Volume 6 | Issue 1 Article 15

October 2016

Regulating The Final Frontier: Asteroid Mining and The Need For A New Regulatory Regime

Priyank D. Doshi
priyank.d.doshi.7@alumni.nd.edu

Regulating The Final Frontier: Asteroid Mining and The Need For A New Regulatory Regime

Priyank D. Doshi†

A Introduction

The wide breadth of human history has been written by explorers, adventurers, and dreamers, driven by a vision to push the boundaries of our collective beliefs and expand our presuppositions about corporeal limits. From Christopher Columbus to Neil Armstrong, the story of mankind is reflected through a desperate need to know the unknown. Consequently, the next step in human history will undoubtedly be written in the last frontier left unexplored, the final frontier: space.[1]

† J.D., Notre Dame Law School; B.A., University of Illinois at Urbana-Champaign.

I would like to thank my Note advisor, Professor Bruce Huber, for his general erudition as well as his encouragement and enthusiasm about me pursuing a potentially obscure legal topic. I would like to thank Rebecca Arnall for her assistance with editing and organization. Also, I want to thank my amazing classmates at Notre Dame who through prodding, and often joking, created an environment of constructive discussion that led to a strengthened Note. Finally, many thanks to the staff of The Notre Dame Journal of International and Comparative Law for their invaluable editing and reviewing assistance.

[1] *Star Trek* (NBC television broadcast Sept. 8, 1966–June 3, 1969). The reference is to the captain's oath narrated by William Shatner at the beginning of every episode of the science fiction television series except *Star Trek: The Cage* (NBC television broadcast Oct. 27, 1988) and *Star Trek: Where No Man Has Gone Before* (NBC television broadcast Sept. 22, 1966).

This Note's introduction highlights the past to predict the future, arguing that while there are great lessons to be learned from the past, future governments need to break with past behavior and blaze a new path that reflects the significance of exploring something as expansive and as prodigious as space. Hidden beneath the mythical retellings of Marco Polo and Christopher Columbus are the historical contexts of the eras which informed them—stories of political chaos, wild land grabs, catastrophic wars, and political feuds that changed the global landscape.[2] Therein lies a lesson—installing regulation after wealth has been found to be problematic, if not nearly impossible; instead, action must be taken preemptively. That being said, aggressive legislation should not dominate at the expense of reason. As in the early exploration periods—where we discovered land routes to eastern empires and sea routes to new continents—the system should incentivize mankind to keep pushing forward.[3] However, the Neil Armstrong age of exploration through modernity has been marked by agreements like the Outer Space Treaty[4] and the Moon Treaty that leave little incentive for private parties to explore further.[5] To ignite the Space Age, a happy medium must be found between the two lessons of the past: regulation and incentivization. A regulatory structure must be put in place not only to prevent the massive socio-political and economic changes of the past, but also to support a regime that allows, aids, and actually encourages a push towards exploration. The first step in that process starts with how we deal with asteroids and the very real future of mining the final frontier. The answer, at least the one purported by this author, is the creation of a new international regulatory regime.

In talking to the average person, the term "asteroid mining" seems to be most commonly associated with a team of brave deep-sea oil drillers that save Earth from a rogue asteroid.[6] To a few others it seems to invoke memories of a space battle in a galaxy far, far away.[7] Either way, it is dismissed as something out of a science fiction fantasy. As expected, few people hear the term "asteroid mining" and think of water, minerals, or precious metals. Few look at asteroids as landing docks, fueling stations, or resource centers, but this is what the future holds.[8] Scientists have analyzed asteroid fragments and done extensive research that shows that the contents of asteroids are more than just

---

[2] For instance, the Mongol Invasion of China redefined borders in Asia; European gold markets experiencing extreme inflation after the discovery of America saw Spain gain significant power from its gold discoveries, which influenced Papal role change, among other things.

[3] The motivating factor behind Dias, Gama, Columbus, Balboa, Magellan, and others risking their lives and reputation to explore the unknown was the urge to gain wealth and fame. That is the same motivation that we need to reawaken to successfully explore space.

[4] 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].

[5] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Treaty].

[6] ARMAGEDDON (Touchstone Pictures 1998).

[7] STAR WARS (Lucasfilm Ltd. 1977).

[8] *Plans for Asteroid Mining Emerge*, BBC (Apr. 24, 2012), `http://www.bbc.com/news/science-environment-17827347`.

useless rock.[9] For example, researchers have discovered a single asteroid that contains more platinum than has ever been mined in the history of the Earth.[10] Asteroids offer an unimaginable amount of wealth, and with this wealth comes the potential for catastrophic international implications. Private companies, like Planetary Resources, have already started to invest in plans to mine an asteroid.[11] Some governments are not far behind; the US has been slowly allocating money for an asteroid capture project.[12] History has shown that massive capital opportunity mixed with no overarching regulation is a recipe for disaster. The silver lining is that along with the potential for havoc there comes the potential for real advancement. Now, at the dawn of this industry's development, there is a golden opportunity to use the intrinsic incentive for personal gain (that is, mining asteroids for money) to create an international organization that lays the groundwork and cradles the economic goals of a regime that is up to the challenge of regulating the peaceful exploration of space.

This Note argues that given the scientific and economic potential of asteroid mining, the world needs to create a new international regulatory regime with three missions: (i) to regulate space exploration in a way that incentivizes the development of technology; (ii) to serve as a forum to manage and limit international disputes over space, and (iii) to regulate the economic and political impact of space activities on Earth. Part I focuses on the steps that have already been taken that make asteroid mining a near and present reality. Part II explains the benefits of asteroid mining. Part III explores the problems and issues surrounding asteroid mining, including the potential political and economic implications. Part IV touches on the current legal frameworks in place that tangentially relate to this issue. Finally, Part V briefly discusses some other proposed solutions for asteroid mining regulations and presents the author's proposal for what a new international regulatory agency could look like.

B Asteroid Mining is an Immediate Reality

Over the last decade private companies have eagerly taken the lead on investing in technology to fund space exploration and expand on its otherwise current capabilities. The "Space Race" of the twenty-first century promises to be between corporations rather than among nations, and the race is already well underway.

---

[9] *How We Know So Much About Asteroids?*, Planetary Resources (Apr. 9, 2014), http://www.planetaryresources.com/2014/04/know-asteroids/.

[10] *How We Choose Our Near-Earth Asteroid Targets*, Planetary Resources (Aug. 28, 2015), http://www.planetaryresources.com/asteriods/#asteroids-overview-composition (last visited Mar. 30, 2016); *Asteroids: Targets of Interest*, Planetary Resources, http://www.planetaryresources.com/asteroids/#asteroids-intro.

[11] *Id.*

[12] Mike Wall, *NASA to Get $100 Million for Asteroid-Capture Mission, Senator Says*, Space (Apr. 5, 2013, 5:16 PM), http://www.space.com/20538-nasa-asteroid-capture-funding.html; *cf.* President Barack Obama, Address on the State of the Union (Jan. 20, 2015).

B.1 SPACE FLIGHT

In 2004, Scaled Composites, a corporation now owned by Virgin Galactic, won a ten million dollar prize for being able to achieve space flights multiple times in a week using the same spacecraft.[13] Virgin Galactic has carried on that work to achieve sustainable spaceflight, and the company is now testing a second model of spacecraft.[14] Even after their most recent spacecraft failed, Virgin Galactic rebuilt and continued to commit to fund space exploration.[15] They are not alone in their ambitious quest. A Russian company named Orbital Technologies planned to have an orbiting hotel by 2016, and while they have been recently acquired by Sierra Nevada Corporation, an altered version of their plan is still in development with an extended timeline.[16] While it may seem that these pursuits are fool's errands, the government certainly does not seem to think so. Orbital Technologies has a deal in place to start developing the equivalent of space taxis for private and governmental use.[17] In addition to Orbital Technologies, NASA has thrown its support behind a few other companies, namely: Elon Musk's SpaceX. SpaceX came to the forefront of the space race after they docked a commercial spacecraft on the International Space Station in 2012.[18] This cargo delivery mission was the first of at least twelve resupply missions it will fulfill under NASA's $1.6 billion Commercial Resupply Services contract.[19] But Musk's dreams do not stop at government contracts. His ultimate goal is the colonization of Mars. SpaceX is currently testing the Falcon Heavy, the world's most powerful rocket, with a goal of "developing reusable rockets, a feat that will transform space exploration by delivering highly reliable vehicles at radically reduced costs."[20] NASA's investments reveal the agency's faith in the private sector's abilities to further space discovery. Lately, NASA contracted with Boeing and Lockheed Martin to launch its new satellites and to help in sending astronauts into space beyond the moon.[21] Additionally, NASA has given three companies, Boeing,

[13] Alan Boyle, *SpaceShipOne Wins $10 Million X Prize*, MSNBC (Oct. 5, 2004, 2:58 AM), http://www.msnbc.msn.com/id/6167761/.

[14] *Virgin Galactic Gears Up for Building Third SpaceShipTwo*, NBC NEWS (Feb. 7, 2015, 5:25 PM), http://www.nbcnews.com/storyline/virgin-voyage/virgin-galactic-gears-building-third-spaceshiptwo-n302191 (last visited Mar. 30, 2016).

[15] *Id.*

[16] Alexander Marquardt, *Out of This World: Russians Plan to Put Hotel in Orbit*, ABC NEWS (Sept. 30, 2010), http://abcnews.go.com/Technology/russians-launch-plan-space-hotel-orbit/story?id=11763787&page=1.

[17] James Pura, *US's Commercial Spaceflight Bargain*, SPACE FRONTIER FOUNDATION (Aug. 6, 2012), http://spacefrontier.org/2012/08/uss-commercial-spaceflight-bargain/.

[18] Kenneth Chang, *First Private Craft Docks with Space Station*, NY TIMES (May 26, 2012), http://www.nytimes.com/2012/05/26/science/space/space-x-capsule-docks-at-space-station.html.

[19] Claudia Pastorius, *Law And Policy In The Global Space Industry's Lift-Off*, 19 BARRY L. REV. 201, 211 (2013); Press Release 12-355, Trent J. Perrotto & Josh Byerly, *National Aeronautics and Space Administration, First Contracted SpaceX Resupply Mission Launches with NASA Cargo to Space Station*, NASA (Oct. 7, 2012), http://www.nasa.gov/home/hqnews/2012/oct/HQ_12-355_SpaceX_CRS-1_Launch.html.

[20] *About*, SPACEX, http://www.spacex.com/about (last visited Mar. 30, 2016).

[21] Press Release 12-429, Trent J. Perrotto & Candrea Thomas, *NASA Awards Contracts In Next Step Toward Safely Launching American Astronauts from U.S. Soil*, NASA (Dec. 10, 2012) [here-

SpaceX, and Sierra Nevada, contracts worth about $10 million each for the programs described above.[22] NASA's partnership with private enterprise is undisputedly the new model for space exploration.[23]

B.2 Space Mining

The examples above, while not directly related to asteroid mining, show the willingness of both the government and private donors to invest in making space flight and exploration a reality. By extension, widespread efforts to begin asteroid mining are necessarily on the horizon. While some still see asteroid mining as a crazy billionaire fantasy, the significant investment and actual research advancements seem to indicate otherwise.[24] The front-runner in the asteroid mining business is Planetary Resources. Founded by geniuses in their own right, it is now financially supported by the likes of Google's cofounder Larry Page and former CEO Eric Schmidt; American businessman Ross Perot; British magnate Sir Richard Branson; and Canadian filmmaker James Cameron.[25] Regarding the Planetary Resources team, famed astrophysicist Michio Kaku said:

> If you put two Google billionaires with Microsoft billionaires with some astronauts together, you can't go wrong. I think private enterprise will boldly go where governments fear to tread.…[W]e need private enterprise, especially people with deep pockets to help jump start the program and maybe mining the heavens is just the ticket.[26]

Planetary Resources' goal has been to target specific asteroids that would be the right candidates for profitable mining.[27] As they have identified a few potential possibilities, Planetary Resources has made "an agreement with Virgin Galactic, LLC that will enable multiple launch opportunities for its series of spacecraft."[28] Their ultimate vision remains to use the water and minerals in

---

inafter NASA Contracts], http://www.nasa.gov/home/hqnews/2012/dec/HQ_12-429_CCP_CPC_Contract.html.

[22] Pastorius, *supra* note 19, at 211.

[23] Stewart Money, *Why SpaceX is Setting the Pace in the Commercial Space Race*, NBC News (July 30, 2012), http://www.nbcnews.com/id/48390277/ns/technology_and_science-space/t/why-spacex-setting-pace-commercial-space-race/#.UUFHDltVQz0.

[24] Duff McDonald, *The World Needs More Crazy Billionaires*, CNN Money (Dec. 15, 2011), http://finance.fortune.cnn.com/2011/12/15/paul-allen-billionaires/; *accord The Daily Show with Jon Stewart: Space Innovators* (Comedy Central television broadcast Apr. 25, 2012).

[25] *Team*, Planetary Resources, http://www.planetaryresources.com/team/ (last visited Mar. 30, 2016).

[26] Pastorius, *supra* note 19, at 215 (citing *James Cameron, Google Executives, Billionaires to Mine for Asteroids?*, Michio Kaku (Apr. 28, 2012), http://mkaku.org/home/?p=1328.

[27] *Why Asteroids Now?*, Planetary Resources, http://www.planetaryresources.com/asteroids/why-asteroids-now/.

[28] Lauren E. Shaw, *Asteroids, The New Western Frontier: Applying Principles Of The General Mining Law Of 1872 To Incentivize Asteroid Mining*, 78 J. Air L. & Com. 121, 129 (2013) (citing *Planetary Resources, Inc. Announces Agreement with Virgin Galactic for Payload Services*, Planetary Resources (July 11, 2012), http://www.planetaryresources.com/2012/07/planetary-resources-inc-announces-contract-with-virgin-galactic-for-payload-services/.

the asteroids to fuel the in-space economy and mine rare metals to meet Earth's resource needs.[29]

But Planetary Resources is just one of many companies looking to mine the final frontier. Another company, Deep Space Industries (DSI), announced less than a year after Planetary Resources had that they too were in the asteroid mining game. Their vision is to offer space-based refueling, power, asteroid processing, and manufacturing in space by the early 2020s.[30] DSI has an aggressive timeline. Their first spacecraft proposed—the 25 kg (55 lb) FireFly—is designed to search for suitable asteroids to mine. Constructed using inexpensive CubeSat components, FireFly is projected to fly in 2015, sharing rockets with much larger communication satellites in order to reduce costs.[31] DSI's second planned satellite, the DragonFly, is predicted by the company to launch starting in 2016, and it will have the capability to bring up to 150 kilograms (330 lb) of asteroid material to the surface of Earth.[32] A third satellite, proposed in 2014, would operate like a mother ship to connect all the smaller satellites around space for deep space communication.[33] By 2023, DSI wants to be actively mining asteroids for metals to bring back to Earth and for water to use as propellant depots for long journey space travel.[34] These goals, while very ambitious, reflect a path to the very near future led by private investment.

Even those who criticize Planetary Resources and DSI as being too optimistic still accept lunar mining as a very real possibility. Moon Express (MoonEx) is a privately held early stage company formed by a group of Silicon Valley and space entrepreneurs. Their goal is to win the Google Lunar X Prize and ultimately to mine the Moon for resources of economic value. In December 2013, MoonEx unveiled the MX-1 lunar lander, a toroidal robotic lander that uses high-test hydrogen peroxide as its rocket propellant to facilitate vertical landing on the Lunar surface.[35] On April 30, 2014, NASA announced that MoonEx was one of the three companies selected for the Lunar CATALYST initiative.[36]

---

[29] *Company Overview*, PLANETARY RESOURCES, http://www.planetaryresources.com/company/overview/#our-vision.

[30] *See* Alex Letourneau, *Asteroid Mining Becoming More of A Reality*, KITCO NEWS (Jan. 25, 2013), http://www.forbes.com/sites/kitconews/2013/01/25/asteroid-mining-becoming-more-of-a-reality/.

[31] *See* Paul Rincon, *New Venture To Mine Asteroids*, BBC (Jan. 22, 2013), http://www.bbc.com/news/science-environment-21144769; *see also Commercial Asteroid Hunters Announce Plans For New Robotic Exploration*, REUTERS (Jan. 22, 2013), http://www.reuters.com/article/idUSnGNXUWZQDa+1fe+GNW20130122.

[32] *Id.*

[33] Marcus Woo, *Designing A Mothership To Deliver Swarms Of Spacecraft To Asteroids*, WIRED (Dec. 17, 2014), http://www.wired.com/2014/12/cubesat-mothership-space-asteroid-exploration/.

[34] Mike Wall, *Asteroid-Mining Project Aims for Deep-Space Colonies*, SPACE (Jan. 22, 2013), http://www.space.com/19368-asteroid-mining-deep-space-industries.html.

[35] Doug Messier, *Moon Express Unveils 'MX-1' Commercial Lunar Lander*, PARABOLIC ARC (Dec. 5, 2013 5:01 PM), http://www.parabolicarc.com/2013/12/05/moon-express-unveils-mx1-commercial-lunar-lander/.

[36] *See* Press Release 14-126, Rachel Kraft, *NASA Selects Partners for U.S. Commercial Lander Capabilities*, NASA (Apr. 30, 2014), http://www.nasa.gov/press/2014/april/nasa-selects-partners-for-us-commercial-lander-capabilities/#.VvCXuRIrKb8.

Since November 3, 2014, MoonEx has been preparing to spend two months test-flying its prototype lander at the Project Morpheus Lander test area at NASA's Kennedy Space Center; the spacecraft is designed to be launched as a secondary payload and to fly to the Moon from GEO.[37]

Another company, Shackleton Energy Company, wants to be the first to successfully mine the Moon for ice that will provide the propellant for planetary missions. They recently began fundraising and have already put together a team of explorers, engineers, robotic mining experts, aerospace managers, economists, and space policy lawyers.[38] Their sister company had a $4 million, four-year NASA contract to develop an ice-drilling robotic probe that would be used to obtain samples from Jupiter's moon, Europa.[39]

The technology needed for further space exploration and space mining is growing rapidly. As discussed above, SpaceX, Virgin Galactic, and MoonEx are only some of the companies working hard to bring down the cost of space flight. Additionally, the success of private cargo-carrying ships and the significant investments made by NASA reflect a commitment to growth through the private industry. The reality is that "developments in reusable spacecraft, in tools used for gathering data on the material compositions of space bodies, and in alternative means of obtaining fuels [...] are all presently multiplying, thereby driving down the costs of exploring and commercializing space."[40] Planetary Resources and DSI have agreements in place to carry their technology to asteroids and they have the ability to achieve this feat. In addition to the existing technology, DSI is tossing around the idea of using "metal-munching microbes" that would mine asteroids on their own.[41]

> The Mothership would be carrying a number of tiny CubeSats, one of which would deploy and spiral down to the asteroid's surface. The CubeSat would then inject into the asteroid a low-temperature fluid laden with bacteria, which would propagate through cracks and fissures generated by the injection process. Over time, the microbes—genetically engineered to process metals efficiently—would break down harmful compounds within the asteroid and/or transform resources into different chemical states that are more amenable to extraction.[42]

The investment and the technology are in place, NASA is on board, and there are asteroids close enough to reach.[43] If these are not signs of an immediate reality, it is hard to say what would be.

---

[37] James Dean, *Start-up at KSC eyes Google Lunar XPRIZE*, Florida Today (Nov. 3, 2014, 7:25 AM), `http://www.floridatoday.com/story/tech/science/space/2014/11/02/start-test-lunar-lander-ksc/18395875/`.

[38] Shaw, *supra* note 28, at 169.

[39] *Id.*

[40] *Id. at 130.*

[41] See Mike Wall, *Asteroid Miners May Get Help from Metal-Munching Microbes*, Space (Jan. 29, 2015), `http://www.space.com/28320-asteroid-mining-bacteria-microbes.html`.

[42] *Id.*

[43] *See* Andrew Tingkang, Comment, *These Aren't the Asteroids You Are Looking For: Classifying Asteroids in Space as Chattels, Not Land*, 35 Seattle U. L. Rev. 559, 567 (2012) ("Many

B.3 GOVERNMENT PLANS

For those who require additional proof of the future of asteroid mining, they need look no further than the major nations in the world. Governments worldwide seem to be shifting their focus to asteroids. The United States is currently funding a project that focuses on asteroid capture. Asteroid capture occurs when an asteroid has enough velocity to keep missing the planet itself when it is falling towards it, but it does not have enough velocity to escape that planet's orbit.[44] Essentially, this keeps the asteroid in a slow orbit around a given body. NASA is currently working on an Asteroid Redirect Mission that would retrieve a near-Earth asteroid (NEA) and put it in an orbit around the moon.[45] The timeline (as of 2013) would allow for a capture by 2019 and have an asteroid in lunar orbit by 2021.[46] This topic is central enough for President Obama to mention asteroids in multiple speeches on the State of the Union, most recently in 2015.[47]

Other governments are also interested. In 2013, China outlined a long-term plan for lunar exploration that involved a large mining operation on the Moon. Additionally, the China Aerospace Corporation (run by the Chinese state) plans to build its own space station with sustainable living technologies by the year 2020.[48] These plans come as no coincidence given that space stations will be a central component to extraterrestrial mining on the Moon and NEAs.[49] Russia is also interested and has raised their space budget, which averaged around $3 billion annually from 2010–2011. It is expected to reach $67 billion by 2020.[50]

An aggregation of the technological advances and plans described above should spur curiosity about the potential for mining the final frontier and ques-

---

asteroids, including 1986 DA, could be mined. Of over 8000 NEAs, at least 1258 pass close enough to Earth to be categorized as Potentially Hazardous Asteroids (PHAs), which are asteroids greater than 150 meters in diameter that pass close enough to Earth. In addition, there are over 2000 NEAs that are less than 100 meters in diameter, which means that there are likely hundreds, if not thousands, of non-PHAs that skim Earth's orbit. Just within the past year, over 900 new NEAs were either discovered or classified as NEAs, and the rate of discovery has increased over the past decade. The most attractive feature of NEAs, and PHAs especially, is that their orbits bring them close to Earth, making rendezvous missions easier than missions elsewhere in the solar system. Some of these asteroids are so close that they are easier to reach than the Moon.")

[44] Sean O'Hare, *Revealed: NASA plan to 'lasso' asteroid the size of two buses and turn it into a 'space station' to orbit the moon*, DAILY MAIL (Dec. 23, 2012).

[45] *Mission Pages: Asteroid Redirect Mission*, NASA, http://www.nasa.gov/mission_pages/asteroids/initiative/index.html.

[46] William Harwood, *NASA's proposed asteroid retrieval mission outlined*, SPACEFLIGHT NOW (Apr. 6, 2013), http://www.spaceflightnow.com/news/n1304/06asteroid/#.VNg-IFXF9eQ.

[47] *See e.g.*, President Barack Obama, Address on the State of the Union (Jan. 27, 2010); *see also* President Barack Obama, Address on the State of the Union (Jan. 20, 2015).

[48] Claudia Pastorius, *Law and Policy in the Global Space Industry's Lift-Off*, 19 BARRY L. REV. 201, 205 (2013).

[49] Chaitanya Giri, *Mining in Space—The Next Frontier?*, THE DIPLOMAT (Jul. 16, 2013), http://thediplomat.com/2013/07/mining-in-space-the-next-frontier/.

[50] Samantha Stainburn, *Russia to Increase Space Program Budget to Nearly $70B For 2013–2020*, GLOBAL POST (Dec. 30, 2012), http://www.globalpost.com/dispatch/news/regions/europe/russia/121230/russia-increase-space-program-budget-nearly-70b-2013-2020; *see also* Lee Rannals, *Russian Space Agency Spending $68 Billion In Next 7 Years*, RED ORBIT (Dec. 28, 2012), http://www.redorbit.com/news/space/1112754896/russian-space-agency-roscosmos-budget-increase-122812/.

tion how far away it really is.

C Benefits of Asteroid Mining

While Part I sought to show that asteroid mining is possible and will soon be a reality, it also raised the question of why asteroid mining might be something the international stage needs to pursue collectively and aggressively. The simple answer is two-fold: the need for the resources and future space exploration.

C.1 The Need For Resources

Scientists posit that the key natural resources we will need to fuel and develop the modern economy will run out within the next fifty to sixty years.[51] Key resources like platinum, zinc, copper, phosphorus, lead, gold, and indium, could become depleted on Earth very soon.[52] As the push for more environmentally friendly solutions to things like energy surges, the actual replacement materials to support that dream grow more and more scarce. Wind turbines and solar panels use rare earth metals in their very construction, and the future of renewable energy will demand more of these resources.[53] Even everyday items like batteries, jewelry, and computer chips use platinum, gold, and nickel, which are starting to become more and more expensive as their supplies decrease. The scarcity problem is exacerbated by the fact that a lot of these elements have no readily available alternative on Earth. Asteroid mining is the solution to the coming scarcity issues. Mining the asteroids isn't just a capitalist dream; it is the average man's necessity.

Most of the minerals being mined on Earth, including gold, iron, platinum, and palladium, originally came from the many asteroids that hit the Earth after the crust cooled during the planet's formation.[54] Asteroids are suspected to be filled with an abundance of natural resources like gold, cobalt, iron, manganese, molybdenum, nickel, osmium, palladium, platinum, rhenium, rhodium, ruthenium, and tungsten that are worth billions to trillions of dollars.[55] Speaking to just one of the many examples,

---

[51] David Cohen, *Earth's Natural Wealth: An Audit*, New Scientist, 34–41, (May 23, 2007), http://www.science.org.au/nova/newscientist/027ns005.htm.

[52] *Id.*

[53] *See Global Resources Stock Check*, BBC (June18, 2012), http://www.bbc.com/future/story/20120618-global-resources-stock-check.

[54] Shaw, *supra* note 28, at 125; *see also Geologists Point to Outer Space as Source of the Earth's Mineral Riches*, Science Daily (Oct. 19, 2009), http://www.sciencedaily.com/releases/2009/10/091018141608.htm; *cf.* James M. Brenan & William F. McDonough, *Core Formation and Metal-Silicate Fractionation of Osmium and Iridium from Gold*, 2 Nature Geoscience 798 (Oct. 18, 2009), http://www.es.utoronto.ca/wp-content/uploads/2014/09/Brenan-and-McDonough-2009.pdf (explaining that asteroids potentially had a significant role in the formation of Earth's crust and were likely the source of many minerals due to their collision with Earth while it was forming).

[55] Brenan & McDonough, *supra* note 54.

> Some of these Near-Earth Asteroids (NEAs) are metallic, composed of metals like iron and nickel, similar to the center of the Earth. One of these asteroids is 1986 DA, a metallic NEA 1.2 miles wide that is likely composed primarily of iron and nickel with significant amounts of gold and platinum. Estimates show 1986 DA contains approximately 10,000 tons of gold and 100,000 tons of platinum, which if completely recovered would be valued on today's market at $460 billion and $5.6 trillion, respectively. Including the value of the iron and nickel, 1986 DA could be worth between $6 and $7 trillion.[56]

These NEAs are close enough to be mined and harvested for the development of human technology. John S. Lewis, professor of planetary science at the University of Arizona and author of *Mining the Sky: Untold Riches from the Asteroids, Comets, and Planets*, estimates that asteroid 3554 Amun is worth $20 trillion. Composed of platinum, iron, nickel, and cobalt, it has enough resources to pay off the U.S. national debt.[57] It is estimated that there are about one to two million asteroids in the solar system that are large enough to consider for mining projects:[58]

> Each of these asteroids is projected to weigh roughly two billion tons and "contain 30 million tons of nickel, 1.5 million tons of metal cobalt, and 7,500 tons of platinum." The value of these items, for both private companies and governments around the world could be significant with the dollar value being somewhere in the trillions or higher. With nickel selling for $14,575 per ton, cobalt selling for $26,600 per ton, and platinum at $1,454 per ounce, mining one single asteroid could be more than profitable.[59]

Though these numbers presuppose that prices of the various resources would stay the same, they provide a telling picture of the potential wealth in wait and its ability to drastically alter the shape of the future.[60]

Providing more than a fix for natural resource shortages, asteroids also contain other elements that are scarce or practically nonexistent on Earth. One of these, helium-3, could be used as a low-cost, efficient energy source that gives

---

[56] Tingkang, *supra* note 43, at 566.

[57] The national debt is currently approaching $16.5 trillion. *How Much Is An Asteroid Worth?*, KURZWEILAI (Feb. 15, 2013), http://www.kurzweilai.net/how-much-is-an-asteroid-worth.

[58] Adam G. Quinn, *The New Age of Space Law: The Outer Space Treaty and the Weaponization of Space*, 17 MINN. J. INT'L L. 475, 500 n. 217 (2008).

[59] Matthew Feinman, *Mining the Final Frontier: Keeping Earth's Asteroid Mining Ventures from Becoming the Next Gold Rush*, 14 PGH. J. TECH. L. & POL'Y 202, 205 (2014) (citing Kevin Bonsor, *How Asteroid Mining Will Work*, HOW STUFF WORKS, http://science.howstuffworks.com/asteroid-mining.htm; *accord LME Nickel*, LONDON METAL EXCH., https://www.lme.com/metals/non-ferrous/%20nickel/; *LME Cobalt*, LONDON METAL EXCH., https://www.lme.com/metals/minor-metals/cobalt/; *Platinum Prices and Platinum Price Charts*, INVESTMINE, http://www.infomine.com/investment/metal-prices/platinum/).

[60] It is unlikely that the prices of resources would remain the same with such a large increase in supply.

only a fraction of the polluting effect of current practices.[61] Helium-3 could potentially light the future, and that is just the beginning of the possibilities reaped from asteroid mining.

C.2 Future Space Exploration

The societal good that could be achieved from mining asteroids, which contain both rare-Earth minerals and scarce and/or non-existent resources, is self-explanatory. Similar is the resultant financial gain from these mining activities. There is extensive scholarship surrounding the potential value of asteroids, and this Note only scratches their proverbial surface. A large share of asteroids' benefits is derived from their position in outer space. They will allow us to push further in space exploration and space colonization by drastically bringing down the cost of travel.

To those still reading this with an eye of incredulity about space, this section may seem the most unnerving, but it is by far the important use for asteroid mining. The largest barriers to space exploration and space colonization are the cost of shipping materials from Earth, and the fuel limitations inherent in travel. Asteroid mining has the potential to help with both of these problems and act as the catalyst for the modern space age. The mining of NEOs will yield great quantities of hydrogen, helium, and water.[62] These materials could be used to fuel human spacefarers, untying them from the need to be refueled or resupplied from Earth.

More specifically, mined water could be extremely useful as rocket fuel or as a fuel for other power and propulsion systems.[63] If water can be found on asteroids (as many believe it can be) the water could also be broken down into its hydrogen and oxygen components, which can then be used to form the basic building blocks of rocket fuel.[64] Mining water alone makes both space colonization and space exploration cheaper and consequently more feasible. Furthermore, sources of water have been identified: a 2006 announcement by the Kech Observatory claimed that 617 Patroclus, a Jupiter Trojan, was essentially an extinct comet that consists largely of ice. Similarly, Jupiter-family comets, and possibly NEAs that are extinct comets, might also economically provide water which through the process of *in-situ* resource utilization—using materials native to space for propellant, tankage, radiation shielding, and other high-mass components of space infrastructure—could lead to radical reductions in its cost for space exploration.[65] Fuel tends to make up the greatest weight of rockets; the

---

[61] Kelly M. Zullo, *The Need to Clarify the Status of Property Rights in International Space Law*, 90 Geo. L. J. 2413, 2433 (2002).

[62] Tingkang, *supra* note 43, at 568.

[63] *Id.*

[64] Steve Connor, *How to Turn Water into Rocket Fuel—Scientists Unlock Power of the Sun*, The Independent (July 31, 2008), `http://www.independent.co.uk/news/science/how-to-turn-water-into-rocket-fuel-ndash-scientists-unlock-power-of-the-sun-882613.html`.

[65] *See* source cited *supra* note 8.

ability to produce fuel in space would provide much needed flexibility to survive in outer space and explore the depths of the solar system.[66]

Part I addressed the technology that is being developed by Planetary Resources and DSI for asteroid mining; that technology will help realize the benefits of asteroid mining for space travel.

> Launches from Earth could be cheaper if the shuttles were able to refuel at a DSI Propellant Refinery. Planetary Resources' ARKYD-300 could scout ahead for possible colonization sites on both asteroids and planets. Imagine a scenario where a DSI Harvestor mines the minerals needed to create a colony, and then the shuttle takes those materials, along with a DSI Microgravity Foundry, to build the colony itself.[67]

Fuel for spaceships to go further and resources to build and re-equip space colonies unburdened by the high costs of Earth-to-colony transport could be the stepping stone we need to begin the new age space race.

Lastly, in addition to mining for supplies, we could also use asteroids as space stations. An asteroid-based space station could be highly beneficial to research and development. It has the potential to provide conditions that cannot easily be replicated on Earth, such as zero-gravity environments, freedom from atmospheric interference, and nearly continuous sunlight for solar power.[68] While on the surface this may not seem like a large benefit, it will be invaluable as a place to test some of the radiation shielding problems that have historically stalled many long-term space exploration plans.[69]

Many people dismiss asteroid mining positing that the benefits are primarily financial ones that will do nothing more than further line already rich pockets. But the reality is far more layered than that simple assertion. Asteroid mining is a societal necessity for global advancement. Modern technology relies increasingly on rare and scarce resources; we will need to find a new source to continue the advancement. Any future with space exploration has to be grounded in the understanding that we will need a cheaper way to deliver materials in space. Asteroid mining is the answer.

D PROBLEMS SURROUNDING ASTEROID MINING

While the significant benefits described above show the impending need and the rewards of asteroids mining, many problems must be addressed before asteroid

---

[66] Tingkang, *supra* note 43, at 568.

[67] Feinman, *supra* note 59, at 210.

[68] Tingkang, *supra* note 43, at 568–69.

[69] Josh Hopkins et al., *Plymouth Rock: An Early Human Mission to Near Earth Asteroids Using Orion Spacecraft*, LOCKHEED MARTIN at 2 (June 2010), http://www.lockheedmartin.com/content/dam/lockheed/data/space/documents/orion/OrionAsteroidMissionWhitePaperAug2010.pdf (positing that radiation shielding is one of the primary concerns of long-term space flight, so a readily available source of shielding would allow astronauts to survive for much longer periods of time in outer space and undertake missions such as a Mars landing).

mining becomes a certain fixture of the future. The main issues confronting asteroid mining are the needs for a massive upfront investment and the economic and political implications of mining asteroids in the future.

The most obvious roadblock to asteroid mining is the high required upfront investment needed to participate. While Part I spoke to some of the plans that the NASA is supporting and the goals the agency has set, it omits an important point: the funding for NASA has decreased drastically over the last twenty years. Currently, it operates using the lowest percentage of the federal budget since 1960.[70] Just when we are on the cusp of cracking open the final frontier, the government is bowing out. According to a Collaborative Modeling for Parametric Assessment of Space Systems (COMPASS) team at NASA's Glenn Research Center in Cleveland, the estimate for a successful asteroid capture endeavor is in the ballpark of $2.6 billion,[71] while the government's grant to NASA for its capture project is only around $100 million.[72] Private companies will have to take the lead and absorb the large costs associated with asteroid mining and space exploration. The costs only continue to increase beyond the creation of asteroid capture technology—from the harnessing technology, or the costs required for the transport and process of raw asteroidal material to Earth for use (on Earth or elsewhere). In this assessment, the administrative costs of running a company are not even taken into account. While the discussion of technology in Part I of this Note highlights a few successfully funded companies, the high costs operate as a roadblock for others. Even though the potential profits are massive, the initial risks of asteroid mining come close to swallowing the benefits. While both Planetary Resources and Deep Space Industries have been very tight-lipped about their costs, the list of big name investors and the ambitious plans insinuate investments in the hundreds of millions of dollars, at a minimum.

As it stands today, mining asteroids is too theoretical and not yet profitable enough to ask the private industry to continue to dump billions into the endeavor. It will require more relative financial certainties, rather than mere mirages of wealth, to propel the industry.

The current legal framework that is in place, as is described in the next section, is not adequate to incentivize investors for such a risky endeavor. These businesses want to be sure that the technology, funding, and efforts they put toward the development of space will be rewarded, and so a properly crafted property law regime, unique to outer space, must be developed to ensure that private space industry continues to invest in cosmic ventures and technologies.[73]

---

[70] Simon Rogers, *NASA Budgets: US Spending on Space Travel Since 1958 Updated*, Guardian Datablog (Feb. 1, 2010), http://www.guardian.co.uk/news/datablog/2010/feb/01/nasa-budgets-us-spending-space-travel (citing Office of Mgmt. & Budget, Exec. Office of the President, Budget of the United States Government, Historical Tables, http://www.whitehouse.gov/omb/budget/Historicals/.

[71] Leonard David, *Is Asteroid Mining Possible? Study Says Yes, For $2.6 Billion*, Space (Apr. 24, 2012), http://www.space.com/15405-asteroid-mining-feasibility-study.html.

[72] *See generally*, Wall, *supra* note 12.

[73] Davin Widgerow, Comment, *Boldly Going Where No Realtor Has Gone Before: The Law Of Outer Space And A Proposal For A New Interplanetary Property Law System*, 28 Wis. Int'l L. J. 490, 500 (2010).

The law needs to create a level of predictability and incentive structure that will actually make investors overlook the long path still ahead of them and see the end goal.

Assuming the substantial financial roadblocks that exist are overcome and private money pours into the industry, there are still other economic and political considerations that are sources of serious concern before asteroid mining can become a reality. The central problem is the issue of control. Once private companies get into space, after investing their own money and bearing all the risk, they will want to control how things operate. To have them take all the risk and then expect corporations to willingly subordinate themselves from their spoils is a fool's dream. So far, the government has had a limited response. On July 10, 2014, two Congressmen proposed the Asteroids Act, intended to facilitate the commercial exploration and utilization of asteroid resources to meet national needs and to promote the right of US commercial entities to explore and utilize resources from asteroids.[74] The Act seeks to create property rights in resources extracted from asteroids, stating: "Any resources obtained in outer space from an asteroid are the property of the entity that obtained such resources, which shall be entitled to all property rights thereto, consistent with applicable provisions of Federal law."[75] The legislation, while noting that no state can lay claim to the asteroids, and giving corporations some protections on their investments, is still the beginning of a scary trend; a trend where national governments are granting and recognizing property rights subject to their own rule. This bill essentially sets the stage for a showdown for when an American company and a foreign company (with their country's support) lay claim to the same asteroid. What happens when a Chinese company subject to Chinese laws starts to mine an asteroid that an American company has rights to under American law? What happens to any company not based in a major superpower, do they just cede their rights when a company backed by a more powerful nation intervenes? Individual governments' respective abilities to regulate, as seen by the Asteroids Act, will lead to conflicting laws and conflicting claims that have the potential to create serious political and military ramifications.

Putting aside the political chaos this could cause in the global system, the question of why corporations would even cede any control comes into question. With practically no governmental involvement in the initial stages of asteroid mining, why would corporations allow the government to share the benefits of something that they, in reality, have no jurisdiction over? Building on the conflict over control, who would control how much of the resource could be brought back? Markets already exist for a lot of the natural resources that would be mined on asteroids; bringing back a large load of the resource could wreak economic havoc on those existing markets and the political systems that rely on them. The social costs to resource-based countries alone would be catas-

[74] American Space Technology for Exploring Resource Opportunities In Deep Space (ASTEROIDS) Act, H.R. 5063, 113th Cong. (2014).

[75] Charles Stotler, *The ASTEROIDS Act and Hearing: Some Observations On International Obligations*, THE SPACE REVIEW (Sept. 22, 2014), http://www.thespacereview.com/article/2604/1.

trophic. Will the corporations care? Can any government really curb the corporation's ability to flood the market? What stops them from creating a false market due to their ability to monopolize an asteroid? Is there a state interest in miner safety and other environmental considerations involved in extra-terrestrial mining? Who can really enforce any safety and protection regulations with only claimed jurisdiction?

This non-exhaustive catalog of questions is asked in an attempt to understand the wide breadth of problems that will arise under the current regulatory regimes that are in place. The problems surrounding asteroid mining are more than just the high costs of investment; there are also questions about control and global cooperation over corporate activities in space.

E Current Law

The problems posed in the last section rise in part due to lack of legal clarity in this area. The international community has no policy that directly speaks to asteroid mining. It has instead relied on the interpretation of a series of tangentially connected treaties and agreements to address the burgeoning industry. This section is focused on briefly introducing some of the international agreements and treaties that try to govern space.

The phrase "space law" draws a blank on most faces, as very little is actually known about the practice area. Still, despite the lack of public knowledge around international space law, there are quite a few guiding documents for asteroid mining, namely: the Outer Space Treaty of 1967, the Registration Convention of 1975, and the Moon Treaty of 1979.

E.1 The Outer Space Treaty of 1967

The Outer Space Treaty of 1967 was the first real international agreement dealing with space. Created in the midst of the Space Race and the Cold War, it was drafted to ensure that space did not become the next battleground. Its legacy has long outlived that original purpose, and almost 50 years later, it still stands as the primary agreement on international space law, serving as the foundation for all agreements and treaties that followed. The most marked and deliberate feature of the agreement was its rejection of the traditional concept of *res nullius*, or treating outer space as unclaimed territory that, since unclaimed, was open for conquest by anyone.[76] The policy laid out in the Treaty opted for the *res communis* theory, there by all entities, individual or corporate, and nations have common or open access to the resources that are contained within its realm and are precluded from making any claims of ownership.[77] The strong tone of the document and the widespread agreement of the treaty has led some to assert

[76] David Everett Marko, *A Kinder Gentler Moon Treaty: A Critical Review of the Current Moon Treaty and a Proposed Alternative*, 8 J. Nat. Resources & Envtl L. 293, 297–98 (1992–1993).
[77] *Id.*

that celestial bodies are res extra commercium as whole, and cannot be owned.[78] This treaty stands at the center of international space law today, making a breakdown of its relevant articles essential.

Article I of the Treaty covers its general purpose. It states that, "the exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and interests of all countries…and shall be the province of all mankind."[79] It is important to recognize the lofty language in this international consensus, as it is the result of concessions given to developing nations. The developed, space-faring nations would have much preferred the open space principle to allow for them to stake their claim. However, they recognized that any international consensus had to take the opinions of developing countries into account, and developing nations refused any agreement that would impede their future rights to space exploration. That understanding still holds today, and any international cooperative agreement on space has to make some concession to the developing and non-space faring states to be workable long-term.

Article II reiterates the underlying purpose of the agreement by stating that outer space "is not subject to national appropriation by claim of sovereignty." But its broad language in this article has created a large and very controversial loophole: nowhere in prohibiting claims of ownership does the treaty mention corporations, private entities, or individuals.[80] In fact, the treaty lacks

> [A]ny explicit mention of property rights. It does not, however, specifically reject individual or corporate property in space. The treaty only prohibits "national appropriation" of space by claim of sovereignty, use, occupation, or other means. The drafters of the Outer Space Treaty chose to limit this prohibition to nations, even though scholars at the International Institute of Space Law had suggested that the Treaty should prohibit "national and private appropriation."[81]

This large loophole becomes extremely relevant given that the Outer Space Treaty is the only space-related treaty onto which the majority of the world has signed.

The next relevant article is Article IX, which addresses environmental considerations. The article is aimed at protecting the environment of outer space, the moon, and other celestial bodies from future contamination and other environmental damage. It requires member states to consider the adverse effects of those activities upon other states. In turn, they must consult with those states before undertaking such activities.[82] While the treaty tries to mitigate some of the concerns addressed earlier in this paper, its scope is limited. The consultation requirement is not interpreted in a standardized manner in the international

---

[78] Austin C. Murnane, *The Prospector's Guide To The Galaxy*, 37 FORDHAM INT'L L. J. 235, 257 (2013).

[79] Outer Space Treaty, *supra* note 4, art. I.

[80] Michael J. Listner, *The Ownership And Exploitation Of Outer Space: A Look At Foundational Law And Future Legal Challenges To Current Claims*, 1 REGENT J. INT'L L. 75, 78 (2003).

[81] Murnane, *supra* note 78, at 261–62.

[82] Outer Space Treaty, *supra* note 4, art. IX.

arena, nor does it have a strong enforcement infrastructure. For the most part, it is agreed that the article requires one state to request an opinion or a common examination of a specific problem. Beyond that, it requires very little; a state is neither required to report on the problem or make a decision based on the ongoing situation.[83] There is no real enforcement bite to this provision, so it functions very much like an aspirational standard.

The remaining articles are less relevant to this immediate discussion. They outline restrictions on "the establishment of military bases, installations and fortifications, the testing of any type of weapons, and the conduct of military maneuvers on celestial bodies…" and are about liability, ownership, and control concerns in space.[84]

E.2 The Registration Convention of 1975

The Registration Convention of 1975, while not traditionally considered an important contribution to a space law regime, has the ability to serve an important legal purpose in the future. Primarily meant as an expansion of Article VIII of Outer Space Treaty, the goal of the agreement was to create a registry of all spacecrafts and objects launched into space by member states so that there would be a way to hold states liable for damages.[85]

> Article I of the Registration Convention provides definitions for the terms "launching state," "space object," and "State of Registry." Article II imposes a duty upon on the states to create and maintain a registry of spacecrafts they launch. Article III imposes the same duty upon the U.N. Secretary-General and opens the contents of the registry for public inspection. Article IV stipulates that registration must include the name of the launching state or states, an appropriate designator of the space object or its registration number, the date and territory or location of launch, basic orbital parameters, which include nodal period, inclination, apogee, perigee, and the general function of the space object.[86]

This agreement marks the first attempt to monitor the activities of individual nations in space. While the other agreements focused on what states *could do*, this is only agreement that creates a method for recording what states were *doing*. The registry requirement, while very weak, at least creates some base of jurisdiction for the international community. However, this (similar to the other space-related treaties) is mostly pomp and little substance. Though the requirements exist and the states signed onto them, violations of the agreement occur often without repercussion. It is generally believed that nations frequently

---

[83] L. H. Philepina Diederiks-Verschoor, An Introduction to Space Law 31–32 (2d. rev. ed. 1999).

[84] Outer Space Treaty, *supra* note 4, art. IV, ¶ 2.

[85] *See* Listner, *supra* note 80, at 85.

[86] *Id.* at 85.

launch space objects without registration and are met with little or no actual consequences.[87]

F THE MOON TREATY OF 1979

The Moon Treaty of 1979 marked the first real attempt after the Outer Space Treaty to reach an international consensus regarding space. While other contemporary treaties attempted to deal with very specific issues like liability, registrations, and damages, the Moon Treaty was the first attempt to look at the new issues facing space law, like moon mining, on an international scale. But such scale also marked the new face of international consensus, or lack thereof. While the United States and the Russian Federation have ratified the Outer Space Treaty and its three prodigies that form the foundation of space law, they have not ratified the Moon Treaty.[88]

Though the era of the Moon Treaty was different than the one in which the Outer Space Treaty was signed, the goals remained the same: a renewal of the promise that outer space belonged to everyone, and as such, all would prevent it from being carved up and exploited. The Moon Treaty attempted to do so with a narrower focus than the Outer Space Treaty—its provisions apply only to the moon and the other celestial bodies in our solar system. The Moon Treaty also stated in Article XI that "neither the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person," in order to close the loophole which did not include private entities in the non-ownership provisions, the largest perceived shortcoming of the Outer Space Treaty.[89] The provision theoretically provides an additional legal barrier to private ownership and commercial exploitation by barring appropriation by private entities and individuals.[90]

While the idea of closing the loophole seems beneficial to all nations, the agreement would mean that corporations in countries that signed the agreement would lose opportunities potentially allowed to them under the Outer Space Treaty. Putting aside the ease with which complicated corporate structures could be propped up to get around this, the corporations in the United States and Russia are not included. Any agreement that binds states and corporations and at the same time advantages the United States and Russia is doomed to failure. The Americans and Russians' refusal to sign reflects the Treaty's overall success.

> Only thirteen nations have ratified the Agreement, and none of them are independently space-competent. Ironically, the Union of Soviet Socialist Republics staunchly opposed the Moon Agreement and its collectivist ideals, and the Russian Federation has done so as well. In

87 *Id.* at 85.
88 DIEDERIKS-VERSCHOOR, *supra* note 83, at 33.
89 Moon Treaty, *supra* note 5, art. XI, ¶ 3.
90 *Id.*

> the United States, a Congressional committee report listed the Agreement's risks to property rights among the reasons not to ratify it. The committee asserted, as did other nations' governments, that the property provisions of the Moon Agreement would discourage private investment in the space industry.[91]

The Moon Treaty has strong goals and would address many of the legal pitfalls that will be problematic with asteroid mining, but its international failure is telling. There is no longer international consensus on the topic of space resources exploitation.

Yet among the lofty and unrequited goals of the Moon Treaty, space-faring states did agree on one provision. Article XI provides that an international governing body shall be established to "govern the exploitation of the natural resources of the moon as such exploitation is about to become feasible."[92] The goal of the Moon Treaty drafters was preventing a race to claim space. In doing so, they realistically added this provision to allow for a regulated exploitation of the moon's natural resources. The article attempted to create the infrastructure for a governing board, assuming the technology to mine the moon was consequently developed. Though this article has been forgotten amidst of the general rejection of the Moon Treaty, it presents an important point: even as early as the 1970s, the world was cognizant of the fact that space needed its own regulatory structure. An absolute prohibition on mining space would not work; something was needed to balance the interests of the non-space-faring states with those of the more developed space-faring states. To date, no official action has been taken to appoint a regulatory body, but the logic behind appointing one still remains strong decades later and is the same reasoning used by this Note's author to argue for the creation of new regulatory agency to govern space.

The current law in place is really just an amalgamation of treaties that are rarely enforced with lofty language that most don't even agree on the meaning of. The international community is divided about how to deal with the issue of space resources. The best answer is to start fresh and build an organization that balances the interests of developed and developing countries, while still being realistic and allowing for regulated space resource gathering. If constructed correctly, this could be the foundation of something much larger that will address the issues sure to arise during the human race's future in space.

G Proposed Alternative

While asteroid mining is not the most popular legal topic, there is still a good deal of scholarship that argues for regulating asteroid mining through the use of property law principles,[93] old mining law principles,[94] asteroids-as-chattel

[91] Murnane, *supra* note 78, at 264–65.
[92] Moon Treaty, *supra* note 5, art. XI, ¶ 5.
[93] *See, e.g.*, Widgerow, *supra* note 73.
[94] *See, e.g.*, Shaw, *supra* note 28.

arrangements,[95] and existing international regimes and treaties.[96] Each proposal attempts to work within the established structure to manufacture a solution that incorporates the concerns regarding asteroid mining. We can't blame them for that approach because it is historically the way human society has handled new concepts.[97] We take the law we have and try to bend it to fit any new problems. But the issue that plagues this task, as it plagues all solutions that seek to extend the law too far, is that the laws are simply not written to cover something so different. Looking to mining laws creates an incentive but also creates a gold rush scenario that intensifies the possibility of global conflict. Looking to the UN or international treaties requires there to actually be an enforceable agreement (that the whole world could agree on) as a foundational set of principles. Regarding property rights, the concept of "property" must include something that moves and figure out how to deal with conflicting claims. Each of the "solutions" leaves most of the problems unanswered. But the failure is not in the articles or the arguments; it is in the approach. When looking to space, it is necessary to realize the potential problems before they arise and create a new solution that is built to address those specific problems, rather than attempting to stretch worn-out and tenuous existing principles. The answer proposed by this Note, is one that learns from history and implores the world to start fresh to give a potential-filled opportunity like space a regulatory regime that matches its potential. The answer is not to work within the existing legal frameworks, but to create a new international regulatory authority that is built to adapt and solve the problems that space mining and space exploration creates.

One of the key points of consideration for this new organization is for it to be independent from the United Nations (UN) and function separately. The UN, for all of its benefits, has a lot of problems. Academic databases are rife with scholarship addressing the outmoded UN structure. It was built post-WWII and still embodies the Cold War dynamic in a very different world. The power of the Security Council in relation to the weakness of the General Assembly is a huge point of concern for a functioning organization that seeks to give everyone a voice. Additionally, the UN minutes reflect a tense and politicalized culture where everything is focused around political and cultural animosity. Space cultivation should function beyond such political landscapes, superseding any border disputes and politicalized show of power. To have a culture that recognizes the importance and the potential of space, an organization with a collective com-

[95] *See, e.g.*, Tingkang, *supra* note 43.

[96] *See, e.g.*, David Johnson, *Limits On The Giant Leap For Mankind: Legal Ambiguities Of Extraterrestrial Resource Extraction*, 26 AM. U. INT'L L. REV. 1477 (2011).

[97] A recent example of this claim is the net neutrality battle and the extension of Title II of the Communications Act of 1934 over broadband. Title II classification by the FCC was intended to cover common carriers; there are a lot of restrictions that govern common carriers like telephone companies. The problem with using it to cover cellphones, and now broadband, is that such an application extends Title II to an unrecognizable point from its original formulation and it renders the law little better than an amalgamation of diverse and non-cohesive regulations. An arguably better approach would have been to build out new categories for each major shift in technology, which could have averted a ton of wasted manpower and litigation to decipher a law that is intrinsically inconsistent because of its now vast breadth.

munal mind is needed.

With the above understanding in mind this Note seeks to articulate the guidelines to form that new international regulatory regime. The guidelines are simply an outline of how to set up a structure that would deal with the aforementioned problems. To that end, the outline below is a rudimentary starting point from which we can create an organization deserving of the great task of space regulation. The job of the organization will be to the set standards for all space-related matters. In its nascent phase it would be focused on asteroid mining. Key jobs for the organization would be to figure out how property and control rights should be divided between those parties vying for rights to mine on asteroids and other related celestial bodies. Second, the organization will function as a mediator to resolve any disputes that arise in space or involve space-related issues. It will also have primary jurisdiction over space property and mining issues. Allowing for individual countries to still hold primary jurisdiction would do nothing to fix the problems discussed above. The only peaceful solution is to give this organization the enforcement mechanism that previous treaties lacked. Lastly, the job of the organization will be to work with all the parties involved and serve as a forum for discourse for the new regulations and directions it wants to implement. To have a working organization, all parties need to be able to have a say in the development of space law, particularly those with the most at stake. Thus, both corporations and member states will be allowed a say in policy. This organization will allow for the all voices to be heard and taken into account, be they the voice of the government or corporations.

Membership in the proposed organization is one the most unique features of the future regulatory regime, as it includes not just states, but also corporations. The voting and representation in the assembly will be distributed by having two-thirds of the votes reserved for member states and one-third of the votes reserved for corporations. If we accept the current government spending patterns in space and the constantly increasing cost of maintaining space programs, it becomes clear that the funding for space exploration will have to come, at least in part, from corporations. Any regulatory regime that hopes to succeed will, therefore, need the approval of corporations.

The UN and existing international law treaties are focused on state action and state membership, based on the assumption that corporations fall within state control. However, in today's economic climate, some multinational corporations have more money than some small governments. If anything, there is an abundance of scholarship that supports the proposition that corporations own multiple governments. The old model of state-based regulatory frameworks will not work in a world where corporations are no longer as responsive or as dependent on states. The proposed space organization will include corporations as a seat at the table because it recognizes their financial impact in funding the new Space Age. However, there will also be checks to the system—any corporation that wants to operate in space, in any fashion outside of existing satellite contracts, will have to register with the organization. Any government that is recognized by the UN will be eligible to be a state member of the organization.

The membership regime raises a question of the incentives underlying the

organization's membership board. Why would any corporation sign up to this agreement and why would any state sign up to this new international order? The simple answer is that there is a "carrot" for both sides. The central benefit for both states and corporations is that the organization will create some semblance of certainty in the law. Corporations seek legal certainty before they act to make sure their investments are not misplaced. The current environment is akin to a pseudo legal sphere because there is general lack of clarity as to what the law is and who ultimately controls that law in space. Having one international set of guidelines avoids the hassle of differing regulations by countries, conflicting obligations by countries, finding some legal way to comparatively meld them together, and the fear of having investments wiped out by arbitrary decisions of questionable jurisdiction. Additionally, corporations would get an active role in shaping the future regulations.

Even for developed and space-faring countries, legal certainty is advantageous. Right now different countries do as they wish, making an unorganized body of law, bound to contradict in universal application. Each government is concerned about being beaten to the resources, and this organization reframes that concern into one focused on developing together. Because companies will be involved from the beginning, the policies can be built in a way to encourage investment and spur technological research and development. Including the votes of private investment will allow for better policies and better policing.

This offers the developed countries a way to pool their resources for the greater good without having to face the perception of "being beaten." Developed and space-faring countries do not want to be perceived as being outdone by the others, but they also don't have the money to keep up. Earlier sections have addressed the cutbacks in NASA and the general government austerity programs leave little room to continue to stay competitive. Additionally, the developed countries have an incentive to join the organization at the early stages because that will allow them the ability to have the most control in decision-making. Waiting until others have set the rules may be too costly of a proposition. Unlike the Moon Agreement, which accepted the premise of space mining but punted to the future and took a "common heritage of mankind" view of space that made developed countries worried about their ability to mine, this new organization makes no such statements. In the new organization, mining and exploration are both allowed and encouraged. Rather than celebrating the common heritage of man, the organization is economically driven, at least early on. The ability to profit, and saying as much, is what sets this proposition apart from the ones that failed in the past.

Further, as the Moon Treaty demonstrated, no agreement will work on an international scale if it does not make some concessions to the developing and non-space-faring states. With that being said, the developing, non-space faring nations will join this organization both because they are given concessions and because they simply cannot afford to get left behind. In the past, developing countries had too loud a voice and it scared the developed space-faring nations. Because this organization will favor the developed countries, as long as they sign on, the developing countries will sign on to ensure their rights are preserved.

Signing on at an early stage, even on a tilted table, gives them some voice versus no voice. Getting involved early will mean they will at least be able to voice concerns and protect some of the interests. International organizations are balancing games, and the developing nations understand that if they sit out there is no one protecting their future interests. Offering everyone a seat at the table is the only way to encourage continuous investment and balance the varying interests of developing and developed states.

Finally, the "stick" of the agreements works as follows: if the member state is not a part of the organization, the corporations that are headquartered in that state will not have their property claim recognized by the organization nor any of its members. While this may seem like an extreme stick, theoretically, it is also an easily avoidable one. Nothing quite motivates a country like corporations moving out. The benefit of this stick is that the more members that sign on, the stronger it gets. So if the developed space-faring nations sign up, the rest will have to follow suit given the ensuing disadvantages promised by this stick.

With a worldwide array of state and corporate members, the organization must manage itself, specifically through voting and funding. To join the organization, each state and corporation will pay a flat fee. The state's fee will be a flat amount plus an extra calculated premium based on a variety of factors like their relevant economic indicators, activeness level in space, number of space related corporations headquartered there, etc. The corporation's fee will be a flat fee and an extra premium based on the kind of work they are doing and how active they are in space. A general tax will also be levied on all for-profit commercial mining activity. The fees should be enough to cover administrative aspects of the organization. Once mining begins, the tax will generate a lucrative stream of money that will allow investment in independent research and further space exploration that recalls the "common heritage of mankind" ideal and explores and researches for such purposes.

Related to the funding dynamics is the voting protocol. Though negotiable, the more funding a member provides, the larger the vote they can get, up to a certain cap. The cap will be accessed to make sure there is still a level of fairness for all the involved members. This way countries and corporations that do more get a larger say and avoid the issue of the general assembly and wooing of unrelated small members which plague the UN. But the cap still creates fairness where one or two members cannot carry the whole organization and create rules and policies that favor only a few parties. A weighed, but capped voting system would be the best.

The organization is built to address the shortcomings of the past while looking to be adaptable to the problems of the future. It creates incentives for corporations' membership by giving them a voice in the discussion; it brings developed space-faring nations to agree because it favors their interests; and developing nations agree in order to protect their threatened interests. The organization will create a forum to limit disputes and take the pressure of competition off of space-faring states.

However, when considering this possibility, it should be considered that this Note in no way is meant to argue that the guidelines above are perfect or should

be implemented exactly. These rules are only a starting point that the collective community can use on which to build. Fundamentally, making a new international organization that incorporates corporations and looks to the future is the best way to prevent the mistakes that have happened in the past. This solution is the happy middle that just might work.

H CONCLUSION

As cliché as the oath that Captain Kirk recites from the bridge of the USS Enterprise to explore space, the final frontier, and "to boldly go where no one has gone before" has become, what seems like a new beginning is very much an end goal from where we stand today. Space is still very much unexplored, but asteroid mining is a very real and near future. If corporations are to lead the world into a new "Space Age," a regulatory scheme must be created that recognizes this new reality while still protecting the interests of the people. Creating an international organization separate from the pre-existing squabbles and built around space-specific concerns recognizes that reality. Moreover, if space is to really be the final frontier, then it goes well beyond just asteroid mining. The solution for asteroid mining ought to be one that can incorporate the future of space expansion. Making a new international regulatory regime addresses the concerns of asteroid mining but also lays the seeds for a future in space. Star Trek may have been seen by millions as a fantasy that distracted them from reality, but the two worlds are going to collide into a new reality sooner rather than later, this Note simply wants the world to be ready for it.