Vancouver Recommendations on Space Mining

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Background

Humanity is entering a new era of developing and utilizing Space that will likely include mining on the Moon, on near-Earth asteroids, and eventually on Mars. As part of this new era, a growing number of state and non-state actors are becoming capable of accessing and operating in Space.

The Global Exploration Roadmap developed by fourteen major national Space agencies emphasizes that *in situ* resource utilization (i.e., space mining and local use of resources, such as sourcing rocket fuel) will be required to realize deep Space activities. Commercial actors have already developed advanced plans to service this future need. Although a private market for Space resources is not yet viable, companies foresee a very large economic potential for providing resources through the mining of celestial bodies.

The speed of development is reflected in the research and exploration missions being conducted by different states, as well as near-future plans for a long-term presence in cis-lunar orbit. For example, the samples being collected from the asteroids Ryugu and Bennu by two robotic spacecraft, Hayabusa2 and OSIRIS-REx, respectively, will help scientists understand the origins of Earth and the Solar System. Bennu is also a "high-risk" asteroid that could potentially strike Earth in the 22nd century; understanding its physical and chemical properties are important for impact avoidance and mitigation efforts. Bennu and Ryugu are further interesting because they contain ice and water-bearing minerals that could potentially be used to produce rocket fuel.

The Lunar Orbital Platform-Gateway ("Gateway") is a proposed multinational initiative to place a Space station in orbit about the Moon. Gateway is planned to be used to facilitate activities on the Moon's surface and in orbits around it. The majority of future lunar missions will require *in situ* resource utilization for sustaining operations, which potentially includes mining ice in polar craters and rare-earth elements in the potassium (K), rare-earth elements (REE), and phosphorous (P) deposits (i.e., lunar KREEP). Gateway is also seen as a stepping stone to Mars.

The existing regime for Space governance is poorly equipped for these developments. For example, Article II of the 1967 Outer Space Treaty states that "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." However, it does not say anything about the recovery and use of Space resources. This gap in the existing regime has left international lawyers divided as to whether commercial Space mining is permitted. The absence of clear international rules could pose problems as Space mining companies emerge in multiple countries and governments adopt national legislation to support and regulate them. It is possible that "flag

of convenience" states will emerge in this field, seeking to attract business through lax regulatory regimes and oversight.

An updated international regime for Space governance could ensure that the scientific opportunities presented by Space mining are fulfilled, for instance, by requiring that companies make unaltered material available to scientists. Such a regime could help address the likelihood that Space mining will result in abandoned equipment and other debris, both on celestial bodies and in orbit, which is a particular concern for the Moon and Mars. Asteroid mining could even give rise to debris streams that threaten satellites in Earth and lunar orbits, as well as activities on the Moon. Last but not least, removing mass from asteroids will cause their trajectories to change. An updated regime could ensure that Space mining only occurs after careful modelling of the astrodynamics, so as to avoid the accidental creation of an Earth impact scenario.

In early March 2020, two dozen experts convened at the Peter Wall Institute for Advanced Studies at the University of British Columbia in Vancouver, Canada. Brought together by the Outer Space Institute, they came from a wide range of countries and backgrounds, including government, industry, and academia. The composition of the group was very transdisciplinary, with representation from astronomy, planetary science, engineering, environmental science, international relations, and international law. The experts adopted the following recommendations as a consensus document; one that reflects the views of the group, but not necessarily, in every respect, the views of each individual participant.

The "Vancouver Recommendations on Space Mining" are intended to augment other existing recommendations and guidelines, most notably the "Building Blocks" adopted by The Hague International Space Resources Governance Working Group in November 2019. Our ultimate goal is to help ensure that Space mining, wherever and whenever it takes place, does so in a safe and sustainable manner.

Vancouver Recommendations on Space Mining

I. These recommendations apply to all Space mining activities, whether carried out by governmental agencies or non-governmental entities. We recognize that states are legally responsible for the Space activities of their nationals, which include companies incorporated within them.

II. We acknowledge the legal debate over Article II of the Outer Space Treaty. We do not take a position on the debate, apart from noting that contested interpretations of international law cannot become binding unless accepted by a significant majority of states.

III. We consider the unilateral adoption of national legislation to be an inadequate response to the need to ensure that Space mining, wherever and whenever it occurs, does so in a safe and sustainable manner.

IV. We recommend multilateral negotiations on an international regime for Space mining. The mandate of the negotiations should be to support safe and sustainable Space mining.

V. The negotiations should be open to all states. Non-Spacefaring states and developing states should be incentivized to develop or acquire the expertise helpful for effective participation in the negotiations. The negotiating states should further seek input from science, industry, and other non-governmental stakeholders.

VI. Options for initiating negotiations may include, but are not limited to, a United Nations General Assembly resolution, a meeting of states parties to the Outer Space Treaty, the activation of Article 18 of the Moon Agreement by states parties to that treaty, or an *ad hoc* process initiated by one or more states (similar to the processes leading to the Landmines Convention and the Convention on Cluster Munitions).

VII. The negotiating states should:

1. Consider the creation of international governance mechanisms, taking into account models or analogies from other areas such as deep seabed mining.

2. Consider the establishment of an international body to provide oversight and ensure accountability with regard to Space mining.

3. Be guided by the precautionary principle, whereby careful and continuous scientific assessment should guide measures to prevent potentially damaging activities even in the presence of scientific uncertainty.

4. Ensure that all Space actors engage in "planetary protection" by preventing harmful forward (Earth to celestial bodies) and backward (celestial bodies to Earth) contamination of all kinds.

5. Encourage the application of the Committee on Space Research (COSPAR) Planetary Protection Policy to all Space mining missions.

6. Further develop standards on planetary protection in the context of Space mining.

7. Recognize that some forms of Space mining could fully consume or destroy some celestial bodies and develop international standards for such cases.

8. Ensure that careful astrodynamical analysis takes place in advance of all Space mining, including with regards to preparatory and post-mining activities as well as secondary effects.

9. Ensure that Space mining does not lead to an increased impact risk between the mined body, Earth, or other celestial bodies.

10. Ensure that Space mining does not create potentially hazardous orbital changes to other celestial bodies.

11. Ensure that the risks posed to Earth and the Space environment by potentially ejected or retrieved material, including the generation of new meteoroid populations, are minimized.

12. Encourage Space actors to consider how Space mining could be used to advance "planetary defence" by protecting Earth from impact events.

13. Establish procedures for ensuring that all actors involved in Space mining provide the maximum amount of publicly available archival information, to support Space science and public awareness and education while taking into account legitimate commercial and security interests.

14. Establish procedures for ensuring that all actors engaged in Space mining secure representative and pristine samples prior to any further extraction on that site, in a manner that is compatible with eventual sample return. These samples should be made available internationally for scientific research.

15. Ensure the continued development of publicly available astrogeological surveys, for all celestial bodies, that include data from governmental and non-governmental actors.

16. Ensure that the regime governing Space mining activities provides for legal accountability in the event of damage from Space activities, regardless of any possible corporate changes or reorganizations concerning private actors or any territorial change affecting states or international organizations.

17. Require that any Space mining activity is accompanied by a system of remote monitoring to record all relevant information and help ensure oversight and accountability with regard to the applicable rules and regulations.

18. Ensure the recognition of intellectual property rights in a manner compatible with effective national and international oversight.

19. Investigate whether and how the concept of "planetary boundaries" can be extended into the Space domain. Such boundaries delineate the safe operating parameters for a complex environmental system that, if crossed, could lead to large, non-linear changes in the system.

20. Encourage the establishment of a mandatory benefits sharing mechanism that includes, but is not limited to, sharing of monetary benefits, for example through an international fund.

21. Encourage significance assessments of existing and future natural and cultural heritage sites, natural and cultural heritage impact assessments of all Space mining activities, and the development of publicly accessible international heritage site lists (natural and

cultural), with input from states, science, industry, and other non-governmental stakeholders.

22. Consider how to protect sites where scientific studies are underway, including from possible secondary effects of Space mining such as unintentional seismic activity.

23. Ensure that operators and autonomous robotic mining equipment are trained, qualified or programmed to recognize biosignatures, to the extent this is feasible, and that all Space mining activities stop immediately if biosignatures are encountered.

24. Ensure that licensing states require environmental impact assessments and management plans to be published well before any Space mining activity takes place to prevent or minimize harmful consequences such as lunar dust, debris streams, and potentially dangerous trajectory changes.

25. Ensure that the lofting and transport of dust and debris from mining activities on the Moon is minimized, for the safety of all operators.

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