, a proposal to create a 'Working Group on Space Resources' was put before the Legal Subcommittee of COPUOS by eight states: Austria, Belgium, the Czech Republic, Finland, Germany, Greece, Slovakia and Spain.[139] The proposal was based on a recognition of 'the increased interest in activities on celestial bodies in general, and activities involving space resources in particular, and taking into account various initiatives to develop normative instruments applicable to space resources activities, as well as the desire for legal certainty and international cooperation in this regard'.[140] Its stated objective was to 'ensure that space resources activities are conducted in a safe, sustainable and peaceful manner, for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and in accordance with international law.'[141]

which generally confirm existing maritime law and practice and fairly balance the interests of all states'.

[137] Outer Space Institute (OSI), 'International open letter on space mining' (August 2020), *OSI*, online: www.outerspaceinstitute.ca/docs/InternationalOpenLetterOnSpaceMining.pdf. The authors of this book led the initiative and were the first two signatories.

[138] Ibid.

[139] United Nations Office for Outer Space Affairs (UNOOSA), 'Working paper on the establishment of a working group on space resources submitted by Austria, Belgium, Czech Republic, Finland, Germany, Greece, Slovakia and Spain' (27 May 2021), *UNOOSA*, online: www.unoosa.org/documents/pdf/copuos/lsc/space-resources/Non-paper-on-the-Establishment-of-a-Working-Group-on-Space_Resources-at-COPUOS_LSC-27-05-2021.pdf.

[140] Ibid.

[141] Ibid.

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The proposal was supported strongly by the G77 and China. The G77 presently includes 134 states, with the original name of the group being retained as a reminder of the considerable successes of collective bargaining by developing states since 1964. China has long been a de facto member of the G77, with the words 'G77 and China' being used to signal whenever the group and the newest superpower are speaking with one voice. Together, they represent 70 per cent of UN member states, 80 per cent of the world's population, and 25 per cent of global GDP.

In their joint statement, the G77 and China identified the need for a multilateral response to the national laws adopted by the United States, Luxembourg and the UAE, 'to avoid gaps or contradictions in the legal framework in this area and to provide a clear understanding of the legal obligations of the States in the space exploration.'[142] They also stressed the need for international co-operation in the development of Space activities 'for the benefit and in the interest of all States taking in particular account the needs on [*sic*] developing countries.'[143]

The statement was emphatic on the necessary role of developing states in any normative or legal developments:

> The Group is of the view that the discussions of this Subcommittee should not lead to any measures, including norms, guidelines and standards that would limit access to outer space by nations with emerging space capabilities, especially the developing countries. Accordingly, the Group believes that the international legal framework should be developed in a manner that addresses the concerns of all States. In this regard, the Group emphasizes the need for COPUOS to devote more efforts for legal capacity-building and make the required expertise available to developing countries, facilitated by UNOOSA.[144]

Indonesia, a member of the G77, made a second, parallel statement of its own that included the following two paragraphs:

> Since space resources are located beyond national jurisdiction, the existing international space law and principles shall apply in their exploration, exploitation, and utilization, including but not limited to: non-appropriation, common heritage of [hu]mankind, exclusive use for peaceful purposes, and for the benefits and interests of all countries.
>
> Indonesia encourages principles of equitable access and collaboration on the issue of space resources so that developing countries are not left

[142] G77 and China, op. cit.
[143] Ibid.
[144] Ibid.

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> behind by spacefaring countries, also consider such arrangements must include the regulation of potential conflicts between space actors.[145]

Russia also supported the creation of the working group. Just one week after the end of the Legal Subcommittee meeting, Dmitry Rogozin, the director general of Roscosmos, called for a 'system of regulations' to address the issue of Space mining at an international level: 'Russia believes that states mustn't adopt any laws and regulations on a unilateral basis because space is our common heritage and belongs to everyone. We consider the United Nations as a suitable [forum] to discuss these issues.'[146]

With all this support, on 9 June 2021 the Legal Subcommittee of COPUOS decided 'to establish, under a five-year workplan, a working group under the agenda item on the general exchange of views on potential legal models for activities in exploration, exploitation and utilization of space resources'.[147] Since COPUOS operates based on consensus, all 95 of its members consented to this decision. On 6 April 2022, the new working group adopted a 'five-year workplan and methods of work of the working group'; again, this was done on the basis of consensus, including the United States and Russia – six weeks after the Russian invasion of Ukraine.[148]

5.7 Optimal Multilateral Outcomes

The Working Group on Space Resources and any subsequent multilateral negotiations could lead to several possible outcomes. The ideal outcome would be a binding treaty that is widely ratified, including by the major

[145] Indonesia, op. cit.

[146] Foust, 'Japan passes space resources law', op. cit.

[147] Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, *Draft Report – General Exchange of Views on Potential Legal Models for Activities in Exploration, Exploitation and Utilization of Space Resources*, UNGAOR, 60th Sess, UN Doc A/AC.105/C.2/L.314/Add.8 (10 June 2021), online: www.unoosa.org/res/oosadoc/data/documents/2021/aac_105c_2l/aac_105c_2l_314add_8_0_html/AC105_C2_L314Add08E.pdf.

[148] Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space, *Draft Report Annex II: Report of the Chair and Vice-Chair of the Working Group Established under the Legal Subcommittee Agenda Item Entitled 'General Exchange of Views on Potential Legal Models for Activities in the Exploration, Exploitation and Utilization of Space Resources'*, UNGAOR, 61st Sess, UN Doc A/AC.105/C.2/2022/SRA/L.1 (5 April 2022), online: www.unoosa.org/res/oosadoc/data/documents/2022/aac_105c_2sra/aac_105c_22022sral_1_0_html/AC105_C2_2022_SRA_L01E.pdf.

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spacefaring states. Such a treaty would build on the Outer Space Treaty, as the Rescue Agreement, Registration Convention and Liability Convention did within the issue areas they addressed. As mentioned above, the 1979 Moon Agreement was a first attempt to create a treaty providing greater specificity on Space mining; it failed to gain broad support, due mostly to larger geopolitical issues – including the Soviet invasion of Afghanistan the following year. However, the widespread recognition that precipitated those negotiations in the late 1970s – that a treaty on resource extraction is needed as humanity expands into Space – is even more widespread and compelling today.

5.7.1 Clarifying Existing Obligations

The working group will want to take a broad approach to the issue of Space mining, one that encompasses all extraction of Space resources, whether conducted by governmental or non-governmental entities, and whether for scientific, mission-critical or profit-oriented purposes. Among the issues that it should address are necessary clarifications to existing rights and obligations, including:

1 Freedoms in Space and the corresponding restrictions on them, as they pertain to resource extraction and use. These freedoms and restrictions are prefigured in Articles I and II of the Outer Space Treaty, but with Space mining now foreseeable, the time has come for the international community to elaborate on them.
2 Limits on the involvement of military personnel and equipment in Space resource extraction and use. Article IV of the Outer Space Treaty specifies that the Moon and other celestial bodies 'shall be used . . . exclusively for peaceful purposes' and forbids 'the establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies.'[149] However, Article IV does permit the use of military personnel 'for scientific research or for any other peaceful purposes', as well as the use of 'any equipment or facility necessary for peaceful exploration of the moon and other celestial bodies'.[150]
3 The obligation to ensure that 'national activities' carried out by 'non-governmental entities' are conducted in accordance with international

[149] Outer Space Treaty, Art. IV.
[150] Ibid.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

law. Article VI of the Outer Space Treaty states, '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.'[151] With Space mining now foreseeable, detailed requirements for the authorisation and supervision of companies and other non-state actors are needed to prevent or mitigate the many risks identified above.

4 The obligation of 'due regard'. Under Article IX of the Outer Space Treaty, states are required to 'conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty'.[152] With Space mining now foreseeable, clarification is needed as to the level of care required. Is the obligation only to avoid reasonably foreseeable harm? Or does 'due regard' require the application of the 'precautionary principle'?

5.7.2 *Applying the Precautionary Principle*

The precautionary principle was set out in Principle 15 of the 1992 Rio Declaration:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.[153]

Today, the precautionary principle is central to numerous treaties, including most recently the 2018 Central Arctic Ocean Fisheries Agreement to which the United States, Russia, China and the European Union are all parties.[154] This treaty prohibits all commercial fishing in the central Arctic Ocean until scientific research establishes that a sustainable fishery can take place.

[151] Outer Space Treaty, Art. VI.
[152] Outer Space Treaty, Art. IX.
[153] United Nations Conference on Environment and Development, *Rio Declaration on Environment and Development*, UNGAOR, UN Doc A/CONF.151/26 (Vol. I) (12 August 1992), Principle 15, online: www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_CONF.151_26_Vol.I_Declaration.pdf.
[154] Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean.

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The precautionary principle has also become part of customary international law, even if the precise content of the principle remains a subject of debate. As Patricia Birnie and Alan Boyle explained two decades ago:

> Use by national and international courts, by international organizations, and in treaties, shows that the precautionary principle does have a legally important core on which there is international consensus – that in performing their obligations of environmental protection and sustainable use of natural resources states cannot rely on scientific uncertainty to justify inaction where there is enough evidence to establish the possibility of a risk of serious harm, even if there is as yet no proof of harm.[155]

Some of the main objections to the precautionary principle are that it is inherently unscientific because it requires action (for instance, regulatory action), or in some cases inaction (for instance, a moratorium on mining in a particular area), before certainty has been obtained, and thus it impedes progress. However, dealing with uncertainty is at the very heart of science, and making decisions based on identified and characterised uncertainty is not the same as making decisions based on conjecture. Nor does the principle require inaction except in grave circumstances; more often, it simply slows activities down so that uncertainties can be properly assessed.

Just as importantly, the precautionary principle (as set out in the Rio Declaration) calls for 'cost-effective' measures when science, with its uncertainty, identifies activities that are causing serious or irreversible damage. As humanity seeks to exploit other worlds for resources, let us be cognisant that we, as a species, might not know what we think we know, and acknowledge that there is far more about Space that we do not understand than that which we do. This is true even for the Moon.

Applying the precautionary principle to Space mining would make scientific assessments of risk necessary prior to any significant activity, including risks to materials of interest to science, risks associated with dust and debris, and risks to Earth and other celestial bodies. Sampling, for science or prospecting purposes, should be permitted, but always also used to inform risk assessment. The risks associated with dust and debris and asteroid trajectory alterations will require strict standards from the outset, at least until these risks become better understood and can be reassessed – not the other way around.

[155] Patricia Birnie and Alan Boyle, *International Law and the Environment*, 2nd ed (Oxford: Oxford University Press, 2002) 120.

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Applying the precautionary principle would also require an acceptance that Space mining operations cannot be allowed to proceed in the face of an unfavourable risk assessment. That said, an operator should be allowed to rework a proposal and have it re-evaluated through a second risk assessment. The goal is not to prevent Space mining, but to make it safer and more sustainable – and therefore a success in the long term.

5.8 A New Multilateral Treaty

A new multilateral treaty could be based on a draft treaty text produced by the Working Group on Space Resources, which would be debated, amended and adopted by the Legal Subcommittee of COPUOS, and then forwarded to COPUOS as a whole and then to the First Committee of the United Nations General Assembly. Ultimately, the treaty would be adopted by a General Assembly resolution, at which point it would be open to states for signature and ratification. Now, it is possible that states might decide to adopt an instrument arising from this process as simply a non-binding General Assembly resolution and not proceed to then elevate its status to a binding multilateral treaty. Such an outcome would not constitute a failure. For the resolution could still influence state behaviour and contribute to customary international law, as Bin Cheng famously explained regarding the General Assembly resolutions on Space adopted in 1961 and 1963.[156] It could also smooth the path to an eventual treaty, perhaps not so very far in the future. Indeed, the adoption of those 1961 and 1963 resolutions provided a firm basis for the negotiation and adoption of the OST just a few short years later.

Alternatively, if it should prove impossible to achieve the consensus required within COPUOS, a treaty on Space mining could be advanced in the form of a protocol to the OST, with negotiations and voting taking place among the parties. Such a protocol would not automatically bind the parties; they would each have to ratify it, just as with a standalone treaty. For the same reason, such an approach would not require the support of each party, which could make it easier for progress to be achieved. A third way forward could involve ad hoc negotiations outside

[156] Bin Cheng, 'United Nations resolutions on outer space: "Instant" international customary law?' (1965) 5 *Indian Journal of International Law* 23. See both the 1961 International Cooperation in the Peaceful Uses of Outer Space and the 1963 Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, op. cit.

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any existing forum, as occurred for the Anti-personnel Landmines and Cluster Munitions conventions.[157]

5.9 Conclusion

Multilateral governance takes time and requires compromise, but it also helps to internalise externalities by solving 'collective-action' problems through scientifically grounded, widely agreed and implemented practices. Multilateral governance can also ensure a form of peer review with respect to the proposed actions of individual governments. To protect the Earth and its natural and cultural heritage, as well as Space, the Moon and other celestial bodies, we need rules that bind all space-faring states and companies. Such rules must take full account of astro-physical realities and their long timescales.

This latter point may be one of the most difficult hurdles on the way to sustainable and effective Space governance, as the effects of activities set in motion today could take a century or more to manifest. A particular danger concerns the demand for strictly data-driven approaches, rather than multifaceted approaches that are not driven solely by data but also seek input from models and analogues – such as terrestrial mining, deep seabed mining, high-seas fishing and the mix of national and international regulatory regimes that have been developed for them. A strictly data-driven approach and the resulting absence of strong changes or clear thresholds might prompt policy makers to continually defer regulatory action – until it is too late. It would be like climate change policy, but with even greater uncertainties and longer timescales.

The US-led effort to secure widespread acceptance that property rights may be acquired over extracted Space resources, and to develop rules and practices in support of commercial Space mining, is unlikely to succeed. As discussed above, the Artemis Accords have to date received support from only 21 of the 112 parties to the OST, with most of those states agreeing only to a 'political commitment', further qualified by the

[157] Timothea Turnbull, 'Prestige, power, principles and pay-off: Middle powers negotiating international conventional weapons treaties' (2022) 76:1 *Australian Journal of International Affairs* 98; Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Anti-personnel Mines and on Their Destruction, 18 September 1997, 2056 UNTS 211 (entered into force 1 March 1999); Convention on Cluster Munitions, 30 May 2008, 2688 UNTS 39 (entered into force 1 August 2010).

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press

ambiguous statement 'the extraction of space resources does not inherently constitute national appropriation'.

None of this is sufficient for success because subsequent practice can only change the accepted interpretation of a treaty provision if it demonstrates the 'agreement of the parties'. Changes to customary international law likewise require widespread consent, which can be withheld through physical action as well as written or verbal statements. For these reasons, it is possible for other states to block changes to the accepted interpretation of a treaty provision or to the development or change of a rule of customary international law. Indeed, the redirection of the Space mining issue into a new Working Group on Space Resources is the immediate outcome of the Global South becoming involved in this matter, most notably through the statement issued by the G77 and China.

It is also significant that the United States, under the newly elected president Joe Biden, joined China and Russia in supporting the creation of this working group. It remains to be seen whether the result will be a draft treaty, a draft resolution or simply a final report. Regardless of the outcome, it matters that a multilateral discussion involving all the major spacefaring states is now under way.

https://doi.org/10.1017/9781108597135.006 Published online by Cambridge University Press