International Journal of Law
ISSN: 2455-2194; Impact Factor: RJIF 5.12
Received: 29-01-2021; Accepted: 16-02-2021; Published: 10-03-2021
www.lawjournals.org
Volume 7; Issue 2; 2021; Page No. 85-90

Outer space mining-An analysis of its legal aspects

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Abstract
With the extensive activities of mining on earth and the interest of mankind in the outer-space, we have reached the stage where nations are interested in conducting outer-space mining. There is abundance of mineral on moon and asteroids which can be tapped into by humans with the right technology and laws. Two nations specifically have shown interests in the activity of space mining when it comes to legislations, namely United States of America and Luxembourg. But the outer space is the province of all mankind and the international space laws have not evolved with time. The two major international legal instruments dealing with the issue of space mining are Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies of 1967 (the Outer Space Treaty) and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies of 1979 (the Moon Agreement). While the former was accepted and ratified widely, the latter was rejected by most nations, especially the major space-faring nations. The Outer Space treaty states outer space to be the province of all mankind and allows for exploration and use of outer space for scientific purposes but expressly prohibits militarisation or any military/weapon activity in outer-space. It also states that the said exploration and use shall be for the 'benefit for all countries'. Further, the treaty prohibits appropriation or claim of Sovereignty of any celestial body by any nation. These are the major concerns when it comes to the issue of outer-space mining since the treaty neither expressly allows it or prohibits. The Moon treaty dealt with the issue of resources expressly and was rejected by major space faring nations because of similar provisions. This paper therefore analyses the concerns stated over the Outer Space Treaty and the Moon Agreement and provides for a logical answer in this context. In the next part, it discusses about 'common but differentiated principles' and 'sustainable development' principles with respect to outer space mining. Lastly, it discusses on possible suggestions for the needed new laws in light of outer space mining to regulate the same efficiently.

Keywords: OST, moon agreement, CBDR, asteroid/moon mining, resources, advancement

Introduction
Mining minerals from the surface of earth has become an essential part of our lives in recent year since the minerals are used in our everyday lives. Be it a house or a cell phone or airplane or electronic devices or automobiles etc., minerals are used in many aspects of our lives. And with the extensive mining activities, the resources are being depleted on a constant rate as they are all non-renewable resources. At the same time, outer space has been an area of interest for mankind and mankind has been exploring, observing and learning more about outer space over time. From sending satellites to learning about the moon to what's on mars and other planets, mankind has always been curious and keen on exploring outer space.

Combining both of these activities, many nations are interested mining minerals in the outer-space. Through exploration, mankind has learnt a lot about the surface of moon and asteroids and certain planets. And several space faring nations such as USA, Luxemburg, China, India and several other countries have expressed their interests in space-mining. But what are the legal implications of the engaging in outer-space mining. International Space Law has not evolved much since the 20th century and there have been constant debates over the legal implications or the lack of legal framework over the activity of outer-space mining. Hence, despite having interest in outer-space mining, examination from a legal point of view is necessary. Though the space mining activities might not take place for years but clarity on its legal context would be an incentive for nations.

Research Problem
Outer-space mining has been an interest by many space faring nations. The international space law has not evolved since the times of cold war between the Soviet Union and the United States. The major treaties to deal with the issue of space mining are the Outer Space Treaty 1967 and the Moon Agreement 1979. These both were passed a generation ago and jurists claim that it does not meet with the current state of technological evolution and interests and is out-dated. With the earth's mineral resources fast depleting and the discovery of the vast of amount common as well as rare and minerals in outer-space, space-mining is a good alternative. But a question naturally arises on how the present international space laws address the activity of space-mining. It is important to analyse the efficiency of International Laws to deal with it especially with USA and Luxembourg already having passed national legislation to that extent.

Existing Legal Situation
At present, the existing legal situation, as far as space laws are concerned with respect to space mining, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967 (the Outer Space Treaty)

and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, 1979 (the Moon Agreement) are the only legal instruments directly dealing with issue of space mining and are the most debated International Laws in that aspect. While the former is widely ratified by the international community, the latter is rejected by most of the international community. Hence, much of the prospects lie in interpretations of these two legal instruments.

Literature Review

1. Sarah Coffey, 'Establishing a Legal Framework for Property Rights to Natural Resources in Outer Space' (2009) 41 Case W Res J Int'l L 119 – This article deals with concept of outer-space mining with respect to moon only and why it is appealing to engage in mining minerals on moon. It also analyses the Outer Space Treaty as well as the Moon Agreement 1979 and its interpretations in the context of outer space mining and also analyses the analogous treaties. The article rejects the idea of existing laws being able to deal with the issue of space mining and suggests ideas for the needed new laws to legalize and regulate the activities of outer-space mining on moon.
2. Virginie Blanchette-Seguin, 'Reaching for the Moon: Mining in Outer Space' (2017) 49 NYU J Int'l L & Pol 959 – This article also deals with the concept of outer-space mining on moon only and analyses the provisions of Outer Space Treaty 1967 and Moon Agreement 1979 from the principle of appropriation of resources mined and also from the perspective of United States. It also mentions the laws of United States with respect to space mining. The article questions if the analogy of the law for the High Seas hold similarly with the space mining activities and answers in negative, expressing the need of new international laws for the same.
3. Gabrielle Leterre, 'Providing a legal framework for sustainable space mining activities' (Masters in Media, Communication and Space Law, University of Luxembourg 2017) – This thesis paper is one of the most elaborate articles on outer space mining and the surrounding International laws. It critically analyses the viewpoints on the interpretations of the Outer Space Treaty 1967 as well as the Moon Agreement 1979 and states how they deal with the issue of space mining. It also discusses on the Space Benefit Declaration adopted in 1996 by the international community. It discusses and analyses the concept of non-appropriation clause challenges. Further, it also analyses the Luxembourg and the USA laws passed on space mining. It creates an analogous connection with the High Seas regime and Deep Sea bed mining and how the similar concepts can be applied to space mining too. Lastly, it also deals with the suggestions for a sui generis legal framework to facilitate the activities of space mining while dealing with environmental aspects of it too.
4. John G Wrench, 'Non-Appropriation, No Problem: The Outer Space Treaty Is Ready For Asteroid Mining' (2019) 51 Case W Res J Int'l L 437 – This article follows the similar pattern of discussing and analyzing the existing two international space laws while dealing with the issue of space mining and discusses on the principle of non-appropriation mentioned in the Outer Space Treaty. The article discusses on United Nations Convention on the Law of the Seas, the Seabed Act and the Antarctic treaty system. After analyzing on the points with respect to outer-space mining, it concludes that the Outer Space Treaty makes outer space mining legal and expects the international community to come up with regulations and needed laws when the time comes.
5. Arkadiy Ursul, and Tatiana Ursul, 'from planetary to space mining: prospects for sustainable development' (2019) 265 MATEC Web Conf. 06015 <https://doi.org/10.1051/matecconf/201926506015> accessed 07 October 2020 –This article briefly discusses about the sustainable development principle and considers sustainable mining development as one of the biggest concerns for global stability. It stresses on the sustainable mountain development and discusses the prospects of sustainable mining from outer space.
6. Per Josephson, 'Common But Differentiated Responsibilities in the Climate Change Regime – Historical Evaluation and Future Outlooks' (International Environmental Law thesis, Stockholm University 2017) – This thesis is an elaborate paper which discusses on the evolution of the CBDR principle along with the sustainable development principles. It provides a clear insight on what the CBDR principle is and how it was born on demands by developing nations and how it evolved and helped with the Climate Change goals along with strengthening other state economies. It also points out the failures of it. The same can be thought along for space-mining too.
7. Vidya Sagar Reddy Avuthu, 'Commercial space mining: Economic and legal implications' (ORF Occasional Paper 122, 28 September 2017), Observer Research Foundation <https://www.orfonline.org/research/commercial-space-mining-economic-and-legal-implications/> accessed 02 December 2020 – This paper examines both economic as well as the legal aspects of the space-mining. It elaborates on the huge economic benefits of the minerals to be mined on moon and asteroid while also discussing the space exploration interests by the western world. It discusses on the existing international space laws and arguing that they were a reason of cold war fears states that it does not allow for space-mining and ownership and that it needs to be amended.
8. Senjuti Mallick and Rajeswari Pillai Rajagopalan, 'If Space is 'the Province of Mankind', who owns its Resources? The Potential of Space Mining and its Legal Implications', (ORF Occasional Paper No. 182, January 2019), Observer Research Foundation < https://www.orfonline.org/research/if-space-is-the-province-of-mankind-who-owns-its-resources-47561/> accessed 02 December 2020 – This article discusses on the various organizations and nations interested in the space activities and the benefits of space mining before discussing on the legal aspects of it. It discusses on the Outer Space treaty as well as the Moon Agreement while discussing them together and states that private ownership of mined resources in space is illegal. It supports the Moon Treaty and discusses on the ideas of new legal framework for space-mining which would be beneficial to all countries.
9. J.A. Dallas, S. Raval, J.P.A. Gaitan, S. Saydam, A.G. Dempster, 'Mining beyond Earth for sustainable

development: Will humanity benefit from resource extraction in outer space?', Acta Astronautica, <https://doi.org/10.1016/j.actaastro.2019.11.006> accessed 02 December 2020 – This article discusses on the space-mining idea from the point of view of sustainable development of the world. It highlights the various UN Agendas for sustainable development and states the advantages as well as the disadvantages of space mining in the present national and international legislations from sustainable development point and discusses on the space gap and mineral economies too. It suggests ideas for new framework too.

Scope and Objective

There have been many debates and opinions with respect to the idea of space mining and the existing space laws. The scope of the paper is to analyse these space laws with both the sides of the debates. The objective of the paper is to identify the key points important from both sides and determine if the existing space laws make outer-space mining legal or not and whether new laws are needed for the same. If new laws are needed, what are the possible factors or ideas that should be considered? The scope is however limited to examining the legal context of space mining.

Research Questions

1. Is the activity of space-mining legal in the context of current international space laws? If yes, how far does it deal with the activity of space mining?
2. Is there a need for new space laws with respect to outer-space mining?

Hypothesis

While there have been positive as well as negative opinions with the legality of outer-space mining in the context of current international space laws, it is mostly legal as per those laws and it is the major space faring nations who are unhappy with the state of its legality and the obligations to fulfil under those laws. But there lacks a proper regulatory framework to deal with the many complicated aspects of outer-space mining which is much needed to indulge in the said activity of outer-space mining. The international community has to come together to frame those much needed laws.

Research Methodoly

This research will be conducted in a systematic way by analysing the existing legal regime in international space law with respect to outer-space mining. An analysis of various literatures will be done to identify legal issues with respect to the prospective industry of space mining. A critical analysis shall be done to identify the gap in the international space law regime in dealing with space mining activities.

Space-Mining and Its Benefits

The idea of exploring or using the outer space was a dream in the earlier centuries but the rapid advancement of technology made the dream came true in the 19th century with the launch of satellites, the moon missions, observing distant planets etc. Similarly, the idea of mining minerals in the outer space wasn't possible in earlier times but it is something that many nations are looking forward to in the near future. With the depleting minerals on the earth's surface and discovering of various metals and minerals on the moon and the asteroids, outer space mining is something which nations are considering at current time. United States' Federal Aviation Administration has already authorized the first private lunar mission in 2016 [1].

Moon

The samples of moon obtained by USA and Russia showed concentrations of silicon, iron, aluminium, titanium, calcium and magnesium among others [2]. Further, Helium-3, an extremely rare element on earth's surface, which in fusion reaction can create an ultra-efficient, non-radioactive, clean source of energy, is found to be in abundance on moon [3].While mining Helium-3 isn't easy, even a small amount of it can produce vast amount of energy but it requires nuclear fusion reactors. There exists only one of them at present in Madison and not of commercial capacity [4].With the construction of ITER at France being regarded as the last step before commercial designs of such fusion reactors [5]. It is possible in the near future especially if Helium-3 is successfully obtained from lunar mining processes. It would be valued at thousand times more than gold or platinum if it can be used in an efficient reactor [6].

Moreover, the lunar surface also contains Thorium, an efficient substitute of Uranium [7]. The poles of the moon are great sources of water which can be used for providing rocket fuel and oxygen supplies to a spacecraft through electrolysation [8].

Asteroid

The next objects of interest in space-mining are asteroids which contain many valuable metals, gases, water and organic compounds [9]. The asteroids are classified into three types (Chondrite, Stony and Metallic) where a 10 metre stony asteroid could provide with 6, 50,000 kg of metals including gold and platinum and a Chondrite asteroid could provide with abundant water and organic compounds such as carbon, phosphorus etc [10]. Water on asteroids can be used for multiple purposes such as for survival and rocket fuel/refill-station. Estimates of the potential value of asteroids range between few billion to more than a trillion dollars, depending on the size, composition and value of the metals they contain [11].

Space-mining is an attractive idea with just two of celestial body's type which is why many private individuals and nations have expressed their interests in it. But the question that remains and is constantly debated is whether outer-space mining legal in international law. With USA and Luxembourg having passed domestic legislations authorizing and legalising space-mining along with ownership of mined resources in 2015 and 2017 respectively and other nations such as China, Russia etc. expressing their interests over it, it is very important to analyse the legal context of space-mining.

Interpretation of the Existing International Space Laws

Existing Relevant Space Laws

Five International Space Laws were drafted post the Civil War between USA and former Soviet Union out of which two are most relevant in context of space-mining.

1. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies 1967 (hereinafter referred to as "OST") [12].

This treaty is considered to be the most important international space law as it sets the principles for all other space laws in the future and is widely ratified by most nations. Therefore, this is the most important and debated law when it comes to the issue of space-mining since it was drafted more than 50 years ago. Article 1 and Article 2 of the OST are the most debated articles for space-mining where Article 1 makes the outer-space the 'province of all mankind' and allows 'exploration and use of outer space by all states without discrimination' 'for peaceful purposes' and 'for the benefit of all countries irrespective of their economic or scientific development' [13]. It provides for freedom of scientific investigation in outer space and calls for international cooperation in that respect. Article 2 prohibits 'any claim of sovereignty' or 'of national appropriation' 'of any celestial body by means of use or occupation or by any other means' by any state [14]. These two articles are the major source of debate. Since space is the province of all mankind and the exploration or use of outer space is to be done for the benefit of all countries along with the non-appropriation principle, is space-mining legal? The question remains that whether a state or private entity of a state can effectively mine and own the mined resources without violating the provisions of the OST? There exists an ambiguity when it comes to resource mining on the celestial bodies since the treaty explicitly hasn't allowed or prohibited it. While many [15]. Have stated that it is not possible and legal to do so under the existing legal regime, many [16] have expressed that it is possible and legal to do so.

The former argument is based on the non-appropriation clause of the Treaty stating that one cannot own the mined resources without appropriating the surface of the celestial body mined and that the said use would not be for scientific use or for all countries but for private commercial exploitation which is not a permitted 'use' under the OST. The latter argument is based on the outlook that the Moon Agreement 1979 was rejected precisely because of non-appropriation of mined resources while the OST was accepted widely which indicates that mined resources can be owned without appropriating the concerned celestial body [17] and the fact that outer-space is already being commercially used since satellites are used for televisions, mobile phones, navigations etc [18]. It is also based on the fact that OST has explicitly prohibited only military uses of outer-space and not this. To this extent, USA and Luxembourg have incorporated domestic legislations encouraging private entities to own mined resources from space and consider it not a violation of their international obligations.

But they have missed the important 'common benefit' clause in Article 1 of the OST which states the use of outer-space shall be for the 'benefit and interest of all countries' [19]. To this extent, the OST legalises the space-mining as long as it benefits all states in some manner and not just the mining state. Further, the logic that OST was ratified while Moon Agreement was not can be viewed in another manner that both legislations were intended to complement each other and that private ownership of space-mined minerals is not permitted because the latter expressly prohibited it.

2. Agreement Governing the Activities of States on the Moon and Other Celestial Bodies 1979 (hereinafter referred to as "Moon Agreement") [20]

This agreement/treaty was widely rejected by the international community including the major space faring nations. This treaty elaborates on the principles/laws to be followed in exploration of moon and extraction of lunar resources. Treaty subjects the said principles/laws to be followed for all celestial bodies in the solar system other than the earth [21]. It reiterated most of the OST provisions while also discussing on the extraction of lunar resources. It extended the 'common benefit' clause to the extracted resources too and called for establishment of an International regime to govern the exploitation of such resources [22]. This treaty complemented the OST and protected the interests of the developing nations. This was the major reason for the rejection of this treaty as mining states did not want to share the extracted resources with other states fearing that the developing nations would exploit the gains in exchange for very little or for nothing [23]. It is important to note that the term used for sharing benefits derived from the resources is 'equitable' and not 'equal' while also creating a distinction between the needs of the developing countries and the efforts of countries directly or indirectly involved in extraction is taken into consideration [24]. The author is of the view that this treaty was a justified treaty which was rejected by the space-faring nations to further private ambitions at the cost of developing nations' inabilities to engage in space-mining. Though the treaty leaves the question of how to share the common benefits unanswered which the author believes is the major cause of its rejection, 'equitable' sharing provides an important insight complemented with an international regime for doing so.

3. Declaration on International Cooperation in the Exploration and Use of Outer-Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries 1996 (hereinafter referred to as 'Space Benefit Declaration') [25]

This declaration provided specific considerations towards the developing nations which had realised that they weren't reaping the benefits of space technologies which the other space faring nations were reaping [26]. It provided for international cooperation between the states on a mutually agreed basis taking into special account the interests of the developing states. The extent and nature of such cooperation, with which states and which not, would depend on the parties themselves. The fifth paragraph of the declaration states the space benefits which are to be shared in this context and provides for development of space capabilities and exchanging expertise and technology among states on a mutual basis [27]. Thus, the declaration defines an intangible way of sharing space benefits rather than the tangible or financial aspects while enabling developing nations to engage in space-mining too. This declaration is also consonance with the intra-generational equity principle of the Rio Declaration on Environment and Development [28].

Outer-Space Mining, Cbdr and Sustainable Development– An Extension

The major concern in OST and Moon Agreement was the sharing of benefits of space-mining with other states by the mining state even though it legalises space-mining.

But it is perfectly reasonable to do that. The nations are taking advantage of the ambiguity of OST for space-mining, interpreting it in their own favour. Hence a new legal framework is needed to regulate it explicitly. The nations want to incorporate 'first come, first serve' concept in space-mining when outer space belongs to all mankind implying that the resources of outer-space should also belong to all mankind. To this extent, the OST also mandates the use of outer-space for benefit of all countries [29]. It is important to learn the lessons from the Climate Change conventions and sustainable development principles where nations incorporated 'common but differentiated responsibility' (hereinafter referred to as 'CBDR') owing to the developed nations' major contributions to climate change and environmental degradation as compared to the minor contributions of developing nations, combined with the social and economic inequality between the developed and developing nations [30]. On a similar analogy, minerals to be mined on moon and 'reachable' asteroids are non-renewable and limited in nature. The space-faring nations have the technology and finances to mine in outer-space while most developing nations do not. If the benefits of space-mining are not shared with all countries when the outer-space is province of all mankind, the space-faring nations that have the technology and the financial capabilities to mine would have an unfair advantage over those which don't, especially the third world countries, and will deplete much of the minerals of outer-space before the developing/third-world nations can acquire such technology and financial capabilities. This would repeat the situation of climate change conventions/treaties [31] with space-mining where the developed nations had exploited the environment longer and more than the developing nations. Furthermore, it would also be against the intra-generational equity and inter-generational equity principle of the sustainable development in Rio Declaration on Environment and Development [32]. The CBDR principle is also linked with the 'common heritage' principle and sustainable development principles [33]. The space-mining activities would not be without environmental concerns either since mining operations would involve releasing hazardous chemicals in outer space and produce space debris too which is a growing concern for international space law and the international community as well in recent times.

Further, the OST clearly provides for the non-appropriation of any celestial body by any state but if a state mines an asteroid out of existence, would it not qualify as appropriating the said asteroid? And since the number of major space-faring nations is few and the number of them to obtain the technology for space-mining will be few too, would it not amount to these few nations collectively appropriating the minerals of outer-space as opposed to outer-space being the province of all mankind? If a celestial body belongs to everyone, the resources in it belong to everyone too because they are a part of the celestial body.

It can lead to the 'tragedy of the commons' [34] as well as an abuse of dominance by those nations in mineral industry. It would also increase the economic inequality between nations since many nations' GDP is dependent on their mineral exports [35]. It would be against sustainable development principles. Outer-space is vast while earth is just a small part of it and therefore applying the same laws followed for earthly resources to outer-space resources isn't reasonable. The OST and the Moon agreement reflect this very idea. The idea of 'equitable' sharing of benefits and the drawing of the distinction between the needs of the developing countries and the efforts of countries directly or indirectly involved in space-mining highlighted in the Moon Agreement [36] can also be read harmoniously with the CDBR principle as well as sustainable development principle of intra-generational and inter-generational equity. Therefore, the CDBR principle can be incorporated in space-mining activities as they already were before in the Moon Agreement but were not incorporated elaborately. The common heritage of all of mankind can be exploited by all nation commonly but with differentiated responsibilities and respective capabilities depending on their interests, technological, socio-economic capabilities and other relevant factors.

Suggestions for New Legal Framework

While the existing legal regime legalizes space-mining, there is need for a regulatory framework and the explicit provisions dealing with space-mining. Below are few suggestions-

1. Clarity on 'sharing benefits' clause and for International Cooperation- While the OST mandates that the benefit of space use be shared by all countries, it doesn't define what benefits is to be shared and how it is to be shared, especially in the context of space-mining. The same needs to be more clearly defined when it comes to International Cooperation among the states. The Space Declaration 1996 [37] did provide for a little clarity on the idea which can be evolved more concretely for space-mining.
2. CBDR, Joint implementation programmes and Credit Exchange Schemes- The evolution of CBDR and climate change conventions can be studied and applied towards the space-mining industry [38]. Space-faring nations can implement joint implementation programmes with non-space-faring/developing/third-world nations to engage in space-mining. This would also enable transfer of technology and the technical know-hows of space-mining to the latter, creating a more equitable ground. Luxembourg's space-mining legislation seeks for space-faring nations to set-up launch-pads in its territory to engage in space-mining. This is quite similar and a successful joint implementation programme can be implemented with nations on a mutual basis. Further, a credit exchange system similar to that of 1997 Kyoto Protocol [39] can be adopted too where credits can be assigned based on population and socio-economic and technological status of the nations and despite having the option of joint implementation and shared benefits scheme, if the nations do not want to engage in space-mining, they can sell it to nations interested to purchase it.
3. Setting up of an international regime and an independent dispute resolution body- Like the Moon Agreement had proposed, an international regime to govern the activity of space-mining should be setup along with an independent dispute resolution body for peaceful dispute settlements between nations.
4. Preservation of Moon [40] - While engaging in lunar-mining, specific provisions for preserving the moon is necessary since it is the only natural satellite of earth and is of significant value to sustain life on earth. It affects ocean tides as well as the earth's axis of

rotation.

5. Protecting outer-space environment- As stated in chapter 3, asteroid mining activities would generate space debris and hazardous chemicals in outer-space and change the shapes of asteroids too. Therefore, provisions to deal with it are essential to be incorporated too. This further supports the idea of 'sharing benefits' because it would be an issue for the entire international community as opposed to just that of the mining nation.

Conclusion

It is clear from the above discussions that the interpretation of OST to differentiate between the ownership of a celestial body from that of the mined resources is based on ill-founded logic and to further private and self-centered ambitions. The outer-space consists of vast amount of resources that can produce unimaginable benefits economically as well as environmentally. It is no secret that the mineral resources on earth are getting depleted fast along with various health hazards and environmental concerns attached to it. Space-mining can be an effective solution to it. And it can be a solution for all countries rather than just for a few space-faring nations without anyone suffering losses in it. And it can be more effectively implemented too with all the countries collectively and informatively engaging in it rather than just a few space-faring nations engaging. The OST and the Moon Agreement highlights these very ideas when read together. As stated earlier, applying the property laws followed on earth to the vast universe comprising of many bodies just like the earth isn't logical or reasonable and the space laws have to be incorporated with a different perspective than that of the laws followed for earth's resources. International cooperation is more necessary for it than national ambitions.

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