ASTEROID MINING AND ITS LEGAL IMPLICATIONS

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> *"There is a tide in the affairs of men. Which, taken at the flood, leads on to fortune. But omitted, and the voyage of their life is bound in shallows and miseries. On such a full sea are we now afloat, and we must take the current when it serves—or lose the ventures before us."*

In the aforementioned scene Brutus tells Cassius that their enemy increases in number every day and they must meet the enemy in battle while they still have a chance of victory. So also, NASA has already predicted that it will send astronauts to Near Earth Asteroids by 2025, and several other private corporations like Planetary Resources and Deep Space Industries are also taking part in the new space race- the race to mine asteroids. Several space agencies and private companies have started raising funds for the same but the framework of international space law regimes, such as the Moon Agreement and the Outer Space Treaty are archaic in this sense. This is because they were created in a time when near-Earth asteroid mining was unfathomable. Accordingly, these laws must be amended prior to commencing mining exploits in space, in order to prevent foreseeable conflict.

This paper, while explaining the concept of asteroid mining, explores the viability of mining Near Earth Asteroids and highlights the lacunas in the existing legal framework. Moreover, it also

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suggests reforms or an overhaul in the said legal regime. The reforms proposed aim to deal not only with dispute resolution but also prevention of disputes in the first instance.

I. WHAT ASTEROIDS ARE

Asteroids are defined as any of many thousands of small bodies, made of rock and minerals that orbit the Sun. Most lie in a region called the asteroid belt between the orbits of Mars and Jupiter, and are thought to be fragments left over from the formation of the Solar System.[1] Asteroids are those small, rocky and airless worlds in space that are too small to be classified as planets.[2] They are those minor planets that were leftover when our Solar System was created-4.6 billion years ago. Most asteroids were those bodies in the Sun's nebula that never grew big enough to become planets. They come in various shapes and sizes and each asteroid has its own different composition. Some may be piles of rubble, with gravity the only thing holding them together, while others can be solid bodies composed of rich metals.

Though there are a countless number of asteroids in our solar system, with most of them yet to be discovered, a vast majority of them- about a hundred thousand, lie in what is known as the 'Asteroid Belt'. The asteroid belt is the vast ring of asteroids between the orbits of Mars and Jupiter that is home to more than 200 asteroids larger than 100 kilometers in diameter, and 750,000 asteroids that are larger than 1 kilometer in size.[3]

However, many groups of asteroids orbit outside the main belt. In fact, three groups in particular-Amors, Apollos and Atens orbit in the inner solar system and have been known to cross paths with Earth and Mars. These are known as Near Earth Asteroids (hereinafter NEA) and these are the asteroids that are occasionally a cause for concern when they come too close to Earth. On the rare

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[1] JULIUS DASCH , A DICTIONARY OF SPACE EXPLORATION (Oxford University Press , 2d ed. 2016).

[2] Charles Q. Choi, *Asteroids: Fun Facts and Information about Asteroids*, Space.com, Nov. 21, 2014, http://www.space.com/51-asteroids-formation-discovery-and-exploration.html.

[3] *Id.*

occasion that an asteroid does crash into Earth, it is called a meteorite. Scientists are constantly keeping track of smaller asteroids that may be on collision course with earth, where asteroids are classified according to the hazard they pose. Scientists estimate that with the advancement of technology possibilities for avoiding an earthbound impact include exploding or diverting the asteroid in its path in the future.

Asteroids are classified into 3 types based on their shape, colour and composition. The classification of asteroids is a crucial factor while conducting probes and deciding which asteroids are worth mining.

A. The Three Types Of Asteroids

C-Type Asteroid

These are asteroids, which are mostly made up of carbon ('C'-carbonaceous). They are the most common, with 75% or more of total asteroids found belonging to this category[4]. Due to the high carbon content they are mostly dark grey or black masses. C-Type asteroids contain water, organic carbon and other trace amounts like phosphorus.[5][6] Despite being the most common C-Type asteroids may very well contain the most valuable substance of all- Water. As will be explained later, water found on these asteroids can be used as space propellant for any further exploration efforts to other planets or bodies, far into space. If utilized correctly, the use of water as rocket fuel can totally transform the way rockets and space travel works.

S-Type Asteroid

Found mostly as NEA, they are attractive targets for mining as they are made up of mostly silicate metals and rock ('S'-Siliceous or Stony). They contain rare metals like gold, platinum, rhodium;

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[4] ASTEROIDS II (SPACE SCIENCE SERIES) 316 (Richard P. Binzel et al., eds., University of Arizona Press, 1989).

[5] Planetary Resources, *Asteroids: Composition,* http://www.planetaryresources.com/asteroids/#asteroids-overview-composition (last visited Jul. 24, 2016).

[6] NASA, *'New NASA Mission to Help Us Learn How to Mine Asteroid's'*, http://www.nasa.gov/content/goddard/new-nasa-mission-to-help-us-learn-how-to-mine-asteroids (last visited Jul. 24, 2016).

nickel, cobalt etc. are making up about 17% of total asteroids[7]. With their reddish to greenish hue colours, they appear more attractive than C- Type Asteroids.[8]

M-Type Asteroid

These are those asteroids where the composition is only partially known and are 10 times rarer than S-Type Asteroids. Found only in the middle region of the Asteroid Belt, they seem to be made up of nickel-iron.[9] They are unlike any other metallic ores found on earth today, and are extremely dense.[10] Scientists estimate that a single M-Type asteroid may have more platinum that has ever been mined on earth till date.

II. REASONS TO MINE ASTEROIDS

Human thinking has seen a radical shift with the progress made in technology. While earlier, asteroids were seen more as a threat to all life on earth, today with the huge steps the human race is taking in space, we are looking at the potential in space instead. In particular we are looking at the potential of asteroid mining- a concept that envisages using the vast resources we know that exist on asteroids for the benefit of all. Asteroid mining will become necessary not only for the furtherance of science, but for meeting the needs of the Earth's 7.1 billion strong population.

Asteroid mining would solve the world's energy crisis faster than any other solution we currently have. Fossil fuels like coal, oil and natural gas currently account for 81% of the world's primary energy. While we look for sources of renewable energy, slow progress is being made as only 2% of the world's consumption of energy was provided non-hydroelectric renewables in 2010.[11] The problem is essentially of risk and cost. The process of renewable energy production is unable to compete head to head with fossil fuels because

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[7] DASCH, *supra* note 1, at 1.

[8] *Id.*

[9] *Id.*

[10] RICKY J. LEE, LAW AND REGULATION OF COMMERCIAL MINING OF MINERALS IN OUTER SPACE 59 (Springer, 2012).

[11] Dana G. Andrews et.al, *Defining a Successful Commercial Asteroid Mining Program* , 108 ACTA ASTRONAUTICA 106, 106-07 (2015).

many of the methods are either too expensive or unproven. Primarily, they are too expensive because they rely on metals that are in short supply.[12] Technology development is also becoming harder for the same reason. As key rare earth elements become scarcer, manufacturing costs are skyrocketing. For all the computers ever made, computer chips were required, and all chips are made with a small amount of a particular rare earth metal. Many other industries like the automobile and television industries are beginning to face the same problem. Platinum, for instance, is used in 1 of 4 industrial goods on earth, despite its high cost. Mining one 500 metre asteroid can produce more platinum than has been mined in the history of humankind.[13]

Many of the critical metals used today were deposited in the Earth's crust by meteorite impacts, thousands of years in the past and their supply was always limited. These metals include gold, cobalt, iron, manganese, molybdenum, nickel, osmium, palladium, platinum, rhenium, rhodium, ruthenium, and tungsten.

To get an idea about the potential value involved we can take the study of John Lewis, who co-directs the Space Engineering Research Center at the University of Arizona at Tucson. He studied one C-type asteroid, a 2-km-wide Near-Earth Object (NEO) called Amun and came to the conclusion that the monetary value of Amun's platinum group metals (PMGS) including palladium, platinum etc.is more than US $6 trillion.[14] Platinum group metals include some of the rarest and most valuable metals on earth. Further, the study said that if the value of cobalt and nickel deposits were added the total value would be an astounding $20 trillion.

Though these figures are only an approximation of the deposits at the current market value at this point in time, there is consensus among different studies that asteroid mining ventures could become a huge economy all on its own.

A. The Use of Water

As stated earlier, water may quite simply become the main target of asteroid mining because of its many uses. Despite being

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[12] *Id.* at 106.

[13] Planetary Resources, *Mining & Delivery*, http://www.planetaryresources.com/asteroids/#mining-delivery (last visited July 28, 2016).

[14] Mark Ingerbresten, *Asteroid Mining*, IEEE SPECTRUM, 34-36, (2001).

such a simple compound composed of hydrogen and oxygen, the importance of water in space travel cannot be overstated. Today, billions of dollars are spent on rocket fuel each year to send rockets into space and keep them in their orbit. As rocket propellant is hydrogen and oxygen based, the majority of the weight of a rocket is taken up by its fuel. Since a rocket has to carry huge quantities of fuel to cover millions of miles, a majority of the money in space missions is spent only on this avenue. Water is also the oil of space. In space, it is vital for hydrating astronauts, providing oxygen for life support and blocking out harmful radiation. The sourcing of water from Earth is the single largest constraint to expansion in space. If humans wish to expand their growth into space, local resources will have to be used and the start will be using water from asteroids. If water is taken from asteroids and broken down into space fuel, rockets will become lighter and missions will become cheaper. Moreover, asteroids can serve as strategically placed orbital refueling stations or depots, which will enable rockets to restock and make interplanetary journeys that, have always been out of our reach.[15]

III. FEASIBILITY OF ASTEROID MINING

First and foremost, though asteroid mining is a seemingly expensive venture-and it is an extremely costly project, it is estimated that the benefits of resources derived from asteroids should reasonably compensate and beyond anyone willing to make the investment. In fact, if the resources are mined properly, not only will asteroid mining be a rich source of supplies, it will be an immensely profitable venture. Earlier, asteroid mining was not feasible primarily because of two reasons. The first reason was that very few governments could afford a project like this and there were no private players as space ventures were run only by the State space agencies. However in today's world private companies and space experts have the ability to raise funds and finance this project either with the cooperation of State governments/countries or independently. The second factor that limited asteroid mining was the lack of cutting edge technology and know-how. Today, in the 21st

[15] J.P. Sanchez & C.R.McInnes, *Assessment on the Feasibility of Future Shepherding of Asteroid Resources*, 73 ACTA ASTRONAUTICA 49, 50-51 (2012).

century we finally have the technical knowledge and the equipment to make asteroid mining a reality. Supremely knowledgeable individuals in the field of astronautics can be brought on board to ensure the benefits of technology are maximized. Due to space telescopes, satellite imaging and unmanned probes, we finally understand asteroids and their composition better than we ever have.

Our interest in asteroid mining has everything to do with gravity. Asteroids are attractive targets because of the negligible gravity of NEO's, which means that the energy expended on sending a probe there is even smaller than the energy taken to reach the Moon.[16] When moving between bodies in space, the primary measure of how hard it is to get from point A to B is calculated not in distance but a quantity called delta-V (ΔV). All movements in space-from launching and escaping gravity to landing on another body require considerable changes in velocity or ΔV.[17]

Therefore, a trip from an asteroid would require an ΔV of just 1km/s or less because many NEO's possess negligible gravity which would translate to very little energy being expended in lifting objects (for mining) off the surface. Moreover, any reduction in velocity would translate directly to rocket fuel saved. For the sake of a comparison, a velocity of ΔV of 3 km/s would be the minimum required to make a trip back to the Earth from the Moon.

A. Process Of Asteroid Mining

If and when humans do get to asteroids, the question of actually extracting the resources they went looking for is of paramount importance. Since, till date, asteroid mining projects continue to be deliberated with various complex calculations being made, successful completion of this exercise is at the least a few years, if not decades away. However, it would be foolish and indeed extremely expensive to launch a mission without actually considering the actual process of extraction. Hence, the following are theories of mining consideration that have been propounded and have been tested to an extent.

The negligible surface gravity of asteroids is what makes them such attractive targets for future mining activities as the materials

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[16] Ingerbresten, *supra* note 14, at 34.

[17] *Id.*

mined from their surface need not be lifted back out of a deep gravity well in order to be delivered to the places where the resources are needed.

Mining operations require special equipment to handle the extraction and processing of ore in outer space.

Planetary Resources, who call themselves the Asteroid Mining Company, have taken the biggest steps yet in theorizing how this process would actually work. Three possible methods have been laid down, all with their own unique advantages and disadvantages.

1. On Site Extraction. This method envisages a robot prospector that drills out precious materials, which will be sent back to earth in capsules. The machinery will need to be anchored to the body, but once in place, the ore can be moved about more readily due to the lack of gravity.

Experts are in general agreement that processing *in situ* for the purpose of extracting high-value minerals will reduce the energy requirements for transporting the materials, although the processing facilities must first be transported to the mining site

Cons Affixing or docking to the surface of a small asteroid in order to actually dig into its regolith or drill into its bedrock, may be easier said than done. And the methods that work for one object may not work at all for another.[18]

2. Tow-Truck Extraction. As the same suggests, this method requires the asteroid to be hauled into Earth's orbit through the use of rocket power, where it will be mined. Basically, a satellite or a rocket would tow the asteroid before it is docked for processing. Docking with an asteroid can be performed using a harpoon-like process, where a projectile penetrates the surface to serve as an anchor then an attached cable is used to winch the vehicle to the surface, if the asteroid is rigid enough for a harpoon to be effective. Harpoons or penetrators may be a tractable option for objects with porous but cohesive surfaces. Electromagnet pads might just work on the iron-rich asteroids.

Cons- The energy levels required for transport will obviously be much higher than simply processing the asteroid in site, which will greatly increase total expenditure. If we pick very small asteroids, our mining facility may not even "land" on the object at all—

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[18] Daniel D. Durda, *The Solar System Beckons with Resources Unimaginable on Earth,* 18 AD ASTRA, (2006), http://www.nss.org/adastra/volume18/durda.html.

the rock could be swallowed whole by the spacecraft itself and mechanically and chemically digested for its resources

3. Bag-It Procedure. In what is effectively a retrieval mission an asteroid of up to 23 feet in diameter (where the appropriate size for each mission has been worked out by astrophysicists) is bagged or enclosed for transport to Earth's orbit.[19]

Planetary Resources have created 3 different types of satellites i.e. the Arkyd Space Telescope Series, with each satellite contributing at a different stage in the process.

Through the Arkyd Series, Planetary Resources, have launches scheduled from 2013-2020 with the hope of identifying asteroids in Near Earth Orbit fit for mining. The satellites, which will orbit Earth and picture target asteroids consist of very basic, easy to assemble equipment like solar panels to generate power, communication systems for guidance, on board screens to replay images and a camera for photography.[20]

The next big target for the Arkyd is the 2014 EK24 asteroid, which has an earth like orbit and is fairly close to earth.[21] A relatively large asteroid at about a 130m, the travel time is about 9 months. The main purpose of the mission is to determine if the asteroid has high concentrations of valuable resources. As this paper is being written, the schedule for launch is less than 6 months away.

Due to the distance of an asteroid to be mined to Earth, the round-trip time for communications will be several minutes or more, except during occasional close approaches to Earth by NEA's. As a result, any mining equipment will either need to be highly automated, or a human presence will be needed nearby. Humans would also be useful for troubleshooting problems and for maintaining the equipment. On the other hand, multi-minute communications delays have not prevented the success of robotic exploration

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[19] Karl Tate, *How Asteroid Mining could Work-Infographic,* Space.com, Jan. 22, 2013, http://www.space.com/15391-asteroid-mining-space-planetary-resources-infographic.html.

[20] *Arkyd: A Space Telescope for Everyone,* Kickstarter.com, https://www.kickstarter.com/projects/arkydforeveryone/arkyd-a-space-telescope-for-everyone-0.

[21] Planetary Resources: The Asteroid Mining Company, *Asteroids: Composition,* http://www.planetaryresources.com/asteroids/#asteroids-targets, (last visited Jul. 27, 2016).

of Mars, and automated systems would be much less expensive to build and deploy.[22]

IV. EXISTING LEGAL FRAMEWORK

Asteroids among other celestial bodies of our solar system contain a vast amount of natural resources, as mentioned earlier. The potential that exists as far as exploring and exploiting these natural resources is massive. The exploitation of these resources may generate a large amount of benefits and improve the quality of life on earth.

Therefore, there is a clear need for an appropriate legal regime organizing this exploitation in an orderly and safe way.

One of the major reasons why we need a concrete legal regime is that of all the major space law treaties signed till date, not one of them contains any specific rule dealing with the use of extraterrestrial resources, with this reason contributing to the slow progress being made in space exploration in general and asteroid mining in particular.

We now deal with the Outer Space Treaty, which is the foundation of existing space law today.

A. Outer Space Treaty

The Outer Space Treaty, formally the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies is one of the treaties that form the basis of international space law. Originating in 1967, to be signed originally by the USA, United Kingdom and the Soviet Union, today it has more than 104 parties who have signed and ratified the treaty.

Incidentally, India happens to be one of the parties to the treaty, having ratified it soon after it was signed in 1967. The Outer Space Treaty, though nearly 50 years old, is still at the forefront of all legislation and principles of international space law. Despite rapid technological innovations that constantly change the way we

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[22] Stephen Harris, *Your questions answered: Asteroid Mining*, The Engineer, April 8, 2013,
http://www.theengineer.co.uk/aerospace/in-depth/your-questions-answered-asteroid-mining/1015966.article.

see space, the Outer Space Treaty is still considered to be that fountain of legal know-how that establishes principles applicable to all activities that are to be carried out in the space environment. Even though newer treaties or laws in the international arena will revolutionize the way things work in space, the core of those treaties will rest firmly on the foundations originally laid down by this treaty.

Ever since the Outer Space Treaty and the first mission to the moon in 1969 (*Apollo 11* Moon Landing), space law has taken small but important strides[23]. While some of those strides were successful, others were not as much. An outstanding example of an international treaty that could never achieve its objective was the Moon Treaty signed in 1979.[24] Drafted to establish a legal regime for the use of the Moon, it was signed by only 16 nations till date. What condemns it is the fact that from the 16 nations that have signed it, not one is a nation that has actually achieved manned space exploration to date. (eg. UK, USA, Russia)

Other examples include the 'Liability Convention,'[25] a treaty from 1972 that expands on the liabilities nations face for objects that cause damage in outer space, and the Registration Convention[26], a treaty from 1974 that promotes disclosure of details of objects States launch into space. Compared to the Moon Treaty both these treaties have been ratified by a majority of the countries in the world that hold an interest in space. All three aforementioned treaties have been adopted by the United Nations General Assembly Resolutions in the past and now fall under the umbrella of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS).

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[23] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

[24] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, *opened for signature* Dec. 18, 1979, 1363 U.N.T.S. 21 [hereinafter Moon Agreement].

[25] Convention on International Liability for Damage Caused by Space Objects, *opened for signature* Mar. 29 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention].

[26] Convention on Registration of Objects Launched into Outer Space, *opened for signature* Nov. 12, 1974, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

COPUOS itself was established with the purpose of codifying and developing legal rules pertaining to the activities of private parties and States in outer space. [27]

The importance of the Outer Space Treaty is stressed by the fact that its principles have received wide acceptance and all space faring nations are parties to it. Indeed, from a historical point of view, it was quite remarkable that the treaty was drafted and widely accepted in a relatively short span of time, when all eyes were on the Cold War.[28] Looking back, one can safely assume the reason for this was the expected space landing by either the Soviet Union or the USA, in what was famously referred to as the 'Space Race or War'[29]. The most relevant part of the treaty was that for the first time, States were legally obliged and responsible to a set of rules. While there are many drawbacks of the Treaty, which will be discussed below, it is pertinent to note that the binding legal value of the Treaty itself has never been brought into question.

Before, we expand on the drawbacks of the Treaty; one would do well to remember that first and foremost the Outer Space Treaty was a treaty of principles, which implied that the aim of the treaty was not to solve all problems that could arise. Secondly, and a major point for criticism was that the Treaty was written in general terms and exact legal meaning of the terms was not provided for, which led to wide-ranging interpretations.

B. Relevant Parts From The Treaty Are Now Analyzed And Explained

Of all the provisions that define the legal status of outer space, and may have the largest impact on its future, Article I and II are the most important as they define the character of space. For the

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[27] United Nations Office for Outer Space Affairs, *Committee on The Peaceful Uses of Outer Space(COPUOS*), (last visited April 25, 2015), http://www.unoosa.org/oosa/en/our-work/copuos/index.html.

[28] FABIO TRONCHETTI, THE EXPLOITATION OF NATURAL RESOURCES OF THE MOON AND OTHER CELESTIAL BODIES- A PROPOSAL FOR A LEGAL REGIME 19, (Martinus Nijhoff, 2009).

[29] The BBC, *The BBC on this Day: 1961: Soviets Win the Space Race*, http://news.bbc.co.uk/onthisday/hi/dates/stories/april/12/newsid_2477000/2477715.stm, (last visited July 28, 2016).

The term 'Space War' or 'Space became a very popular as a reference to the rivalry in spaceflight capability between the US and the Soviet Union during the Cold War crisis.

purposes of this paper only Article I and II will be explained in detail, as their principles are also the source of major debate.

Article I

> 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 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 cooperation in such investigation.[30]

Article I (2) establishes the freedom of exploration and use of outer space, which is one of the most important principles. This confirms the *res communis omnium* character of space.[31] *Res communis omnium* as opposed to *res nullius* refers to things or objects which area available to all and cannot be owned by anyone, including States. The air and sea are good examples of this concept.

Likewise attention must be paid to the use of the words 'without discrimination of any kind' during exploration and 'on a basis of equality' which means that all States have equal rights to access and use outer space without discrimination based on their economic development.[32] It also means no State can be prevented from exercising this right, and any violation would be tantamount to a violation of the Treaty.

Drawbacks: Article 1(2) of the Treaty sets out three basic rights: the rights of free access, the right of free exploration and the

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[30] Outer Space Treaty, *supra* note 23.

[31] Tronchetti, *supra* note 28, at 21.

[32] *Id.* at 23.

right of free use. However it does not define these terms.[33] This is one of the faults of the Treaty. Since there is no explanation or definition provided, their meaning and implications arising from that understanding is not clear at all.

However an attempt can be made to understand these terms. The term 'exploration' does not generate much debate. It refers to activities in space for the purpose of discovery and scientific reasons. The problems arise with regards to the interpretation of the term 'use.' The 'use' of outer space and its resources may refer to use for either commercial or scientific purposes. While there is a general consensus on the fact that the latter is allowed, questions remain over the former. The major and most striking question that exists is whether the term 'use' does or does not include or encompass the term 'exploitation.'

While the three rights (free access, exploration, and of use of outer space) give States a wide ambit for activities in space, they are not unlimited. The term 'province of all mankind' means the exploration and use of space is aimed at serving the interests of all mankind acting collectively, by way of international cooperation.

While this is a noble concept, scholars argue that the 'province of mankind' concept is just a moral obligation without any legal value as the Treaty fails to lay down how exploration for all should place, nor does it prescribe a method for sharing of resources derived from space activities.[34]

Though Article I establishes fundamental principles that is recognized by all States and treated as the customary law that it is, the vagueness of the terms raises serious questions. It underlines the importance of international cooperation but does not specify the extent to which States have to cooperate. What 'space benefits' means in practical terms finds no mention at all.

The 1996 Declaration on Space Benefits was a result of negotiations to clarify the text of Article I. The UN General Assembly

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[33] *Id.* at 24.
[34] *Id.* at 24.

adopted the Declaration, a product of COPUOS, in 1996.[35] However, the very nature of a declaration makes its chances of enforcement far lesser than even the Outer Space Treaty.

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[36]

The 'non-appropriation' principle contained here is a fundamental concept of space law. Article II says that 'outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of occupation, or by any other means'.[37]

The non-appropriative nature of space was the best possible guarantee for preserving peace for the creators of the space law regime.[38] It clearly laid down that States were not allowed to extend their sovereignty rights over outer space and neither could they consequently, claim property rights over outer space and its parts. It could be argued that the non-appropriation principle is the first among equals as only with the existence of this principle in its form can other activities like exploration guaranteed by other Articles be fulfilled.

Drawbacks: One of the major drawbacks in Article II is that it does not expressly prevent private appropriation of outer space. However, this can be put down to the fact that when this Treaty was signed, States were the only players in the space arena.[39] Scholars argue that the absence of any reference to private appropriation does not mean private operators can claim property rights in outer space. On the contrary, as stated in Article VI, it is the responsibility of States to regulate activities in outer space whether carried

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[35] Declaration on International Co-operation 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, United Nations, (13 December, 1996), http://www.un.org/documents/ga/res/51/a51r122.htm (last visited July 30, 2016).

[36] Outer Space Treaty, *supra* note 23, at art. II.

[37] Tronchetti, *supra* note 28, at 26.

[38] *Id.* at 27.

[39] *Id.* at 29.

out by governmental or non-governmental agencies, which effectively means that prohibition of appropriation that extends to States applies implicitly by extension to private parties. Article VI continues, saying that all activities in outer space will require the authorization and supervision by the appropriate State Party to the treaty.

In recent years questions have arisen as to whether Article II should be amended to allow appropriation of the outer space and its resources in the current commercial space age. Many argue that the existing space law restrains the commercial development of space. They feel that the law as it stands would discourage private parties from entering space and would affect development.

Though it may be true that amendments should be considered in light of technological developments and the want for space commercialization, any changes made should be carefully considered so as to not abrogate the status of Article II as the guiding principle for present and future activities in space.

V. THE NEED FOR A LEGAL REGIME & DISPUTE SETTLEMENT MECHANISM

There are two ways to resolve any probable dispute in International law: The first being dispute resolution, which aims at settling an existing dispute between the parties concerned. The second method involves developing mechanisms that help prevent disputes in the first place.

We can predict that 'Asteroid Mining', much like the period of Gold Rush in the late 19th century will drive Governments, private companies and individuals in their private capacity or through crowd-funding to invest in this enterprise in a frenzy never seen before. If this was allowed to be done in an uncontrolled manner, it would lead to several issues. Further, assurances would be needed to be given to investors like private companies who will potentially be spending billions of dollars on this venture. Concerns would remain- Whether the Government will allow marketing of mined products at their prices? Would taxation norms and policies be a setback? The possibility of a dispute arising between two private companies over exclusivity of mining rights over an asteroid would also need to be examined.

State Governments would have their own difficulties; with powerful nations setting aside budgets for their state-run space programmes, while developing nations will not be able to do so. Nonetheless, just like nuclear power, even developing and certain underdeveloped nations would like to invest in mining of asteroids but its viability would always be questioned as the government may not be able cut down on its welfare or defense budget. Furthermore, even after investments it may not be able to recover its initial capital. Besides a private company's aim would be profit maximization, but should the government have the same aim? Should they mine and market for welfare of the people or for profit maximization? Questions like these would have to be answered first.

Many mining enthusiasts are of the opinion that asteroid mining should be carried out solely for procuring platinum. This is in fact a myth that we wish to debunk. Though platinum is a useful commodity, there are far greater treasures on asteroids waiting to be employed, as we have enumerated earlier. Platinum is one of the rarest metals on earth and it is true that platinum we have mined till date does not exceed the size of a room. To lend some perspective to this, a single asteroid when mined could yield more platinum than we have ever mined on Earth. Despite its patent benefits it could prove to be a major problem. A look back at history right from the tulip mania to the housing bubble in the United States shows us that anything in excess will lead to a fall in prices followed by lack of demand for the product. In the case of platinum, we have evolved in a way where we do not require platinum beyond a certain point as we have managed to use substitutes. If excess platinum is mined, it may lead to a fall in demand and prices subsequently, and asteroid mining ventures may not be able to able to recover the billions they have invested which may in turn further harm other explorations. The price of platinum is approximately $1140 USD per ounce and it is primarily used in chemical reactors and in vehicles as a catalytic converter, facilitating the complete combustion of unburned hydrocarbon passing through the exhaust.[40] Scientists have started using metals like Rhenium, tungsten and molybdenum as substitutes. This shows that despite being rare it is not an essential

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[40] NASDAQ Markets, *Latest Price & Chart for Platinum,* http://www.nasdaq.com/markets/platinum.aspx, (last visited July 27, 2016).

metal for human beings, and any mining exploration will have to take a considered view of the same.

There are three steps to asteroid mining. The first step involves research, development and exploration, it means determining if mining a certain asteroid is viable. The second step is the actual mining phase and the third step involves commercialization of the mined products. For the planned and organized development of extraterritorial natural resources it is important to determine how these three phases will be structured and what principles and rules are to be applied to them. This will make space enterprises aware about the legal framework from the beginning and will act according to the formulated rules and regulations.

Some critics are of the opinion that the money and resources that will be spent on asteroid mining can better be utilized for welfare of people at large and development on earth. This argument maybe true because the amount of investment may exceed every breakthrough technology we have ever invested in but such arguments will need to be compared to the possible benefits (which have been enumerated earlier in the paper) that will arise out of mining these asteroids.

The law of space is not consummated but some important points are established- Principles enumerating that no one can own any property on space, while space exploration (including taking samples) is permissible. This is as far as it goes, as there is complete silence over commercialization of asteroids and other planetary bodies. Before any system or rules of law are affected they must contain a balance between overregulation and inadequate regulation. Too much bureaucracy and ruling would discourage potential enterprises from undertaking exploitation activities. Too vague or limited regulation may fail to ensure proper legal environment for development of industrial use of lunar and other celestial bodies resources.[41] To deal with these shortcomings in the law, we propose the formation of an 'International Space Body' that regulates asteroid mining exclusively.

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[41] Tronchetti, *supra* note 28, at 240.

A. International Space Body

One possible proposition is the formation of an 'International Space Body' (ISB), which should be a separate, independent legal entity which functions as a part of the United Nations and is accorded the status of a specialized agency. under the garb of the United Nations. Just like the General Assembly, all the nations must be its members. These members must in turn elect a panel of experts and must lay down the powers and functions of the panel. The panel must then formulate rules and regulations applicable to whole range of activities that exploitation of celestial bodies would consist of. The panel will decide which asteroid must be mined out of several viable options, with their decision based on several factors such as the risk involved, demand in the market, possible adverse effects on the market or individual consumers etc. The ISB must also formulate a way of issuing licenses for mining of asteroids. It must also consider any liability arising for any damage caused to a third party or the space environment as a result of any activity related to asteroid mining. The panel must also create a dispute settlement mechanism. Their aim must be the benefit of people at large. Only once the panel adopts the above-mentioned rules should it start the process of allocating asteroids.

Private companies and Government bodies should be encouraged to apply via tenders based on their plan, financial strength and resources and a license may then be granted to the most capable enterprise or government agency. The ISB must also establish conditions and terms according to which exploitation must be carried out, the duration, the location, the right of licensee, third parties rights, etc. The rights of the licensee to obtain property rights over the extracted minerals must be laid down.[42] The ISB must also have the power to revoke the license and impose fines in cases of non-compliance of the terms and conditions by the licensee. In return the licensee must have undisturbed access of the select asteroid mentioned in the license for the purpose and time period specified.

The body must be given the power to have a final say on the execution of the mining process. The ISB must determine the prices

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[42] *Id.* at 245.

of mined products in a way that enables companies to make profits, but not supernatural profits.

Funding of an asteroid mining project could be done in two major ways-either the official, elected government of member States or private companies could finance it. Two or more private companies/ governments may collaborate to make a bid. The most popular way to raise money seems to be crowd funding. The only asteroid mining companies today-Planetary Resources and Deep Space Industries, which are still in a nascent stage, have not yet revealed their funding plans. Space Tourism could emerge as a possible source of revenue for asteroid mining. Companies like Virgin Galactic where over 700 tickets valued at over $250,000 have been sold for space tourism can definitely enter the asteroid mining race[43]. In addition, in this decade alone, a private citizen has paid $20 million dollars to travel to space, while eight other citizens have also undertaken the same journey, with many more to certainly follow.[44].[45] Space Adventures suggests that this number could increase fifteen-fold by 2020[46]. Even companies like Blue Origin, Boeing, Space X and Sierra Nevada Corporation are in the fray to start their own space tourism expeditions. The Russian Space agency also has plans to take space tourists to the International Space Station from 2018[47]. This only goes to show that Space Tourism is a goldmine waiting to be utilized.

Appointment of Experts: The following factors must be considered while appointing experts to the panel:[48]

- Panels shall be composed of well-qualified governmental and/or non-governmental individuals, including persons

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[43] Virgin Galactic.com, *Why We Go: Exploring Space Makes Life Better on Earth,* http://www.virgingalactic.com/why-we-go/, (last visited July 27, 2016).

[44] Pete Spotts, *A Space Tourism Trip to the Moon? It Could Happen by 2015,* The Christian Science Monitor, May 6, 2011, http://www.csmonitor.com/USA/2011/0506/A-space-tourism-trip-to-the-moon-It-could-happen-by-2015.

[45] The BBC, *Profile: Tito the Spaceman,* http://news.bbc.co.uk/2/hi/science/nature/1297924.stm, (last visited July 16, 2016).

[46] Spotts, *supra* note 44.

[47] TASS-Russian News Agency, *Russian Space Agency to Resume Regular Tourist Flights to ISS as of 2018*, http://tass.ru/en/russia/784497, (last visited July 27, 2016).

[48] World Trade Organization, *Understanding on Rules and Procedures Governing the Settlement of Disputes- Uruguay Round Agreement-Article 8*, https://www.wto.org/english/docs_e/legal_e/28-dsu_e.htm, (last visited July 27, 2016).

who have served on or presented a case to a panel, served as a representative of a Member or of a contracting party to the International Space Body. Member countries may make their recommendations for the constitution of the panel.

- Panel members should be selected with a view to ensuring the independence of the members, a sufficiently diverse background and a wide spectrum of experience.
- Citizens or representatives of those countries, whose asteroid mining rights and interests are to be decided by the panel, will not serve as members for that particular decision to ensure independence and fairness.
- Panelists shall serve in their individual capacities and not as government representatives, nor as representatives of any organization. Members shall therefore not give them instructions nor seek to influence them as individuals with regard to matters before a panel.
- Panelists must have representation from different professional backgrounds. For example, Economists, Space Scientists, Lawyers, NGO's, etc.

B. Dispute Settlement

1. Appeal To The International Court of Justice (ICJ)

As stated above, the decision of the panel of experts with regard to any proposed asteroid mining expedition is to be final and binding on all parties concerned. However, in the interests of justice and fair play, contingencies have to be made which would allow an appeal to a duly authorized international adjudicatory body like the International Court of Justice. Taking inspiration from the Arbitration & Conciliation Act, 1996[49] an appeal can be preferred by any of the parties on the following grounds:

i If the party furnishes proof that any expert on the panel has acted under some incapacity, or in a biased or prejudiced manner;

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[49] Indian Arbitration & Conciliation Act Ch.VII §34 (1996).

ii If the decision of the panel is not valid or in in conflict with international law, or the law to which the parties are subject;

iii The decision of the panel is based on grounds which were not part of the original proposal made to it, or if it contains decisions on matters which prima facie fall outside its authority;

iv The composition of the panel or appointment of experts was not in accordance with the procedure laid down and agreed to by all member countries;

v Any other ground on which the ICJ is of the opinion that an appeal should be allowed based on the facts and circumstances of the case, in light of the principles of justice, equity and good conscience.

2. The Concept Of A Multi-Door Courthouse

Though parties would be advised and would rightly so stick to a proven dispute resolution mechanism like the ICJ, it is worth mentioning the novel idea of the Multi-Door Courthouse that may be the future of dispute resolution in all forms, and not only for asteroid mining.

A multi-door courthouse is a means of directing cases filed in court to various "dispute resolution doors" or options.[50] Parties are referred to different dispute resolution options in an effort to select that option which best suit the needs of their particular dispute. The dispute resolution options include mediation, arbitration, conciliation, case evaluation and finally adjudication. In the multi-door courthouse system, trained intake workers inform the parties of the various alternative dispute resolution programs available and direct the parties towards the most appropriate process or series of processes based on factors such as the relationship of the parties, the nature of the dispute, the amount at stake, and the type of relief sought. The goal of the multi-door courthouse is to streamline the court process and afford parties various options to resolve their dis-

[50] GERARDINE MEISHAN GOH, DISPUTE SETTLEMENT IN INTERNATIONAL SPACE LAW: A MULTI-DOOR COURTHOUSE FOR OUTER SPACE, Studies in Space Law, 270, 297 (Martinus Nijhoff Publishers, 2007).

putes beyond the standard option of litigation. Multi-door courthouse programs have been in place in several states for many years and have proven an effective means of channeling cases to alternate options for dispute resolution to meet the specific needs of a case.

With respect to asteroid mining, this process can be used, where instead of referring a dispute to the ICJ directly, alternatively a dispute can be sent to a multi-door courthouse which would have to be set up under the International Space Body with the agreement of all members. The courthouse would then decide which process would best suit the issue at hand.

3. Asteroid Mining Legislation: The United States Commercial Space Law Competitiveness Act (2015)

While establishing a legal framework fit to deal with asteroid mining activities is of paramount importance, and is what has been proposed in this paper, it is pertinent to take on record that the United States through the U.S. Commercial Space Law Competitiveness Act[51] which was signed by President Obama in 2015, has become one of the first nations to take a step in this direction by enacting a law that encourages the commercial exploitation of asteroid resources, and also recognizes the right of a U.S. citizen to own the resources so obtained[52]. It also rakes a significant step forward by actually defining the terms 'asteroid resource' and 'space resource' The progressive legislation becomes a hugely important step towards advancing space exploration and by doing so the U.S has become the first nation to enact a law that deals exclusively with Asteroid Mining.

VI. CONCLUSION

The law can only be effective when it learns from the past, works on the present, and keeps one eye on the future. To ensure the scales of justice are always balanced, the law must always be

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[51] U.S. Space Launch Commercial Competitiveness Act, Pub. L. 114-90, § 51302, 129 Stat. 704 (2015).
https://www.congress.gov/bill/114th-congress/house-bill/2262.

[52] Planetary Resources-The Asteroid Mining Company, *President Obama Signs Bill Recognizing Asteroid Resource Property Rights in Law*
http://www.planetaryresources.com/2015/11/president-obama-signs-bill-recognizing-asteroid-resource-property-rights-into-law/, (last visited July, 16, 2016).

rigid enough to enable enforcement, but flexible enough too to meet the needs of changing times. Truth be told, times today are changing faster than they were ever before. Asteroid mining, as we have explained, is not only set to become a reality very soon, but will change the global economy and guarantee large steps in scientific progress unlike anything ever seen before. Even if all we provided is glance on how mining will take place in the future, the possible legal implications and the need for an international regulatory body, we hope to have taken a step in the right direction. If an idea can be judged by its potential for change, the world as a whole is sitting on one major breakthrough. As the late Neil Armstrong said when we took our first small steps into the moon in 1969-"That's one small step for man, one giant leap for mankind", he too would be proud to see how far we have come if we mine that asteroid.