EXCUSE ME, YOU'RE MINING MY ASTEROID: SPACE PROPERTY RIGHTS AND THE U.S. SPACE RESOURCE EXPLORATION AND UTILIZATION ACT OF 2015

Craig Foster[*]

TABLE OF CONTENTS

* J.D., University of Illinois College of Law, May 2017 (expected). B.A., Religious Studies, East Texas Baptist University, 2006. M.Div., Baylor University Truett Theological Seminary, 2009. I want to thank my wife, Lindsay, for being endlessly supportive through my law school endeavors and for being a wonderful mom to our sons. A special thanks also to my parents, Randy and Leigh, and siblings, Curtis and Cindy, for their continued encouragement. To the entire JLTP staff, thank you for putting in the effort to make this Note presentable to the public. Finally, thank you to Professor Lesley Wexler for sacrificing your time to provide guidance throughout the editing process.

I. INTRODUCTION

The ever-expanding world of technology is constantly turning science fiction into science reality. Space mining is an exciting example of this. For decades, scientists have understood that celestial bodies—namely asteroids—contain sometimes high levels of precious metals and other resources.[1] A handful of companies and nations now hope to bring these resources out of orbit and back to Earth, but that raises the question of property rights. In particular, who can own a resource mined from space?

This Note will examine the current legal situation—at both the international and national levels—as it pertains to asteroid mining and property rights. Part II will look at what resources can be mined and what types of technologies and governmental programs are being produced in order to extract the resources. It will then examine the state of international law and its understanding of property rights in space. Part III will analyze the Space Resource Exploration and Utilization Act, a new law signed by President Obama in November 2015, which seeks to remedy the issue of property rights over space resources for U.S. citizens. It will then analyze how the Act compares to the law governing deep seabed mining, an area of international law with similar property rights implications. Part IV will recommend that Congress and the international community balance excitement, treaty obligations, and the history of mining efforts on Earth in order to better anticipate and regulate potential problems that might arise when mining in space. It will also recommend that the U.S. be involved in creating and ratifying an international agreement to ensure that rights over space resources are allocated in a judicious manner.

1. William Steigerwald, *New NASA Mission to Help Us Learn How to Mine Asteroids*, NASA (Aug. 8, 2013), https://www.nasa.gov/content/goddard/new-nasa-mission-to-help-us-learn-how-to-mine-asteroids.

II. BACKGROUND

A. What's Actually Up There?

The largest mass migration in U.S. history saw some 300,000 people swarm into the territory now known as California.[2] These people were enticed by one thing: gold.[3] They came from all corners of the world and uprooted their lives for the promise of becoming abundantly wealthy by mining one of Earth's most precious minerals.[4] Today, more than one hundred fifty years after the California gold rush, a number of visionary commercialists are similarly enticed—this time to leave Earth's atmosphere to mine precious minerals from asteroids and other celestial bodies.

But what is actually on these asteroids that is enticing entrepreneurs to spend millions of dollars to create space-mining systems? There are three commonly cited types of asteroids that contain different elements of significant value: "C-type," "S-type," and "M-type."[5]

"C-type" asteroids are dark and carbon-rich.[6] Because of their high carbon content and distance from the Sun, these asteroids contain a lot of water that could prove important for a couple of reasons.[7] First, if privatized space exploration becomes more normalized, there will be great need for water for human consumption.[8] Second, when broken down into liquid hydrogen and oxygen, water could be used to create rocket fuel in space for the many different types of vehicles and satellites already in space.[9] It is difficult and costly to transport water from Earth to space for these purposes, so if done efficiently, extracting and using water already located in space for refueling and consumption could prove very fruitful.[10] C-type asteroids likely also contain levels of phosphorous that, when combined with the carbon, could be used as fertilizer to create more sustainable methods of food production in space.[11]

"S-type" asteroids are stonier in composition.[12] Not only do they have significant amounts of iron, nickel, and cobalt, they also contain smaller amounts of gold, platinum, and rhodium.[13] Efficient extraction from S-type asteroids could prove most fruitful by bringing platinum and gold back to Earth and selling them in traditional metal markets.[14] The other metals would

2. Barbara Maranzani, *8 Things You May Not Know About the California Gold Rush*, HISTORY (Jan. 24, 2013), http://www.history.com/news/8-things-you-may-not-know-about-the-california-gold-rush.
3. *Id.*
4. *Id.*
5. Steigerwald, *supra* note 1.
6. *Id.*
7. *Id.*
8. *Id.*
9. *Plans for Asteroid Mining Emerge*, BBC (Apr. 24, 2012), http://www.bbc.com/news/science-environment-17827347.
10. *Id.*
11. Steigerwald, *supra* note 1.
12. *Id.*
13. *Id.*
14. Philip Metzger, *The Type of Asteroid to Mine, Part 3*, PHILIP METZGER BLOG: SPACE MINING,

prove most useful if extracted and kept to be used in space.[15]

Finally, "M-type" asteroids contain the largest amounts of precious metals.[16] These asteroids are far more rare, but would be the most fertile asteroids for mining purposes.[17] They are believed to have originated from the cores of small, planet-like celestial bodies that were broken apart and thus are potentially made up of pure metals, such as platinum, nickel, and iron.[18] Some have suggested that bringing platinum back to Earth would lower its price, thus spurring innovation in energy-sector technology that relies on platinum.[19]

B. Technological Advancements

Minerals on asteroids are ripe for the taking, but space-mining technology is still in its infancy. People who sought riches of gold in the mid-1800s sped to California with dreams and primitive tools. The available technology was sufficient to allow even the layperson to extract small bits of gold from the ground.[20] The same is not true with asteroid mining. Quite simply, dreams of asteroid mining are bountiful, but the tools needed to do it simply do not exist yet.[21] Some estimate that it will be a decade or more before a company is actually able to extract anything of value from an asteroid.[22]

Not surprisingly, the development of these tools costs an extraordinary amount of money—possibly into the billions of dollars.[23] So costly, in fact, that some believe the endeavor to be "pie-in-the-sky" and will never prove worth the time and money invested.[24]

Three private companies are at the forefront of the development of space-mining technology.[25] These companies are Planetary Resources (PR), Deep Space Industries (DSI), and Kepler Energy and Space Engineering LLC (KESE).[26] Additionally, a number of countries have taken steps to create state-

---

SPACE SETTLEMENT & SPACE SCI.! (May 20, 2013), www.philipmetzger.com/blog/type-of-asteroid-to-mine-part-3/.

15. *Id.*; *see also* Andrea Nowicki et al., *Near-Earth Asteriod Mining: What and How*, EVERGREEN ST. C., http://academic.evergreen.edu/curricular/astro/astro98/aprojfolder/Asteroid/mining.htm (last visited Oct. 24, 2016) ("[S]ending any item into space, such as a satellite, space station, or the materials to build either, will cost literally hundreds times more than the item itself. If these items could be manufactured in space from asteroidal materials, the costs could be brought down significantly.").

16. Steigerwald, *supra* note 1.

17. *Id.*

18. Metzger, *supra* note 14.

19. *Market for Metals*, PLANETARY RES., http://www.planetaryresources.com/asteroids/market-for-metals/ (last visited Oct. 11, 2016).

20. Julian Murdoch, *How Gold Gets Out of the Ground*, ETF.COM (May 18, 2009), http://www.etf.com/sections/features-and-news/1574-how-gold-gets-out-of-the-ground.

21. Emily Calandrelli, *The Potential $100 Trillion Market for Space Mining*, TECHCRUNCH (July 9, 2015), http://techcrunch.com/2015/07/09/the-potential-100-trillion-market-for-space-mining/.

22. *Id.*

23. Steigerwald, *supra* note 1.

24. *Id.*

25. Scott Smith, *The Ultra Rich Are Starting to Like the Risks Involved in Asteroid Mining*, QUARTZ (Mar. 5, 2014), http://qz.com/184502/the-ultra-rich-are-starting-to-like-the-risks-involved-in-asteroid-mining/.

26. Matthew Feinman, *Mining the Final Frontier: Keeping Earth's Asteroid Mining Ventures from Becoming the Next Gold Rush*, 14 PITT. J. TECH. L. & POL'Y 202, 205–06 (2014); DEEP SPACE INDUS., http://deepspaceindustries.com/ (last visited Oct. 11, 2016); KEPLER ENERGY & SPACE ENG'G LLC,

sponsored space-mining programs for non-commercial purposes, such as Japan, the United States, Luxembourg, and Russia.

1. Planetary Resources

PR plans to create a robotic asteroid mining system[27] and is currently focusing most of its technology development on prospecting.[28] One does, after all, need to find asteroids and determine if they are ripe for mining before any mining actually takes place. This initial stage is mostly dedicated to creating avionic, communications, and observational tools in order to target asteroids that might be most fruitful.[29]

To this end, PR developed a small satellite called the *Arkyd 3*, which was set for a test orbit but was destroyed aboard the Antares rocket when it exploded on takeoff in 2014.[30] PR recreated the satellite, calling it the *Arkyd 3 Reflight*, and successfully launched it in July 2015 from the International Space Station for a ninety-day mission to test various avionic and communications technologies.[31] Another satellite, the *Arkyd 6*, is set to launch in the near future in order to test other communications and sensor technologies.[32]

All of these tested technologies are expected to be used in the *Arkyd 100*, a spacecraft that will carry a space telescope to be used for prospecting purposes.[33] In the more distant future, all of these tests will lead to launches of larger and more sophisticated satellites—the *Arkyd 200 Series Interceptor* and *Arkyd 300 Series Rendezvous Prospector*—that will be able to orbit asteroids and obtain very specific information that is currently impossible to acquire.[34]

Finally, PR recently announced its newest technology, the *Ceres* system.[35] The *Ceres*, based upon the *Arkyd 100*, is a satellite system made up of ten smaller satellites.[36] It will orbit the Earth and provide "hyperspectral

---

http://www.kesellc.com (last visited Oct. 11, 2016); PLANETARY RES., http://www.planetaryresources.com/ (last visited Oct. 11, 2016).

27. Adam Mann, *Tech Billionaires Plan Audacious Mission to Mine Asteroids*, WIRED (Apr. 23, 2012, 7:45 PM), http://www.wired.com/2012/04/planetary-resources-asteroid-mining/.

28. *Our Mission Demands the Best*, PLANETARY RES., http://www.planetaryresources.com/technology/#technology-overview (last visited Oct. 11, 2016).

29. *Id.*

30. Sarah Lewin, *Asteroid Mining Company's 1st Satellite Launches from Space Station*, SPACE.COM (July 17, 2015, 12:30 PM), http://www.space.com/29975-asteroid-mining-planetary-resources-satellite-launch.html.

31. *Id.*

32. Safar Haddad, *Planetary Resources Successfully Deployed Its Spacecraft Arkyd 3 Reflight from ISS*, PERFSCI. (July 17, 2015, 12:05 AM), http://perfscience.com/content/2142276-planetary-resources-successfully-deployed-its-spacecraft-arkyd-3-reflight-iss.

33. *Id.* While it appears that the *Arkyd 100* is still in the works, a recently failed crowd-sourcing campaign has pushed its realization date into 2019. DL Cade, *No Space Selfie for You: ARKYD Project Fails, Will Refund $1.5M to Backers*, PETAPIXEL (May 26, 2016), http://petapixel.com/2016/05/26/no-space-selfie-arkyd-project-fails-will-refund-1-5m-backers/.

34. *The Arkyd Spacecraft Development Platform*, PLANETARY RES., http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3273&context=smallsat (last visited Oct. 11, 2016).

35. Jeff Foust, *Planetary Resources Raises Financing Round for Earth Observation System*, SPACENEWS (May 27, 2016), http://spacenews.com/planetary-resources-raises-financing-round-for-earth-observation-system/.

36. *Id.*

and mid-infrared observations of the entire Earth on a weekly basis."[37] This information will provide key and unique information for the natural resources, agricultural, and other industries.[38] Further, the *Ceres* operation will serve as a beta test of sorts for the company's ultimate task of prospecting on asteroids.[39] PR president Chris Lewicki says that upon completion of the *Ceres* mission, PR will "have retired the risk and gone operational on much of the system that's required to do the asteroid mission."[40]

2. Deep Space Industries

DSI is also creating technology for asteroid mining and prospecting. They have plans to launch a small satellite called *Firefly*, which is about the size of a briefcase and will orbit asteroids in order to obtain prospecting information.[41] Using standard CubeSat technology, these small satellites are relatively inexpensive and can be tucked away on larger rockets in order to enter space.[42] DSI also plans to launch a larger spacecraft, called *Dragonfly*, that will bring small samples of minerals from the asteroids back to Earth.[43] A *Dragonfly* mission is expected to take two to fours years, be fully robotic, and render between sixty and one hundred fifty pounds of asteroid material.[44]

DSI has also announced another spacecraft called the *Mothership*, a craft that weighs about three hundred thirty pounds and will carry, and then launch, a "swarm" of six-inch nano-satellites.[45] These nano-satellites will explore deeper into space, obtaining information from asteroids to relay back to the *Mothership*, which then relays the information back to Earth.[46]

Finally, DSI has started developing technology that can be used to manufacture products in space using metals obtained from asteroids, without ever having to bring those metals back to Earth.[47] This technology, called the "MicroGravity Foundry," is a "3D printer that uses lasers to draw patterns in a nickel-charged gas medium, causing the nickel to be deposited in precise patterns."[48] Such technology, one NASA official posits, could make NASA missions safer and cheaper by making it possible to "print replacements for broken parts, or to create brand new parts invented after the expedition was on its way to the Red Planet."[49]

---

37. *Id.*
38. *Id.*
39. *Id.*
40. *Id.*
41. Press Release, Deep Space Indus., World's First Fleet of Asteroid-Hunting Spacecraft Announced by Deep Space Industries Inc. (Jan. 22, 2013), https://deepspaceindustries.com/wp-content/uploads/2013/02/DSIPR_RollOut_20130122.pdf.
42. *Id.*
43. *Id.*
44. *Id.*
45. 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/.
46. *Id.*
47. Press Release, Deep Space Indus., *supra* note 41.
48. *Id.*
49. Robert Pearlman, *Deep Space Industries Announces Fleet of Asteroid Hunting Spacecraft*,

3. Kepler Energy and Space Engineering LLC

Out of the three leading private companies, KESE's space-mining program appears to be in the most infant stages. KESE plans to create a fully robotic mining system using technology already used and proven effective in missions by other companies and governmental entities.[50] KESE touts its mining program, called "Cornucopia," as a "keep it simple" system aimed at returning a large amount of asteroid material—up to forty metric tons—back to low Earth orbit by the end of this decade.[51] Once in low Earth orbit, the main goal is to keep most of the materials in space and manufacture them, using ore-processing systems, into building materials, propellants, and radiation shielding to be used for space-related activities.[52] If any of the obtained samples contain precious metals, they could be returned to Earth to be manufactured and sold.[53] KESE also envisions that their ore-processing systems might be used to recycle thousands of tons of aluminum contained in debris already within lower Earth orbit.[54]

4. State-Sponsored Space-Mining Programs

A number of countries have also dedicated themselves to investing in and developing programs aimed at mining materials from space for non-commercial purposes. Japan, the United States, Luxembourg, and Russia are emerging as leaders in this realm, albeit in different ways.

a. Japan Aerospace Exploration Agency (JAXA)

JAXA is a Japanese governmental entity that exists, among other reasons, to develop space technology and promote the development and utilization of space.[55] In May 2003, JAXA launched the spacecraft *Hayabusa* in order to land it on Itokawa, an S-type asteroid.[56] The *Hayabusa*'s major objective was to be the first spacecraft to obtain asteroid materials and return them to Earth for research.[57]

After more than seven years in flight, the *Hayabusa* returned to Earth, and its onboard capsule was retrieved in the Australian outback.[58] Inspection of the capsule confirmed that dust particles, measuring less than four thousandths of

---

COLLECTSPACE (Jan. 22, 2013, 4:19 PM), http://www.collectspace.com/ubb/Forum35/HTML/000570.html.

50. Michael Buet & Robert Frantz, *Asteroid Mining: Why and How?*, 3 J. SPACE PHIL. 127, 129 (2014), http://www.bobkrone.com/sites/default/files/Asteroid%20Mining%20Why%20and%20How%20-%20Michael%20Buet%20and%20Robert%20Frantz.pdf.

51. *Id.*

52. *Id.*

53. *Id.*

54. *Id.*

55. Law Concerning Japan Aerospace Exploration Agency, Law No. 161 of 13th Dec. 2002, art. 4 (Japan) (unofficial translation), http://global.jaxa.jp/about/law/law_e.pdf.

56. *Asteroid Explorer "Hayabusa" (Muses-C)*, JAXA, http://global.jaxa.jp/projects/sat/muses_c/ (last visited Oct. 11 2016).

57. *Id.*

58. *Id.*

an inch in length, were in fact made up of asteroid materials.[59] The particles are believed to have been lying on the asteroid's surface for more than eight million years.[60]

Following the success of the *Hayabusa*, JAXA launched another asteroid-exploring spacecraft, the *Hayabusa 2*, in December 2014.[61] The *Hayabusa 2* is targeting a C-type asteroid known as Ryugu, with the objective of obtaining materials useful for the study of the history of the solar system as well as potential extraterrestrial life.[62] Onboard the *Hayabusa 2* is a "collision device," which will create a meters-wide crater on the surface of the asteroid in order to expose material samples that have been less eroded by the forces of space and, thus, more useful for research purposes.[63] The *Hayabusa 2* is expected to land on the asteroid in mid-2018, stay for eighteen months, and then return to Earth by the end of 2020.[64]

b. NASA's *OSIRIS-REx* Mission

NASA's *OSIRIS-REx* took off in September 2016[65] and seeks to be the first U.S. spacecraft to obtain and return asteroid materials.[66] After a three-year journey, the spacecraft will approach the asteroid Bennu—which measures in diameter the length of six football fields—and complete a six-month-long operation to map its surface.[67] The spacecraft will then retrieve samples weighing more than two ounces from the asteroid's surface using a robotic arm.[68] Bennu is believed to contain a high concentration of carbon and to "represent a snapshot of our solar system's infancy."[69] The spacecraft is expected to return to Earth sometime in 2023.[70]

c. Luxembourg's Space Resources Program

On March 3, 2016, Luxembourg's government announced an initiative that would position the country as "a European hub in the exploration and use of space resources."[71] Luxembourg, one of Europe's smallest but wealthiest

59. Sindya N. Bhanoo, *Asteroid Dust Confirms Meteorites' Origins*, N.Y. TIMES (Aug. 25, 2011), http://www.nytimes.com/2011/08/30/science/30obmeteor.html?_r=0.

60. *Id.*

61. *Asteroid Explorer "Hayabusa2"*, JAXA, http://global.jaxa.jp/projects/sat/hayabusa2/ (last visited Oct. 11, 2016).

62. *Id.*

63. *Id.*

64. *Id.*

65. Sarah Lewin, *Journey to an Asteroid: 3D Software Plots OSIRIS-Rex's Complex Route*, SPACE.COM (Sept. 14, 2016, 7:30 AM), http://www.space.com/34059-osiris-rex-asteroid-journey-visualization. html.

66. *OSIRIS-REx*, NASA, http://science.nasa.gov/missions/osiris-rex/ (last visited Oct. 11, 2016).

67. *Id.*

68. *Id.*

69. *Id.*

70. *Id.*

71. Transcript of Press Conference by Étienne Schneider, Deputy Prime Minister of the Economy, Le Gouvernement du Grand-Duché de Luxembourg (Feb. 3, 2016), https://www.gouvernement.lu/5678423/Press-conference-SpaceResources_lu-Transcript.pdf.

countries,[72] has already positioned itself as an international innovator in satellite technology.[73] With the announcement of this space-resources initiative, Luxembourg became the first European nation to "announce its intention to set out to form [a] legal framework that ensures that private operators working in space can be confident about their rights to the resources they extract, for example rare minerals from asteroids."[74]

The Luxembourg government feels confident that such a framework will be in keeping with international space treaties, and will provide investors with appropriate assurances in their space-mining endeavors.[75] In addition to these immediate plans to create a legal framework, the initiative envisions more long-term goals to research and develop space-resource-utilization technologies and to invest in companies doing the same.[76] To these ends, Luxembourg signed a Memorandum of Understanding with Planetary Resources, establishing a European headquarters for the company and further signaling to the world that Luxembourg is fully dedicated to space-mining research and development.[77] Ultimately, this initiative could help "lead to a thriving new space economy and support the path of human expansion into our solar system."[78]

d. Russia's Moon-Mining Program

Russia's Federal Space Program (FSP) has also injected itself into the rush to obtain space resources—specifically, from the Moon.[79] Beginning in 2016, FSP plans to send an unmanned spacecraft to the Moon in order to deliver comet material back to Earth.[80] By 2030, though, FSP plans to send a manned spacecraft to the Moon, which would be the country's first such mission since 1976.[81] FSP plans to eventually establish space stations on the Moon, which will, by the mid-2050s, include a "full-fledged scientific and mining base with an observatory." Such stations will also serve as hubs to enable travel to other planets and celestial bodies.[82]

FSP believes that the Moon's poles contain large amounts of frozen gases

72. Katy Barnato, *Lift-off: Luxembourg's Asteroid Mining Plan*, CNBC (Feb. 3, 2016, 6:30 AM), http://www.cnbc.com/2016/02/03/luxembourgs-asteroid-mining-plan.html.

73. Camila Domonoske, *Luxembourg Hopes to Rocket to Front of Asteroid-Mining Space Race*, NPR (Feb. 3, 2016, 4:16 PM), http://www.npr.org/sections/thetwo-way/2016/02/03/465448871/luxembourg-hopes-to-rocket-to-front-of-asteroid-mining-space-race.

74. Transcript of Press Conference by Étienne Schneider, *supra* note 71.

75. *Id.*

76. *Id.*

77. *Planetary Resources and the Government of Luxembourg Partner to Advance the Space Resource Industry*, PLANETARY RES. (June 13, 2016), http://www.planetaryresources.com/2016/06/planetary-resources-and-the-government-of-luxembourg-partner-to-advance-the-space-resource-industry/.

78. *Id.*

79. Aram Ter-Ghazaryan, *Moon Exploration Will Reduce the Shortage of Rare Earth Metals*, RUSS. BEYOND HEADLINES (Oct. 26, 2014), http://rbth.com/science_and_tech/2014/10/26/moon_exploration_will_reduce_the_shortage_of_rare_earth_meta_40887.html.

80. *Id.*

81. *Id.*

82. *Id.*

and other rare minerals from comets.[83] Such minerals might include cerium, lanthanum, neodymium, praseodymium, and other metals used to create high-tech products.[84] With technology continuously advancing, Russian experts see these lunar reserves as a cost-effective way to solve the problem of Earth's limited supply of these minerals.[85]

In sum, while private companies and national governments have made recent strides in developing the technology and programming needed to harvest minerals from space, there is still a long way to go before it becomes a reality, especially for commercial purposes.

C. The Current State of International Law and Property Rights in Space

Many applaud efforts being made to mine asteroids and cite its potential to greatly enhance the Earth's economy and reduce reliance on fossil fuels.[86] Without the promise that extracted resources will be able to be sold for profit, though, private companies like PR, DSI, and KESE will have little incentive to continue their asteroid mining efforts. So, what assurances currently exist for these companies to believe that they will be conveyed ownership of resources mined from asteroids? The short answer is that current international laws seem to frown upon owning celestial materials, but precedent suggests that the practical effect of these laws on ownership of space materials is minimal.[87]

1. International Treaties

Space is understood as a global commons owned by all of humankind—like the high seas, polar regions, and the atmosphere.[88] The doctrine of the "global commons" refers to resource domains that lay outside of any individual nation's political control; these areas are thus often governed by international law.[89] Because space is part of this commons, international law and treaties are typically understood to govern space activities.[90] This, of course, requires a nation to ratify and follow any given treaty for it to govern the nation's activities—something that has created significant problems for the international community in trying to control space resource ownership.[91]

Currently, the most broadly controlling space treaty is the Outer Space Treaty.[92] The U.N. Outer Space Treaty, which has been in force since 1967

83. *Id.*
84. *Id.*
85. *Id.*
86. Michael A. Robinson, *Why the Wall Street Journal Is Dead Wrong About Asteroid Mining*, MONEY MORNING (June 10, 2012), http://moneymorning.com/2012/06/10/why-the-wall-street-journal-is-dead-wrong-about-asteroid-mining/.
87. Benjamin G. Davis, *Property Rights in Space: Assuring Economic Development*, 11 SCITECH LAW. 18, 19 (2014).
88. *Id.*
89. *IEG of the Global Commons*, U.N. ENV'T PROGRAMME, http://www.unep.org/delc/GlobalCommons/tabid/54404/ (last visited Oct. 11, 2016).
90. Davis, *supra* note 87.
91. *IEG of the Global Commons*, *supra* note 89.
92. G.A. Res. 2222 (XXI), annex, Treaty on Principles Governing the Activities of States in the

and is ratified by the major spacefaring nations, establishes that space is the province of all humankind and promotes the "exploration and use of outer space" for peaceful purposes.[93] It aims to quell a space arms race (harkening back to its Cold War origins), but also speaks broadly about jurisdiction and property rights.[94]

Article II of the Treaty states that "[o]uter space, including the [M]oon 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."[95] Additionally, Articles VII and VIII make it clear that the nation from which an object is launched retains jurisdiction, control, and liability over launched objects while they are in space.[96]

In the early 1980s, the U.N. Moon Treaty was adopted.[97] One of its stated purposes was to build upon the Outer Space Treaty and control the exploitation of resources from the Moon and other celestial bodies.[98] The Treaty requires that nations inform the U.N. Secretary General of all space activities they have planned.[99] Additionally, any materials obtained for scientific purposes can remain in possession of the obtaining nation but must be shared with the international community.[100] It also explicitly states that no entity—whether state or nongovernmental—can lay claim to any part of the surface or subsurface of a celestial body, to include natural resources.[101]

The Moon Treaty is seen as a relative failure, though, as none of the spacefaring nations with the ability to launch manned missions have ratified the agreement, rendering the Moon Treaty almost entirely ineffective.[102] Nonetheless, it highlights the disagreement between the international community that desires to curb property rights and spacefaring nations who are not yet willing to relinquish them.[103]

2. Common Law Principles

Against this undeveloped international law backdrop exists the common law understanding of *pedis possessio*. The doctrine of *pedis possessio*, which

---

Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Dec. 19, 1966), http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/outerspacetreaty.html [hereinafter Outer Space Treaty].

93. *Id.* art. I.

94. *Id.* art. IV.

95. *Id.* art. II.

96. *Id.* arts. VII, VIII.

97. G.A. Res. 34/68, annex, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Dec. 5, 1979), http://www.unoosa.org/pdf/gares/ARES_34_68E.pdf [hereinafter Moon Treaty].

98. *Id.*

99. *Id.* art. 5.

100. *Id.* art. 6.

101. *Id.* art. 11.

102. *Status of the Treaty: Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, U.N. OFF. FOR DISARMAMENT AFF., http://disarmament.un.org/treaties/t/moon (last visited Oct. 11, 2016).

103. Sarah Coffey, *Establishing a Legal Framework for Property Rights to Natural Resources in Outer Space*, 41 CASE W. RES. J. INT'L L. 119, 128 (2009).

was first developed in ancient Rome, most generally grants ownership to the first person to set foot upon and claim formerly unclaimed property in the public domain.[104] In the western world, this doctrine came to be most useful in the mining context.

> *Pedis Possessio* Doctrine is a principle of mining law which says that a qualified person who peaceably and in good faith enters a land in the public domain in search of valuable minerals may hold the place exclusively against others having no better title provided s/he remains in continuous exclusive occupancy and diligently and in good faith prosecutes work towards making a discovery. This principle provides a person exploring an area freedom from fraudulent or forcible intrusions while actually working on the site.[105]

The Outer Space Treaty makes appropriation of celestial bodies impossible,[106] but it might be argued under the doctrine of *pedis possessio* that, because asteroids are within the public domain, prospectors are granted the exclusive and unimpeded right to any resources they seek to extract.[107] "Regarding claiming ownership over asteroidal resources, it appears that the ancient Roman law of *pedis possessio* will apply. *Pedis possessio* is the basis for Western law on ownership, and analogies have long existed in other parts of the world as well."[108]

3. Historical International Precedent

There is some historical precedent that suggests that the international community might be open to the commercialization of space resources. In 2004, the International Institute of Space Law (IISL), an independent nongovernmental organization, released a statement affirming that private appropriation of entire space bodies is prohibited under the Outer Space Treaty.[109] Notwithstanding this prohibition, the IISL also acknowledged that "other private activities on the Moon and other celestial bodies are permitted."[110] The IISL stated, "Article VI of the Outer Space Treaty affirms that nongovernmental entities, including private individuals, companies, and organizations, have the right to conduct activities in space in accordance with international space law, and subject to the authorization and continuing supervision of the appropriate State Party."[111]

---

104. *Legal History and Issues*, PERMANENT, http://www.permanent.com/legal-international-laws.html (last visited Oct. 11, 2016).

105. *Pedis Possessio Doctrine Law & Legal Definition*, USLEGAL.COM, http://definitions.uslegal.com/p/pedis-possessio-doctrine/ (last visited Oct. 11, 2016).

106. Outer Space Treaty, *supra* note 92, art. II.

107. Davis, *supra* note 87, at 19.

108. *Legal History and Issues*, *supra* note 104.

109. *Statement by the Board of Directors of the International Institute of Space Law (IISL) on Claims to Property Rights Regarding the Moon and Other Celestial Bodies*, INT'L INST. SPACE L. (2004), http://www.iislweb.org/docs/IISL_Outer_Space_Treaty_Statement.pdf.

110. *Id.*

111. *Id.*

Additionally, both the U.S. and Russia have removed rock and dust from the Moon without facing legal repercussions.[112] In fact, small lunar particles, brought back on the Soviet Luna 16 probe in 1970, were sold at auction for $442,500 in 1993.[113] President Nixon even handed out plaques to 192 foreign dignitaries that contained lunar dust from the Apollo 11 mission.[114] Congress also passed a law in 2012 that allows U.S. astronauts to own and sell various mementos from their time in space—a number of which are caked with lunar dust.[115] The law, though, explicitly prohibits them from selling lunar rocks and other lunar materials.[116]

III. ANALYSIS

A. Need for Legislation

Even if companies are able to mine precious resources from asteroids, it is not entirely clear that they have any ownership rights to those resources. Mining on Earth, especially in the U.S., is heavily regulated.[117] There are complex and well-developed laws governing every part of the process—both at the federal and state level.[118]

By contrast, as already discussed, the existing international law on property acquired in space is vague.[119] This poses a number of problems for companies and nations as they make strides to mine from asteroids. The most obvious problem is whether a mining entity can legally claim ownership of resources mined from asteroids.[120] A related concern for companies—especially in the early stages of technology development—is funding.[121] If asteroid mining is to be encouraged, then companies will need to convince potential investors that the resources obtained can be claimed and sold to make a profit.[122] Investor confidence will be greatly enhanced by such ownership protections.[123]

Conflict and jurisdiction are additional concerns. What happens if two competitors or nations try to mine from the same asteroid? What if a company causes irreparable damage to the asteroid or the equipment of a competitor?

---

112. Davis, *supra* note 87, at 21.

113. Christina Reed, *Moon Rocks for Sale!*, GEOTIMES (Sept. 2002), http://www.geotimes.org/sept02/NN_moon.html.

114. *Id.*

115. *New Law Says Astronauts Can Keep (or Sell) Their Space Artifacts*, COLLECTSPACE (Sept. 26, 2012), http://www.collectspace.com/news/news-092612a.html.

116. *Id.*

117. *Federal Environmental Laws that Govern U.S. Mining*, NAT'L MINING ASS'N, http://nma.dev.networkats.com/index.php/federal-environmental-laws-that-govern-u-s-mining (last visited Oct. 11, 2016).

118. *Id.*; *see also* Janet Fairchild, Annotation, *Validity and Construction of Statutes Regulating Strip Mining*, 86 A.L.R.3d 27 (2016) (providing a broad overview of state mining laws).

119. Brian Merchant, *The Problem with Asteroid Mining*, MOTHERBOARD (Jan. 23, 2013, 11:28 AM), http://motherboard.vice.com/blog/the-problem-with-asteroid-mining.

120. Davis, *supra* note 87, at 18.

121. H.R. REP. NO. 114-153 (2015), at 7.

122. *Id.*

123. *Id.*

What country's laws govern a conflict between two nations? One can imagine a swarm of similar conflicts that might arise. Such conflicts could be greatly mitigated with proactive legislation, both at the national and international levels.

Finally, there is also concern about diving headlong into mining without considering the effects on the space environment. Namely, the "space debris problem" is concerning to some scientists who note that the area around the Earth is already filling up with debris from spacecraft and missions.[124] This debris can threaten humanity's ability to safely leave Earth's atmosphere, as well as the ability for satellites (which are used in everyday life for a multitude of reasons) to move effectively in orbit.[125] If a modern gold rush in space is in the near future, this debris problem could grow exponentially worse without regulations to protect against it.

It is easy to imagine many other problems that would arise if nations do not develop laws to govern the asteroid-mining process. With this in mind, this Part will analyze the recently adopted U.S. Space Resource Exploration and Utilization Act and consider how it compares to the law governing deep seabed mining.

B. Recently Passed U.S. Legislation

Because international space laws are vague or not controlling,[126] there has been recent activity within the U.S. Congress to provide a better framework for understanding property rights concerning resources mined from celestial bodies.[127] This activity culminated in November 2015 when President Obama signed into law the Space Resource Exploration and Utilization Act ("Space Act").[128]

The Space Act is broad and designed to "promote the development of a United States commercial space resource exploration and utilization industry and to increase the exploration and utilization of resources in outer space."[129] The House report makes it clear that the Space Act is not aimed at circumventing the national appropriation prohibitions from the Outer Space Treaty, but rather seeks to provide certainty as to the rights of private entities to "remove, take possession of, and use in-situ asteroid resources."[130]

The Space Act directs the President to:

> (1) facilitate commercial exploration for and commercial recovery of space resources by United States citizens;

---

124. Timothy Justin Trapp, *Taking Up Space by Any Other Means: Coming to Terms with the Nonappropriation Article of the Outer Space Treaty*, 2013 U. ILL. L. REV. 1681, 1683 (2013).

125. *Id.*

126. Daniel Hastings & Jeffrey Hoffman, *Space Policy*, MIT OPENCOURSEWARE, https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-891j-space-policy-seminar-spring-2003/lecture-notes/lawandpolicy.pdf (last visited Oct. 11, 2016).

127. Space Resource Exploration and Utilization Act of 2015, H.R. 1508, 114th Cong. (2015).

128. Space Resource Exploration and Utilization Act of 2015, Pub. L. No. 114-90, 129 Stat. 720 (2015) (codified as amended at 51 U.S.C. §§ 51301–03 (2012)).

129. H.R. REP. NO. 114-153, at 1 (2015).

130. *Id.* at 7.

> (2) discourage government barriers to the development in the United States of economically viable, safe, and stable industries for commercial exploration for and commercial recovery of space resources in manners consistent with the international obligations of the United States; and
>
> (3) promote the right of United States citizens to engage in commercial exploration for and commercial recovery of space resources free from harmful interference, in accordance with the international obligations of the United States and subject to authorization and continuing supervision by the Federal Government.[131]

The idea of *pedis possessio*, though not expressly mentioned in the legislative history or in the statute itself, seems to be a driving force in the above statutory language because it provides that citizens should have the right to explore for and recover space resources "free from harmful interference."[132] This strongly suggests that Congress foresees a system in which U.S. commercial entities have exclusive right to possess and extract from any asteroid, or at least part of an asteroid, on which they have landed.

Further, the Space Act requires the President to submit a report to Congress within one hundred eighty days, which will specify authorities and agencies needed to meet international obligations and fulfill the responsibilities of the Act.[133] The Act then defines "asteroid resource" as "a space resource found on or within a single asteroid" and "space resource" as "an abiotic resource in situ in outer space" to include "water and minerals."[134]

The Space Act then outlines the property rights for U.S. citizens over asteroid and space resources:

> A United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.[135]

Within the public law version of the Space Act, Congress inserted a disclaimer stating that it is their "sense" that this enactment does not "assert sovereignty or sovereign or exclusive rights or jurisdiction over, or the ownership of, any celestial body."[136]

---

131. Space Resource Exploration and Utilization Act of 2015 § 402 (codified as amended at 51 U.S.C. § 51302(a)).

132. *Id.*; *see also* H.R. REP. NO. 114-153, at 6–7 (discussing the need to allow private entities to explore and utilize space resources).

133. Space Resource Exploration and Utilization Act of 2015 § 402 (codified as amended at 51 U.S.C. § 51302(b)).

134. *Id.* § 402 (codified as amended at 51 U.S.C. § 51301).

135. *Id.* § 402 (codified as amended at 51 U.S.C. § 51303).

136. *Id.* § 403.

1. Pros of the Space Act

The most obvious positive feature of the Space Act is that it seeks to put some meat on the bare bones of space property rights. The Outer Space Treaty clearly prohibits appropriation of whole celestial bodies but is far less clear concerning rights over extracted resources.[137] As discussed earlier, the Treaty seems to foresee some sort of resource extraction and use[138]—though the enactment of the Moon Treaty and its prohibitions on owning resources cast doubt upon whether private ownership and commercialized use of these resources is acceptable to the international community at large.[139] With the promise of property rights comes confidence for investors, which invariably leads to more money and technology.[140]

In providing confidence for investors, companies can move forward with their plans to extract resources. This will create jobs and allow U.S. companies to keep pace with other countries, such as China, Russia, and India—and their private companies that intend to move forward with their own space commercialization missions.[141] Not surprisingly, the Space Act has been heralded by DSI as a "tipping point that will facilitate growth of a global space economy for the benefit of all mankind."[142]

2. Cons of the Space Act

There are also a number of concerns surrounding the passage of the Space Act. One source points out how important the issue of space resources is and fears that Congress is pushing through the legislation too quickly.[143] There is also the fear that the Space Act will lead to inevitable breaches of the Outer Space Treaty.[144] The Outer Space Treaty seeks to quell any land grabs and to promote the "free access to all areas of celestial bodies."[145] If, though, an entity is given too much freedom in its operations to extract resources, free access might be hindered. "Failing to balance these rights adequately could create overly expansive 'bright line' zones that could amount to land grabs

137. Outer Space Treaty, *supra* note 92, art. I.

138. *Id.*

139. Moon Treaty, *supra* note 97, art. 11; *see also* Fabio Tronchetti, *The Space Resource Exploration and Utilization Act: A Move Forward or a Step Back?*, 34 SPACE POL'Y 6, 8 ("[U]nder Article II of the Outer Space Treaty celestial bodies are non-appropriable, the argument has been made that any conferral of property rights over asteroid natural resources in place could amount to a US ownership claim over asteroids, a behavior in adamant violation with the provisions of Article II and a breach of the US obligations under the treaty.").

140. Tanja Masson-Zwaan & Bob Richards, *International Perspectives on Space Resource Rights*, SPACENEWS (Dec. 8, 2015), http://spacenews.com/op-ed-international-perspectives-on-space-resource-rights/.

141. *Id.*

142. *New Law Enables Commercial Exploration and Use of Space Resources*, DEEP SPACE INDUS. (Nov. 25, 2015), https://deepspaceindustries.com/new-law-enables-commercial-exploration-and-use-of-space-resources/.

143. Evan Swarztrauber, *Congress Should Fix Space Property Rights Bill*, TECHFREEDOM (May 19, 2015), http://techfreedom.org/post/119383374264/congress-should-fix-space-property-rights-bill.

144. *Id.*

145. Outer Space Treaty, *supra* note 92, art. I.

strictly prohibited by the Treaty."[146]

Others are concerned by the Space Act's lack of a system of licensing.[147] This is troubling to some because the Outer Space Treaty requires countries to take control over their citizens operating in space, and the lack of a licensing scheme might mean that the U.S. is refusing to meet these international obligations.[148] While it appears that a licensing scheme is forthcoming upon the presidential report required under the Space Act,[149] it is not clear how long it will take for the scheme to be in place.

The Space Act might also violate Article II of the Outer Space Treaty's prohibition on national appropriation of celestial bodies.[150] In international law, there are no property rights unless they are granted by a superior power.[151] With the Space Act, the U.S. gives itself the authority to confer property rights over space resources even before they are extracted.[152] Thus, it seems to follow logically that the U.S. is appropriating at least some part of a celestial body in order to do this—against the express prohibitions of the Outer Space Treaty.[153]

In contrast to this interpretation of the Outer Space Treaty, the IISL issued a paper in which it concludes that the United States' Space Act does not appear to violate the Outer Space Treaty.[154] The paper does not outright endorse the Space Act, but it points out that the Space Act does not give rights over celestial bodies themselves nor does it supersede the United States' international obligations, which, presumably, include the Outer Space Treaty.[155] Still, the paper warns that "[i]t is an open question whether this legal situation is satisfactory" and that it remains to be seen to what extent such an interpretation will be acceptable to other countries.[156]

C. Space Resource Mining Versus Deep Seabed Mining

Comparisons have been drawn between the mining of space resources and the extraction of minerals from the high seas.[157] Such comparisons might prove helpful in analyzing the need for and devising an international legal framework to govern space mining.

---

146. Swarztrauber, *supra* note 143.

147. Maggie Koerth-Baker, *Who Makes the Rules for Outer Space?*, NOVA NEXT (Nov. 30, 2015), http://www.pbs.org/wgbh/nova/next/space/space-law/.

148. *Id.*

149. Space Resource Exploration and Utilization Act of 2015, Pub. L. No. 114-90, § 402, 129 Stat. 720, 721 (2015) (codified as amended at 51 U.S.C. § 51302(b) (2012)).

150. Tronchetti, *supra* note 139, at 8.

151. *Id.*

152. *Id.*

153. *Id.*

154. Marcia S. Smith, *International Institute of Space Law OK with U.S. Asteroid Mining Law*, SPACEPOLICYONLINE.COM (Dec. 24, 2015, 7:05 AM), http://www.spacepolicyonline.com/news/international-institute-of-space-law-ok-with-u-s-asteroid-mining-law.

155. *Id.*

156. *Id.*

157. Masson-Zwaan & Richards, *supra* note 140.

1. Deep Seabed Mining and Legislation

In the 1960s, it was proposed that the deep seabed might contain nearly limitless deposits of precious resources such as cobalt and nickel.[158] Based on this proposition, a number of countries, including the United States, France, and Germany, set out to devise methods of extracting these resources.[159] Though hundreds of millions of dollars were spent on these missions, they initially proved fruitless, and the hope of deep seabed mining was all but abandoned.[160] Deep seabed mining has been described as "standing atop a New York City skyscraper on a windy day, trying to suck up marbles off the street below with a vacuum cleaner attached to a long hose."[161] Thus, the challenges in deep seabed mining are great and the technology, for several decades, was unavailable.[162] Within the last decade, though, new technology and the discovery of a number of promising resource sites has led to renewed interest in deep seabed mining.[163]

Recognizing the need to regulate deep seabed mining, the U.S. and other international bodies created various laws and regulations. Because much of the resources are located in international waters, deep seabed mining is governed by the United Nations Conventions on the Law of the Sea (UNCLOS).[164] UNCLOS is an exhaustive treaty that governs everything from navigational rights to environmental protections.[165] Of pertinence, it gives express title rights over minerals extracted in accordance with its provisions.[166]

In 1970, the U.N. declared that seabed resources located within international waters were the "common heritage of mankind."[167] Based on this belief, UNCLOS created the International Seabed Authority (ISA).[168] The ISA seeks to balance the interests of developed countries and their businesses with those of undeveloped countries and their claim to the resources, based on the idea that the resources belong to all of humankind.[169] Originally, UNCLOS, through the ISA, sought to redistribute mining technology and royalties to less developed member states.[170] These requirements caused vehement opposition

158. G.P. Glasby, *Lessons Learned from Deep-Sea Mining*, 289 SCI. 551 (July 28 2000), http://science.sciencemag.org/content/289/5479/551.full.

159. *Id.*

160. *Id.*

161. *The United Nations Convention on the Law of the Sea (A Historical Perspective)*, DIV. FOR OCEAN AFF. & L. SEA, U.N. (1998), http://www.un.org/Depts/los/convention_agreements/convention_historical_perspective.htm [hereinafter *U.N. Convention*].

162. *Treasure on the Ocean Floor*, ECONOMIST (Nov. 30, 2006), http://www.economist.com/node/8312172.

163. *Id.*

164. United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397.

165. *Id.*

166. *Id.* annex III art. 1.

167. *U.N. Convention*, *supra* note 161.

168. *Id.*

169. *Id.*

170. Christopher Mirasola, *Why the US Should Ratify UNCLOS: A View from the South and East China Seas*, HARV. L. SCH. NAT'L SECURITY J. (Mar. 15, 2015, 5:53 PM), http://harvardnsj.org/2015/03/why-the-us-should-ratify-unclos-a-view-from-the-south-and-east-china-seas/.

to UNCLOS from a number of countries, including the U.S.[171] After a period of negotiation with the U.S. under the Clinton administration, the technology-sharing requirement was removed and the U.S. was promised a permanent seat on the ISA with budgetary veto power.[172]

Despite these changes, the Senate has kept the U.S. from joining 166 other countries in ratifying UNCLOS, against the recommendations of the Clinton, Bush, and Obama administrations and many other lobbyist groups.[173] A handful of senators are halting ratification, constantly citing President Reagan's opposition and based solely on the belief that "anti-U.S. interests" dominate the ISA and would end up redistributing wealth to fund "corrupt and despotic regimes."[174] They believe that international customary law provides enough governance, making UNCLOS superfluous.[175]

In 1980, due in large part to the aforementioned dissatisfaction with UNCLOS, President Reagan signed into law the Deep Seabed Hard Mineral Resources Act ("Seabed Act").[176] Broadly, Congress passed the Seabed Act to regulate and promote exploration and commercial recovery of hard minerals from the deep seabed by U.S. citizens and companies, until such time as an acceptable international treaty was created.[177] The Seabed Act is fairly exhaustive, covering many topics, including: licensing,[178] environmental protections,[179] interference with other uses of the high seas,[180] safety,[181] civil remedies,[182] court jurisdiction,[183] and civil and criminal penalties.[184]

Concerning property rights, the Seabed Act provides that any entity holding a valid license is entitled to a permit that "recognizes the right of the holder to recover hard mineral resources, and to own, transport, use, and sell hard mineral resources recovered . . . ."[185] In other words, the Seabed Act grants property rights over minerals to any licensed U.S. citizen who extracts them, even from parts of the seabed that are not within U.S. jurisdiction.

171. *Id.*
172. *Id.*
173. *Id.*
174. *U.N. Convention on the Law of the Sea: It's Still a Bad Idea*, HERITAGE FOUND. (July 7, 2011), http://www.heritage.org/research/factsheets/2011/07/un-convention-on-the-law-of-the-sea-its-still-a-bad-idea.
175. *Id.*
176. Deep Seabed Hard Mineral Resources Act, Pub. L. No. 96-283, 94 Stat. 553 (1980) (codified as amended at 30 U.S.C. §§ 1401–73 (2012)).
177. 30 U.S.C. § 1401.
178. *Id.* §§ 1411–17.
179. *Id.* § 1419.
180. *Id.* § 1421.
181. *Id.* § 1422.
182. *Id.* § 1427.
183. *Id.* § 1467.
184. *Id.* § 1462–63.
185. *Id.* § 1412(b)(3).

2. The Current State of Deep Seabed Mining Legislation Versus That of Space Resource Mining Legislation

a. Comparisons Between Deep Seabed and Space Resource Mining

The comparisons between deep seabed mining and space resource mining are easy to see. Both are based upon the idea that valuable resources are available and abundant within difficult-to-reach areas that are not within the jurisdiction of any state. Because the resources are not under any state jurisdiction, they are commonly believed to belong to all of humankind. Additionally, because the resources are so remotely located, there grew a foundational need to develop new and sophisticated technology in order to find and extract them.

Of course, it follows that such technology will be very costly, which creates a need for large sums of money and investors willing to fund the research and development stages. The need for large investments creates a group of investors in need of investment confidence.[186] This need, when recognized as legitimate to state and international interests, has been, and is being, addressed by legislative bodies, namely the U.S. Congress and the U.N., who can pass laws that will persuade investors that property rights will attach to the commercial endeavors that they fund.[187] This, in turn, means that investors will have a higher probability of seeing returns on their investments in the future.[188]

Concerning the commerciality of deep seabed mining, this is exactly the type of investor confidence that the U.N. and U.S. sought to create with UNCLOS and the Seabed Act.[189] They both created regulatory schemes under which a person could obtain property rights over minerals extracted from the deep seabed.[190] The U.N. created the ISA in order to regulate deep seabed mining and ensure that every nation, regardless of their political and economic position, would realize their rights to extracted minerals, based on the idea that they belong to all of humankind.[191] The U.S. adopted the Seabed Act in order to regulate its citizens and their deep seabed endeavors.[192]

b. Comparing the Seabed Act and the Space Act

Like the United States' Seabed Act, its Space Act grants property rights over extracted minerals to U.S. citizens.[193] It also tasks the executive branch

186. Luc Olinga, *New Space Mining Law to Spark Interplanetary Gold Rush*, PHYS.ORG (Dec. 8, 2015), http://phys.org/news/2015-12-space-law-interplanetary-gold.html.

187. *Id.*

188. *Id.*

189. *Id.*

190. *Id.*

191. *U.N. Convention*, *supra* note 161.

192. Deep Seabed Hard Mineral Resources Act, Pub. L. No. 96-283, 94 Stat. 553 (1980) (codified as amended at 30 U.S.C. §§ 1401–73 (2012)).

193. 30 U.S.C. § 1412(b)(3); 51 U.S.C. § 51303 (2012).

with regulatory activities[194] and subjects itself to obligations under national treaties.[195]

There are also a number of striking differences between the Seabed Act and the Space Act. Where the Seabed Act is exhaustive,[196] the Space Act is nearly devoid of any regulatory framework.[197] It contains no provisions about licensing, environmental protections, liabilities, jurisdiction, safety, or a plethora of other provisions seemingly vital to ensuring proper administration and adherence to international obligations.[198] The Space Act was passed in conjunction with the Spurring Private Aerospace Competitiveness and Entrepreneurship Act of 2015 ("Competitiveness Act").[199] Interestingly, the Competitiveness Act regulates commercial space flight, but includes a more complete framework for licensing, liability, jurisdiction, and even the environmental impacts of launching commercial space vehicles.[200]

Another notable difference is the lack of any congressional concern for the common heritage of humankind within the Space Act.[201] The Seabed Act states that one of its purposes is to "encourage the successful conclusion of a comprehensive Law of the Sea Treaty, which will give legal definition to the principle that the hard mineral resources of the deep seabed are the common heritage of mankind and which will assure, among other things, nondiscriminatory access to such resources for all nations . . . ."[202] The Space Act makes no such declaration, nor does it discuss the importance of creating and ratifying a similar comprehensive space treaty.[203]

Many of these differences are likely a product of the Space Act being in its infancy, but they also highlight the concerns of those who fear Congress rushed this legislation through too quickly.[204]

c. Efforts to Create an International Space-Mining Legal Framework

At the international level, beyond the broad provisions of the Outer Space and Moon Treaties mentioned above,[205] there is nothing to regulate space resource mining in the same way that UNCLOS regulates deep seabed mining—but there is movement in that direction. There has been discussion within the U.N. at various workshops and gatherings about both the need to strengthen international space law adherence in general and to create a framework that guides and governs commercial space activities.[206]

194. 30 U.S.C. § 1468; 51 U.S.C. § 51302.
195. 30 U.S.C. § 1468(d); 51 U.S.C. § 51303.
196. 30 U.S.C. §§ 1401–73.
197. 51 U.S.C. §§ 51301–03.
198. *Id.*
199. U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 705 (codified as amended at 51 U.S.C. §§ 50901–19 (2012) and scattered sections of 42 U.S.C.).
200. *Id.*
201. 51 U.S.C. §§ 51301–03.
202. 30 U.S.C. § 1401(b)(1).
203. 51 U.S.C. §§ 51301–03.
204. Swarztrauber, *supra* note 143.
205. Outer Space Treaty, *supra* note 92; Moon Treaty, *supra* note 97.
206. *See, e.g.*, *United Nations/Islamic Republic of Iran Workshop on Space Law: Role of International*

A number of recommendations have been proffered in these workshops.[207] It is first recommended that an international framework be developed in order to "determine the rules of the game," which should include rewarding innovation, removal of regulations over export control, and the protection of property rights.[208] Then, within this framework, individual states should create national legislation that will help them adhere to their international obligations and protect their national interests.[209]

To these ends, the International Institute of Air and Space Law, a leading space law research institution, has created the Hague Space Resources Governance Working Group ("Working Group").[210] The Working Group was created in recognition that a clear, international framework does not exist to govern space resource activities.[211] With this in mind, the Working Group will "encourage States to engage in negotiations for an international agreement or non-legally binding instrument."[212] At the end of its project, which is projected to last from October 2015 until the end of 2017, the Working Group will offer recommendations for formulating such agreements.[213]

IV. RECOMMENDATIONS

There are many reasons to be excited about the prospect of mining resources from space. Hopes are high that these mining efforts will provide an economic boon by producing jobs and injecting more money into the economy.[214] Additionally, the negative impact of mining natural resources on Earth is widely reported[215] and might be mitigated by space mining. If mining precious resources from space can minimize the burden on Earth, then this would lend even greater support for asteroid mining. Finally, little enchants the human mind and propels innovation more than sending people and manmade objects into space. For good reason, there is much enthusiasm about the prospect of space mining.

On the other hand, it is troublesome to some that private, commercial entities will be paving the way and making up many of the rules as they go.

Space Law in the Development and Strengthening of International Regional Cooperation in the Peaceful Exploration and Use of Outer Space, OFF. FOR OUTER SPACE AFF., U.N. (Nov. 2009), http://www.unoosa.org/res/oosadoc/data/documents/2010/stspace/stspace47_0_html/st_space_47E.pdf. [hereinafter *U.N. Workshop*] (discussing deficiencies in international space law pertaining to commercial space activities and providing recommendations for developing a framework to fix such deficiencies).

207. *Id.*

208. Christoph Venet, *The Development of Private and Commercial Space Activities*, EUR. SPACE POL'Y INST., *in U.N. Workshop*, *supra* note 206, at session 3.

209. *Id.*

210. *The Hague Space Resources Governance Working Group*, LEIDEN U.: INT'L. INST. AIR & SPACE L., http://law.leiden.edu/organisation/publiclaw/iiasl/working-group/the-hague-space-resources-governance-working-group.html (last visited Oct. 11, 2016).

211. *Id.*

212. *Id.*

213. *Id.*

214. Robinson, *supra* note 86 (stating that space mining will happen, and that resources will be needed to get to space).

215. *See, e.g.*, *id.* (stating that there are not the same concerns for human and animal life in space as there is on Earth).

Might this lead to repeating many of the mistakes humans have made on Earth? Might there be unforeseen problems that could spell trouble if mining efforts are not properly regulated? The answer to these questions is likely "yes" as well.

It will be important in the coming years to balance the former excitement against the latter caution. Space might seem limitless and impossible to affect in any significant fashion; but, history must be a major voice for the space-mining industry.[216] It must be remembered that humans can make an impact that will be felt for generations to come. Thus, it will be important that lawmakers and the international community be as proactive as possible—both in outlining property rights and protecting the final frontier from being harmed by an industry that might become overzealous if left unchecked.

Specifically, it will be vital for countries to enter into some sort of international agreement. One option is to create an agreement similar to UNCLOS, which would regulate how individual states and their citizens interact with resources mined from space.[217] Such an agreement should recognize not only the property rights of the extracting commercial entities but also the rights of non-spacefaring countries to benefit from the minerals as well. This might include the creation of an international body, much like the ISA, that will ensure that the interests of all nations are maintained by distributing funds and technology to less wealthy or non-spacefaring nations. The U.S. would do well to help create and ratify such an agreement—something they have failed to do with UNCLOS.

If the U.S. and other countries are uneasy about entering into such a restrictive agreement, they might also consider an international regulatory body and scheme much like the one used for satellites. The International Telecommunications Union (ITU) is a United Nations agency that, among other services, provides the international community with uniform satellite-orbit oversight and regulatory guidance.[218] Currently, 193 countries follow the ITU regulations and utilize their services, which have been likened to domain-name registration.[219] In the same way, spacefaring countries could form an international body that helps create and maintain a uniform space-mining legal framework.[220]

Without some sort of international framework as described above, the U.S. and other space-mining countries leave themselves open to great conflict and will be required to patch together a multitude of treaties between

---

216. *See* James Anthony Froude, *The Science of History*, *in* PROSE MASTERPIECES FROM MODERN ESSAYISTS 3, 36–37 (1885) ("History . . . is a voice forever sounding across the centuries the laws of right and wrong.").

217. Adam Minter, *Asteroid-Mining Race Starts with Few Laws in Place*, JAPAN TIMES (Sept. 12, 2014), http://www.japantimes.co.jp/opinion/2014/09/12/commentary/world-commentary/asteroid-mining-race-starts-with-few-laws-in-place.

218. *Welcome to ITU-R*, INT'L TELECOMM. UNION, http://www.itu.int/en/ITU-R/information/Pages/default.aspx (last visited Oct. 11, 2016).

219. Clive Thompson, *Space Mining Could Set Off a Star War*, WIRED (Jan. 14, 2016, 7:00 AM), http://www.wired.com/2016/01/clive-thompson-11/.

220. *Id.*

themselves as problems inevitably arise.[221]

V. CONCLUSION

The idea of mining resources from celestial bodies is something that has always been relegated to video games and sci-fi movies. But as technology continues to progress at an exponential rate, such mining is starting to come within the realm of possibility. A number of companies are currently creating prospecting technologies that will allow them to determine exactly what an individual asteroid holds. They hope to eventually harvest these resources and sell them for lucrative profits.

Fortunately for these companies, the current legal regime governing property rights to space resources is undergoing rapid change at the national level. The U.S. recently passed the Space Resource Exploration and Utilization Act of 2015, which explicitly entitles U.S. citizens to property rights over any space resources they obtain. This is certain to induce confidence in U.S. investors.

The situation at the international level is different. Current international space agreements are vague, lacking in consensus, and provide little precedent for ownership of space resources. This has led the international community to move in the direction of creating a better regulatory framework, but this movement is still in discussion stages and is likely to take a while to come to fruition.

Because of this state of international uncertainty and the currently bare-bones structure of the Space Act, serious questions remain to be answered concerning whether the recently passed Space Act will both comport with international law and lead to efficient and safe space-mining operations.

221. Minter, *supra* note 217.