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SUSTAINABLE MINING: INCENTIVIZING ASTEROID MINING IN THE NAME OF ENVIRONMENTALISM

KEVIN MACWHORTER*

INTRODUCTION

Long a part of the science fiction imagination,¹ mining in space has attracted interest both seriously and for amusement.² Though many have looked to the stars as a destination to fulfill mankind's ambitions, to colonize the solar system, or to increase the wealth of humanity, few have considered the massive environmental benefits that could result. Lifeless hunks of rock and precious metals orbit the sun with no hope of supporting life: why not export harmful, exploitative mining practices to a distant satellite?

As the Earth's supplies of precious metals dwindle, private investors have begun to look to asteroids for the solution.³ A substantial problem exists, however, between the solution to many of Earth's environmental woes and its practical application. Private companies cannot be secure in the right to own the material they extract, because the law on the matter is far from clear.⁴ Companies therefore have little incentive to invest in asteroid mining at all, given the high costs of space flight⁵ and development of proper technology. The Outer Space Treaty⁶ (the "OST" or the

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¹ *Market for Metals*, PLANETARY RES., <http://www.planetaryresources.com/asteroids/market-for-metals> [<https://perma.cc/SEG7-SLLM>] (last visited Nov. 12, 2015). See also discussion *infra* Part I.C.

² See *Overview: About the Google Lunar XPrize*, GOOGLE LUNAR XPRIZE, <http://lunar.xprize.org/about/overview> [<http://perma.cc/8UJF-SA5C>] (last visited Nov. 12, 2015).

³ Matthew Feinman, *Mining the Final Frontier: Keeping Earth's Asteroid Mining Ventures from Becoming the Next Gold Rush*, 14 U. PITT. J. TECH. L. & POL'Y 202, 202 (2014).

⁴ See *id.*

⁵ See Adam Summers, *Space Privatization Update*, REASON FOUND. (Apr. 15, 2013), <http://reason.org/news/show/apr-2013-space-privatization> [<http://perma.cc/4FVU-5TUQ>].

⁶ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, G.A. Res. 2222 (XXI), U.N. Doc. A/RES/1348 (XIII) (Dec. 19, 1966) [hereinafter Outer Space Treaty or OST].

"Treaty"), dedicated as it is to the common use of space for all nations, is laudable. It was adopted in 1967,⁷ however, the realities of today's growing population and shrinking supply of crucial resources requires rethinking the Treaty's application.

This Note examines the legal and environmental implications of asteroid mining. It argues that the OST provides a workable framework for a scheme of limited property ownership in extracted material, but requires an amendment to iron out any ambiguity. To that end, the United States Congress should pass a law reassuring American companies that they have enforceable property rights in the minerals they extract.⁸ Further, it should direct the President to treat with the OST signatories to amend the Treaty. This would incentivize asteroid mining by eventually removing legal ambiguity and guaranteeing American companies of their claims to minerals on asteroids. The Earth's environment would then substantially benefit.

Part I surveys the private space flight and Earth-based mining industries, as well as early asteroid mining technology and investments. Part II outlines relevant space law, highlighting the continuing problem of legal ambiguity in property ownership in space. Further, it critiques a congressional attempt to secure rights for U.S. industry and looks at some proposed legal frameworks. Part III proposes a new law that would get the ball rolling towards an amendment to the OST in order to resolve existing ambiguity and discusses the benefits such a law would provide.

I. WHY ASTEROID MINING? THE ENVIRONMENTAL CONSEQUENCES OF RARE ELEMENT MINING AND THE RISE OF THE PRIVATE SPACE INDUSTRY

One may question whether asteroid mining is desirable, or even possible. There are many compelling reasons to suggest that it is: mining on Earth is incredibly destructive to the environment and to many societies;⁹ the private space industry is booming with investment and government contracts;¹⁰ and technology has come far enough to warrant

⁷ *Id.*

⁸ The SPACE Act, H.R. 2262, 114th Cong. (2015) which passed in the House of Representatives on May 21, 2015, accomplishes this much already, but needs more substance. See *infra* Part II.B.

⁹ Int'l Mountain Soc'y, MINING, 4 MOUNTAIN RES. & DEV. 175, 175 (1984).

¹⁰ Summers, *supra* note 5.

serious inquiry into the future of space mining.¹¹ This section examines each point in turn.

A. *Rare Element Mining on Earth*

In the next sixty years, scientists predict that certain elements crucial to modern industry—such as platinum, zinc, copper, phosphorous, lead, gold, and indium—could be exhausted on Earth.¹² Many of these have no synthetic alternative, unlike chemical elements such as oil or diamonds.¹³ Liquid-crystal display (“LCD”) televisions, cellphones, and laptops are among the various consumer technologies that use precious metals.¹⁴ Further, green technologies—including wind turbines, solar panels, and catalytic converters—require these rare elements.¹⁵ As demand rises for both types of technologies, and as reserves of rare metals fall, prices skyrocket.¹⁶ Demand for nonrenewable resources creates conflict, and consumerism in rich countries results in harsh labor treatment for poorer countries.¹⁷

In general, the mining industry is extremely destructive to Earth’s environment.¹⁸ In fact, depending on the method employed, mining can destroy entire ecosystems by polluting water sources and contributing to deforestation.¹⁹ It is by its nature an unsustainable practice, because it involves the extraction of a finite and non-renewable resource.²⁰ Moreover,

¹¹ See Raymond Beauchemin, ‘Peak Metal’ Problems Loom, Warns Scientist, THE NAT’L, Aug. 7, 2008, available at <http://www.thenational.ae/news/world/europe/peak-metal-problems-loom-warns-scientist#full> [<http://perma.cc/RU3Q-RF5V>].

¹² David Cohen, *Earth’s Natural Wealth: An Audit*, NEW SCIENTIST, May 23, 2007, at 34–41, available at <https://www.newscientist.com/article/mg19426051.200-earths-natural-wealth-an-audit/> [<https://perma.cc/G7AG-7PN6>].

¹³ *Id.*

¹⁴ Beauchemin, *supra* note 11.

¹⁵ *Id.*

¹⁶ *Id.*

¹⁷ See *id.*; Bonnie J. Glaister & Gavin M. Mudd, *The Environmental Cost of Platinum—PGM Mining and Sustainability*, 23 MIN. ENG’G 438, 438 (2010) (describing the effects of rare element mining in localized areas such as South Africa, which holds roughly 88% of global platinum resources).

¹⁸ Int’l Mountain Soc’y, *supra* note 9, at 175.

¹⁹ *Id.* (“Mining is a mode of natural resources exploitation that modifies the environment more extensively than most forms of human activity”); Stuart Kirsch, *Sustainable Mining*, 34 DIALECTICAL ANTHROPOLOGY 87, 88 (2010) (“The mining industry moves more earth than any other human endeavor.”).

²⁰ Glaister & Mudd, *supra* note 17, at 441.

by extracting tiny amounts of metals from relatively large quantities of ore, the mining industry contributes the largest portion of solid wastes in the world.²¹ The Environmental Protection Agency (“EPA”) describes the industry as the source of “more toxic and hazardous waste than any other industrial sector [in the United States], costing billions of dollars to address the public health and environmental threats to communities.”²² Poor regulations and oxymoronic corporate definitions of “sustainability,” however, make it unclear as to just how much waste the industry actually produces.²³

Platinum provides an excellent case study of the issue, because it is an extremely rare and expensive metal—an ore expected to exist in vast quantities in asteroids.²⁴ Further, production of platinum has increased sharply in the past sixty years in order to keep up with growing demand for use in new technologies.²⁵ In fact, “despite their high costs, platinum group metals are so useful that [one] of [four] industrial goods on Earth require them in production.”²⁶ Scholars do not expect demand to slow any time soon.²⁷ Among other technologies, industries use platinum in products such as catalytic converters, jewelry production, various catalysts for chemical processing, and hydrogen fuel cells.²⁸ While there is no consensus on how far the Earth’s reserves of platinum will take humanity, many scientists agree that platinum ore reserves will deplete in a relatively short amount of time.²⁹

²¹ *Id.* at 448. Mining waste includes any waste produced when extracting and processing minerals. *Mining Waste*, ENVTL. PROT. AGENCY, <http://www.epa.gov/epawaste/nonhaz/industrial/special/mining> [<http://perma.cc/ZHD3-ZVY9>] (last visited Nov. 12, 2015).

²² *National Enforcement Initiative: Reducing Pollution from Mineral Processing Operations*, ENVTL. PROT. AGENCY, <http://www.epa.gov/enforcement/national-enforcement-initiative-reducing-pollution-mineral-processing-operations> [<http://perma.cc/WBW8-3MMM>] (last visited Nov. 12, 2015).

²³ Glaister & Mudd, *supra* note 17, at 448. See Kirsch, *supra* note 19, at 87–88 (describing the corporate practice of redefining “sustainable mining” to manipulate public opinion).

²⁴ *Market for Metals*, *supra* note 1; see also discussion *infra* Part I.C.

²⁵ See Glaister & Mudd, *supra* note 17, at 439, fig. 1.

²⁶ *Market for Metals*, *supra* note 1.

²⁷ Glaister & Mudd, *supra* note 17, at 438.

²⁸ *Id.* For a look at the main industries for which platinum is used, measured against the rate platinum is recycled, see *id.* at 442.

²⁹ Compare Gordon et al., *Metal Stocks and Sustainability*, 103 PROC. NAT'L ACAD. SCI. 1209, 1209 (2006) (arguing that platinum resources could be depleted in a matter of decades), with Glaister & Mudd, *supra* note 17, at 442 (contending that “[t]he critical sustainability issue in the future is not resource size but the associated environmental costs.”).

With the rate of mining at an all-time high,³⁰ “it is increasingly clear that historical patterns of mineral resources and development cannot simply be assumed to continue unaltered into the future.”³¹ The platinum mining industry, however, has a strong incentive to increase its rate of extraction as profits grow with the rate of demand. Without any alternative, this destructive practice will continue into the future.³²

So-called platinum-group metal (“PGM”) ores are mined through underground or open cut techniques.³³ Due to these practices, all but a very small fraction of the mined platinum ore is disposed of as solid waste.³⁴ The environmental consequences of platinum production are thus quite significant, but like the mining industry in general, the amount of waste is typically under-reported.³⁵

While this is due to high production levels at the moment, those levels will only increase given the estimated future demand of platinum.³⁶ In spite of the negative consequences, mining continues unabated because it is economically important to many areas.³⁷ The future environmental costs provide a major challenge in creating a sustainable system. Relegating at least some mining companies to near-Earth asteroids would reduce the negative effects of future mining levels on Earth. The economic benefits of mining need not be sacrificed for the sake of the environment.³⁸

B. Privatization of the Space Industry

For most of the Space Age, the role of private companies has been as that of government contractors.³⁹ During the past fifteen years, however, space flight has become increasingly the realm of private industry.⁴⁰

³⁰ *Market for Metals*, *supra* note 1.

³¹ Glaister & Mudd, *supra* note 17, at 441.

³² *See, e.g., id.* at 447, fig. 8.

³³ *Id.* at 439.

³⁴ *Id.* at 448.

³⁵ *Id.* at 448–49.

³⁶ *Id.* at 449.

³⁷ *See Int’l Mountain Soc’y*, *supra* note 9, at 175.

³⁸ *But see* Muzaffar Assadi, *Kudremukh: Of Mining and Environment*, 37 *ECON. & POL. WKLY.* 4898, 4898 (2002) (describing the “contradiction between ecology/environment on the one hand and capitalism on the other.”).

³⁹ Summers, *supra* note 5.

⁴⁰ MATTHEW J. KLEIMAN, *THE LITTLE BOOK OF SPACE LAW X* (2013) (“The prominence of space law has grown in recent years as private companies assume many of the roles traditionally performed by government agencies.”).

Space tourism is on the rise,⁴¹ and private companies have been launching their own satellites into orbit for decades.⁴² In May 2012, SpaceX docked with the International Space Station—the first private company to do so.⁴³

While the National Aeronautics and Space Administration's ("NASA") federal outlay has increased since 1958, NASA's budget as a percentage of US spending has decreased dramatically.⁴⁴ The private space industry has seen dramatic growth as a result.⁴⁵ Since NASA retired its shuttle fleet in 2011, the agency has turned to private actors to design and build spacecraft.⁴⁶ That year, NASA awarded four private space companies—SpaceX, Blue Origin LLC, Boeing Co., and Sierra Nevada Corp.—contracts worth a combined total of \$269.3 million to transport cargo and crew to and from the International Space Station.⁴⁷ More companies, such as Orbital Sciences, have followed suit.⁴⁸

Space mining in particular has been a focus of private investment.⁴⁹ The promise of abundant rare Earth resources creates the possibility of vast wealth for intrepid investors.⁵⁰ For example, Google founders Larry Page and Eric Schmidt have invested heavily in private space flight.⁵¹ Google is offering the Lunar X Prize: \$30 million in prizes to any team who is able to "safely land a robot on the surface of the Moon, have that robot travel 500 meters [1,640 feet] over the lunar surface, and send video, images, and data back to the Earth" before 2016.⁵² The purpose behind the contest should be apparent: investors think private space flight and

⁴¹ *Id.*

⁴² JULIAN HERMIDA, LEGAL BASIS FOR A NATIONAL SPACE LEGISLATION xiii (2004).

⁴³ KLEIMAN, *supra* note 40, at X.

⁴⁴ Simon Rogers, *NASA Budgets: US Spending on Space Travel Since 1958 UPDATED*, THE GUARDIAN (Feb. 1, 2010), available at <http://www.theguardian.com/news/datablog/2010/feb/01/nasa-budgets-us-spending-space-travel> [<http://perma.cc/SUW3-TGX6>].

⁴⁵ See generally Summers, *supra* note 5.

⁴⁶ *Id.*

⁴⁷ *Id.*

⁴⁸ *Id.* The U.S. government has looked to the private sector for other missions as well. For example, in 2012, NASA contracted with Bigelow Aerospace "to build an inflatable space habitat that would be attached to the [International Space Station]." *Id.*

⁴⁹ See Summers, *supra* note 5.

⁵⁰ *Market for Metals*, *supra* note 1; see also *supra* Parts I.A & I.C.

⁵¹ Paul Marks, *So You're Going to Mine Asteroids? Oh, Really: How Google Billionaires Invest Their Spare Cash*, SLATE (Aug. 19, 2012), http://www.slate.com/articles/health_and_science/new_scientist/2012/08/asteroid_mining_by_planetary_resources_google_billionaires_are_backing_an_outlandish_venture_.html [<http://perma.cc/QY26-WFH5>].

⁵² GOOGLE LUNARX PRIZE, *supra* note 2.

mining could be extremely lucrative.⁵³ Rare metals, such as platinum, could become far more accessible.⁵⁴

In 2012, Page, Schmidt, director James Cameron, and other distinguished entrepreneurs announced they were investing “considerable financial resources” in Planetary Resources, a company developing the technology to mine an asteroid.⁵⁵ The company’s goal is to land a mining vessel on a near-Earth asteroid, mine its valuable minerals, and bring “the natural resources of space within humanity’s economic sphere.”⁵⁶ To that end, many companies are focused on the idea of asteroid mining.⁵⁷

Privatization, however, has brought many legal and economic considerations to the forefront. One of the most significant obstacles for the private space industry has been the price tag of traveling into space. Complicating matters, the current law governing claims of property in space is ambiguous.⁵⁸ Companies therefore cannot be sure whether their property claims will be enforced after they extract minerals in space and bring them back to Earth.⁵⁹ When investing large sums of money such a consideration is absolutely critical.⁶⁰ Although there has been investment in the area, sending an actual mission to an asteroid will require less ambiguous property provisions in international space law.

C. Asteroid Mining 101

As the Planetary Resources website exclaims, “[T]he more we learn about asteroids, the more enticing they become!”⁶¹ Certain types of asteroids—including X-type and S-type asteroids—contain both precious and base metals in quantities sufficient to make any entrepreneur

⁵³ Bradley D’Souza, *US Space Policy Shifts with Privatized Contract*, THE BATTALION (Oct. 1, 2014), http://www.thebatt.com/news/view.php/850197/US-space-policy-shifts-with-privatized-contract/article_7186b3be-ac35-5192-9426-a6ab57f518a3.html [<http://perma.cc/976L-A9N2>] (last visited Nov. 12, 2015).

⁵⁴ *Id.* (quoting Gregory Chamitoff, former astronaut and aerospace professor of engineering practice).

⁵⁵ KLEIMAN, *supra* note 40, at X; Marks, *supra* note 51.

⁵⁶ KLEIMAN, *supra* note 40, at X.

⁵⁷ *Id.*

⁵⁸ *See infra* Part II.

⁵⁹ *Id.*

⁶⁰ KLEIMAN, *supra* note 40, at XI (“Well thought-out laws that govern spaceflight activities minimize the risk to people and property in outer space and on the ground, while not prematurely stifling innovation in this emerging industry.”).

⁶¹ *Asteroid Composition*, PLANETARY RES., <http://www.planetaryresources.com/asteroids/composition/> [<http://perma.cc/5P2P-NY27>] (last visited Nov. 12, 2015).

salivate.⁶² Metals on which many current technologies rely—such as iron, gold, and platinum—can be found in most asteroids.⁶³ Current estimates count around two million asteroids in the solar system that are a kilometer or more in diameter.⁶⁴ Astrophysicists estimate that each could contain 30 million tons of nickel, 1.5 million tons of cobalt, and 7,500 tons of platinum, among other minerals.⁶⁵ To put that in economic terms, the value of each asteroid could be “somewhere in the trillions [of dollars] or higher.”⁶⁶

Indeed, because of their zero gravity fields and availability of metals, asteroids have been considered as candidates for resource extraction since the beginning of the space age.⁶⁷ The technology needed to extract resources from asteroids, however, is a very recent phenomenon.⁶⁸ With the European Space Agency successfully landing the Philae Lander on Comet 67P, it is much more plausible to land a mining operation on an asteroid.⁶⁹

Although companies likely are not able to send mining ventures to asteroids immediately, as the preceding section suggested, asteroid mining is a possibility in the near future.⁷⁰ First of all, two companies are developing the technology needed to mine asteroids.⁷¹ Planetary Resources

⁶² See Kevin Bonsor, *How Asteroid Mining Will Work*, HOW STUFF WORKS, <http://science.howstuffworks.com/asteroid-mining1.htm> [<http://perma.cc/G9DB-TPGR>] (last visited Nov. 12, 2015). See generally *Market for Metals*, *supra* note 1.

⁶³ Renee Cho, *Rare Earth Metals: Will We Have Enough?*, STATE OF THE PLANET (Sept. 19, 2012), <http://blogs.ei.columbia.edu/2012/09/19/rare-earth-metals-will-we-have-enough/> [<http://perma.cc/7X4E-A3MG>].

⁶⁴ 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).

⁶⁵ Bonsor, *supra* note 62.

⁶⁶ Feinman, *supra* note 3, at 205. See also Bonsor, *supra* note 62, at 1 (suggesting a similarly high dollar value).

⁶⁷ Brian O'Leary, *Mining the Apollo and Amor Asteroids*, 197 SCI. 363, 363 (1977).

⁶⁸ In 1990, for example, one scholar lamented that “asteroid mining looks unpromising by wide margins, even for the most precious metals.” Neville Brown, *An International Expedition to Mars?*, 46 THE WORLD TODAY 12, 14 (1990); see also Hugh Albert Millward, *Geographical Aspects of the “High Frontier” Concept*, 61 HUMAN GEOGRAPHY 113, 116 (1979) (“Until asteroid mining is fully practical, possible sources of raw materials are limited to the earth and the moon.”).

⁶⁹ See Kenneth Chang, *Comet Landing Bumpier than Initially Thought*, N.Y. TIMES, Nov. 14, 2014, at A11, available at <http://www.nytimes.com/2014/11/14/science/space/philae-rosetta-spacecraft-bounced-at-landing.html?module=Search&mabReward=relbias%3A%2C%7B%22%22%3A%22RI%3A10%22%7D> [<http://perma.cc/B8XZ-PS89>].

⁷⁰ See *infra* Part I.B.

⁷¹ *Id.*

is creating cheaper prospecting spacecraft “small enough to hitch a ride into space with larger, primary payloads.”⁷² Another company, Deep Space Industries (“DSI”), is developing a four-stage system for mining in space: Prospecting, Processing, Harvesting, and Manufacturing.⁷³ It has already invented one spacecraft to be used for the Prospecting stage: a tiny probe, called FireFly, designed to scout asteroids and study their “size, shape, spin and composition”⁷⁴ For the Processing phase, DSI is creating technology required to “transform regolith to raw materials” for manufacture.⁷⁵ The company is currently developing another spacecraft, called a Harvester, for the third stage to collect and transport resources.⁷⁶ Finally, the company is creating technology to manufacture finished products in space.⁷⁷

The United States’ space policy is also embracing the idea of asteroid mining. In April 2010, President Obama promised to send astronauts to explore an asteroid by 2025.⁷⁸ In 2014, NASA requested, much to the surprise of asteroid scientists, a budget that “includes \$105 million to begin work on a mission that would send a robotic spacecraft to capture an asteroid as early as 2019 and haul it back so that astronauts could rendezvous with it by 2022.”⁷⁹ Further, NASA has awarded contracts to

⁷² *There are No Roads Where We’re Headed, But We Have a Map*, PLANETARY RES., <http://www.planetaryresources.com/technology> [<http://perma.cc/T5R8-HHLZ>] (last visited Nov. 12, 2015) (describing the Arkyd spacecraft).

⁷³ *Space Resources*, DEEP SPACE INDUS., <http://deepspaceindustries.com/space-resources/> [<http://perma.cc/Q7V5-H7FL>] (last visited Nov. 12, 2015).

⁷⁴ *Prospecting*, DEEP SPACE INDUS., <http://deepspaceindustries.com/prospecting/> [<http://perma.cc/7H7V-NBLX>] (last visited Nov. 12, 2015).

⁷⁵ *Processing*, DEEP SPACE INDUS., <http://deepspaceindustries.com/processing/> [<http://perma.cc/6FL8-6AQX>] (last visited Nov. 12, 2015).

⁷⁶ *Harvesting*, DEEP SPACE INDUS., <http://deepspaceindustries.com/harvesting/> [<http://perma.cc/PS5T-QBPY>] (last visited Nov. 12, 2015).

⁷⁷ *Manufacturing*, DEEP SPACE INDUS., <http://deepspaceindustries.com/manufacturing/> [<http://perma.cc/5W59-XGZ5>] (last visited Nov. 12, 2015).

⁷⁸ Richard A. Kerr, *Planetary Scientists Casting Doubt on Feasibility of Plan to Corral Asteroid*, 340 SCI. 668, 668 (2013).

⁷⁹ *Id.* As the title of the article suggests, however, scientists are skeptical of the plan. One member of NASA went so far as to suggest that a “small group at [NASA] headquarters with little consultation with subject matter experts thought [the retrieval mission] would be a great headline. But that’s not enough.” *Id.* Another says that NASA’s “claims about resource utilization and planetary defense are pretty empty.” *Id.* But see *NASA Selects Deep Space for Two Asteroid Contracts*, DEEP SPACE INDUS. (June 19, 2014), <http://deepspaceindustries.com/nasa-selects-deep-space-for-two-asteroid-contracts/> [<http://perma.cc/LMR7-G7Q4>] (describing NASA’s award of two contracts to Deep Space Industries, Inc.

Planetary Resources and Deep Space Industries “to prepare for and ultimately execute missions to land on and mine asteroids for valuable resources.”⁸⁰ NASA is also designing a spacecraft, the primary goal of which is to land on an asteroid and take samples.⁸¹ It is scheduled for launch in September 2016.⁸²

As all this recent development suggests, the technology to mine asteroids is not far off. In fact, the requisite technology exists—it just needs to be adapted for use in an extraterrestrial environment.⁸³ As Chris Lewicki, president of Planetary Resources, said: “[T]he single biggest challenge” that Planetary Resources will have to overcome “is convincing people that asteroid mining will happen sooner than they think.”⁸⁴ Asteroid mining will gain in popularity as resources deplete, forcing humans to dig deeper and deeper in the Earth’s crust for minerals.⁸⁵ A recent article summarized some of Lewicki’s reasoning succinctly:

[T]he energy required to extract minerals from an asteroid is considerably less than to extract from the Earth, or even the moon . . . , because in space there is no atmosphere to oxidise or salt to corrode, no weather, no gravity or friction to oppose transportation, dissipate energy and waste heat and unlimited heat from the sun and coldness in space for refrigeration, creating the perfect vacuum⁸⁶

When people think of sustainability, they do not typically consider exploiting resources in places other than Earth. But that is exactly what should happen—and will, if current ambiguities with the law are sorted out.

“to accelerate [NASA’s] plans to partner with private industry on asteroid prospecting and harvesting” as part of the Asteroid Redirect Mission). At the very least, though, this debate reveals that NASA is serious about asteroid exploration.

⁸⁰ Brook Hays, *NASA contracts two firms to work on asteroid mining*, UPI (Nov. 24, 2014, 4:10 PM), http://www.upi.com/Science_News/2014/11/24/NASA-contracts-two-firms-to-work-on-asteroid/5301416856690/ [<http://perma.cc/3ERY-MELR>].

⁸¹ *Id.*

⁸² *Id.*

⁸³ Nilima Choudhury, *Asteroid Minerals Mining to be Achieved Within Five Years*, INDUS. MIN. (Mar. 14, 2014), <http://www.indmin.com/Article/3319663/Asteroid-minerals-mining-to-be-achieved-within-five-years.html> [<http://perma.cc/F6P2-K4YC>].

⁸⁴ *Id.* (quoting Chris Lewicki) (internal quotation marks omitted).

⁸⁵ *Id.*

⁸⁶ *Id.* (summarizing Chris Lewicki’s remarks) (internal quotation marks omitted).

II. SPACE LAW IN THE PRESENT AND FUTURE: A CONTINUING AMBIGUITY

The truth inherent in space law is that it is constantly playing catch-up with technology.⁸⁷ Because of this, many areas of space law are ambiguous—in particular, the status of property in space.⁸⁸ This ambiguity disincentivizes private investment in space exploration, technology, and mineral exploitation. Instead of exploring new opportunities in space, the law incentivizes cheaper methods of Earth-based mineral extraction. At the moment there is no viable alternative.⁸⁹ Without a new source of precious minerals, demand for consumer products and green technologies will keep production in mines at full tilt.

The number of claims and attempts to sell moon real estate illustrate the problem of ambiguity.⁹⁰ For example, Gregory Nemitz—a very entrepreneurial sort of man—filed with the Archimedes Institute in order to claim the asteroid Eros.⁹¹ When NASA landed the NEAR Shoemaker probe on the asteroid on February 12, 2001,⁹² he decided to charge twenty dollars for parking.⁹³ NASA, of course, told him he could have no claim to a celestial body.⁹⁴ Another example, which is perhaps more telling, involves the Apollo astronauts. Several of them brought moon rocks back to Earth.⁹⁵ NASA declared the rocks to be the property of the U.S. government.⁹⁶ For four decades, the international community has

⁸⁷ Leonard David, *Space Law 101: Filling the Legal Vacuum*, SPACE NEWS (Mar. 31, 2015), <http://spacenews.com/space-law-101-helping-fill-a-legal-vacuum/> [<http://perma.cc/7TJS-P6UU>].

⁸⁸ See generally Kelly M. Zullo, *The Need to Clarify the Status of Property Rights in International Space Law*, 90 GEO. L.J. 2413, 2416–35 (2002).

⁸⁹ See generally Dominic Basulto, *One Small Step for Mankind, One Giant Step for the Commercialization of the Moon*, WASH. POST (Feb. 12, 2015), available at <https://www.washingtonpost.com/news/innovations/wp/2015/02/12/one-small-step-for-man-one-giant-step-for-the-commercialization-of-the-moon/> [<https://perma.cc/4VKU-BJQF>].

⁹⁰ See VIRGILIU POP, WHO OWNS THE MOON? EXTRATERRESTRIAL ASPECTS OF LAND AND MINERAL RESOURCES OWNERSHIP 2–10 (2009).

⁹¹ Zullo, *supra* note 88, at 2414–15.

⁹² *Near-Shoemaker*, NASA, <http://science.nasa.gov/missions/near/> [<http://perma.cc/5S2B-KJ6H>] (last visited Nov. 12, 2015). *Landing on Eros*, NEAR, http://near.jhuapl.edu/news/sci_updates/01feb20.html [<http://perma.cc/B762-EH3Y>] (last visited Nov. 12, 2015).

⁹³ Zullo, *supra* note 88, at 2414–15.

⁹⁴ *Id.*

⁹⁵ *Id.* at 2432.

⁹⁶ *Id.*

acquiesced—albeit tacitly—to the United States’ claim of ownership over rocks harvested from the Moon.⁹⁷

These examples raise several questions: may individuals obtain property rights in extracted materials, so long as a government protects those rights rather than appropriate the mineral? Does the current international legal framework provide for some way to enforce those rights? Some scholars think a private party can claim mined space minerals.⁹⁸ But first, one must consider the issues in their legal context.

A. *The Current Legal Framework*

Space law has been a subject of debate since as early as 1926.⁹⁹ “Space law” refers to a wide swathe of legal doctrine. It ranges from commercial contract terms that determine the specifics of individual space launches to more general issues of a state’s behavior in space.¹⁰⁰ Many principles of space law, therefore, have been adopted from other fields of law, such as commercial contracting, and applied to exotic circumstances.¹⁰¹ As Lyall and Larsen explain, “‘Space law’ is particulate law, developed to deal with the practical problems of the use and exploration of outer space.”¹⁰²

Among those “practical problems” is the rapid pace of technology in space travel. Since the Wright brothers’ first manned flight, the law of space and aviation has had to respond to ever-changing circumstances. Additionally, space “law never seeks to regulate technology, but rather aims to place order in the competing human interests that result from that technology.”¹⁰³ As technology develops, governments have had to create new regulations and procedures.¹⁰⁴ The unfortunate truth is that the law

⁹⁷ *Id.*

⁹⁸ *Id.* (“This is an indication that the international community recognizes as customary international law the right to own extraterrestrial resources harvested from celestial bodies.”).

⁹⁹ FRANCIS LYALL & PAUL B. LARSEN, *SPACE LAW: A TREATISE* 5 (2009). There is some debate as to when “space law” can be said to have been born. *See, e.g.*, KLEIMAN, *supra* note 40, at VII (“Space law was born with the Space Age on October 4, 1957” when the first intercontinental ballistic missile was launched).

¹⁰⁰ LYALL & LARSEN, *supra* note 99, at 2.

¹⁰¹ *Id.*

¹⁰² *Id.*

¹⁰³ *Id.* (quoting M. Bourbonniere, *National-Security Law in Outer Space: The Interface of Exploration and Security*, 70 J. AIRL. & COMM. 3, 3 (2005)) (internal quotations omitted).

¹⁰⁴ *Id.*

will never keep up with the development of technology, especially in space.¹⁰⁵ Indeed, following the launch of Sputnik, many feared an obvious outer space legal vacuum.¹⁰⁶ Much like the property issue faced today, Sputnik's orbit raised questions about the ambiguity associated with space exploration.¹⁰⁷

Although an academic debate at this point, the legal status of property in space is necessary for any future exploration and exploitation of natural resources in space. Until then, private exploration is severely disincentivized. Further, the technology behind asteroid mining is fast becoming a reality.¹⁰⁸ The law must respond. In order to evaluate what the international community needs to accomplish to ensure future exploration, one must explore the international agreements already in place that speak to the issue of property rights.

To begin, the United Nations ("UN") established the UN Office of Outer Space Affairs ("UNOOSA") in 1958¹⁰⁹ to promote international cooperation in space and promote its peaceful use.¹¹⁰ UNOOSA oversees the UN's Committee on the Peaceful Uses of Outer Space ("COPUOS") and implements its decisions.¹¹¹ The UN founded COPUOS to avoid international rivalries in space.¹¹² The OST, the Liability Convention,¹¹³ and the Moon Agreement¹¹⁴ are all within the jurisdiction of COPUOS. There are

¹⁰⁵ *Id.*

¹⁰⁶ KLEIMAN, *supra* note 40, at VIII.

¹⁰⁷ One author describes the uncertain legal implications of Sputnik:

The conventional wisdom at the time was that the rules that governed airspace would extend upward to Earth orbit once humanity began operating in that domain. International air law had long held that a nation's sovereignty extended vertically to the airspace over its territory. If national sovereignty extended into outer space, launching Sputnik into an orbit that passed over many countries without permission would have been illegal.

Id. at VIII–IX.

¹⁰⁸ *See supra* Part I.C.

¹⁰⁹ *About Us*, UNITED NATIONS OFFICE FOR OUTER SPACE USAGE, <http://www.unoosa.org/oosa/en/OOSA/index.html> [<http://perma.cc/N3AL-6KWS>] (last visited Nov. 12, 2015) [hereinafter UNOOSA].

¹¹⁰ *Id.*; Simonetta Di Pippo, *The Peaceful Use of Space*, 1 THE SPACE J. 68, 68 (2014), available at http://www.issuu.com/unoosa/docs/room_di_pippo [<http://perma.cc/Y5LG-CKMK>].

¹¹¹ UNOOSA, *supra* note 109.

¹¹² Feinman, *supra* note 3, at 214–15.

¹¹³ G.A. Res. 2777 (XXVI), U.N. Doc. A/RES/2777 (XXVI) (Nov. 29, 1971) [hereinafter Liability Convention].

¹¹⁴ G.A. Res. 34/68, U.N. Soc. A/RES/34/68 (Dec. 5, 1979) [hereinafter Moon Treaty].

five international agreements that lay a framework of space law and, more importantly, ownership of objects and celestial bodies in space:

- The Treaty on Principles Governing the Activities of Space, Including the Moon and Other Celestial Bodies (“OST”);¹¹⁵
- The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Space Objects Launched into Outer Space (“ARRA”);¹¹⁶
- The Convention on International Liability for Damage Caused by Space Objects (“Liability Convention”);¹¹⁷
- The Convention on Registration of Objects Launched into Outer Space (“Registration Convention”);¹¹⁸ and
- The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (“Moon Treaty”).¹¹⁹

As with all international law, however, the actual authority of these treaties is debatable, because countries often ignore their precepts or disagree on the meaning of their substance.¹²⁰ International custom, therefore, is the major indication of what international law exactly is.¹²¹ The Law of the Sea is an instructive analogy on that point, and as Lyall and Larsen explain, “The practice need not be wholly uniform, but must be undertaken in the belief it is binding and required by law as opposed to being merely convenient or mutually beneficial.”¹²² Further, international law in general “was conceived to deal with relations between States,” not to deal with private claims of property.¹²³ International

¹¹⁵ OST, *supra* note 6.

¹¹⁶ G.A. Res. 2345 (XXII), U.N. Doc. A/RES/2345 (XXII) (Dec. 19, 1967) [hereinafter ARRA].

¹¹⁷ Liability Convention, *supra* note 113.

¹¹⁸ G.A. Res. 3235 (XXIX), U.N. Doc. A/RES/3235 (XXIX) (Nov. 12, 1974) [hereinafter Registration Convention].

¹¹⁹ 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, 77 (2003).

¹²⁰ LYALL & LARSEN, *supra* note 99, at 44.

¹²¹ *Id.* at 42 (quoting Art. 38.1.b of the ICJ Statute).

¹²² *Id.* (quoting Art. 38.1.b of the ICJ Statute).

¹²³ POP, *supra* note 90, at 36.

conventions offer some guidelines, though they do not formally establish a property regime.¹²⁴

In the context of international law, space law is very unique. The international community has developed a set of laws and customs over hundreds of years.¹²⁵ Space law, however, is far more recent.¹²⁶ It has developed rapidly in a globalized world where different legal systems, values, interests, and debates must be reconciled in order to produce some semblance of order. Modern technology and innovation occur at a blistering rate, and space law will always lag behind.¹²⁷

1. The Outer Space Treaty, 1967

The most obvious starting place is the OST of 1967, to which 103 nations are parties.¹²⁸ As most scholars recognize, the OST is best described as “the Magna Carta of Space.”¹²⁹ The Treaty is directed at national appropriation of celestial bodies, as well as the use of space for peaceful ventures.¹³⁰ Its principles include:

- A guarantee that the use and exploration of outer space is for the benefit of all mankind;
- freedom of exploration and use of celestial bodies by all spacefaring nations;
- an explicit provision against national appropriation of outer space and celestial bodies, as well as a ban on weapons of mass destruction;

¹²⁴ *Id.*

¹²⁵ See, e.g., *The United Nations Convention on the Law of the Sea (A historical perspective)*, U.N., http://www.un.org/depts/los/convention_agreements/convention_historical_perspective.htm [<http://perma.cc/EQ9F-YTEM>] (last visited Nov. 12, 2015) (discussing the Law of the Sea which developed starting in the seventeenth century).

¹²⁶ See KLEIMAN, *supra* note 40, at VII (stating “Space law was born with the Space Age on October 4, 1957” when the first intercontinental ballistic missile was launched.).

¹²⁷ See LYALL & LARSEN, *supra* note 99, at 84.

¹²⁸ *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, U.N. OFFICE FOR DISARMAMENT AFFAIRS, http://disarmament.un.org/treaties/t/outer_space [<http://perma.cc/3824-CVWD>] (last visited Nov. 12, 2015).

¹²⁹ LYALL & LARSEN, *supra* note 99, at 53; POP, *supra* note 90, at 37 (describing the OST as a “‘Constitution’ for outer space”).

¹³⁰ See *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, U.S. STATE DEP’T, <http://www.state.gov/www/global/arms/treaties/space1.html> [<http://perma.cc/ABJ8-KBMP>] (last visited Nov. 12, 2015) [hereinafter U.S. STATE DEP’T].

- the use of celestial bodies for peaceful purposes only;
- responsibility—by governmental and non-governmental bodies—for national activities in space;
- supervision by the States of non-governmental entities;
- control and jurisdiction over space objections and personnel by States;
- liability for damage; and
- avoiding “harmful contamination” of outer space.¹³¹

At the time of the Treaty’s adoption, only two states were truly spacefaring nations: the United States and the USSR.¹³² The Treaty was drafted during the Cold War, when the international community wanted to avoid the extension of the arms race into space.¹³³ The Preamble explains the concerns behind the Treaty, including “the general common interest in space, in its use for peaceful purposes, that the use of space should benefit all and the need for mutual understanding and co-operation.”¹³⁴

Given the historical backdrop, the Treaty drafters did not contemplate the rise of private space flight. Further, the OST sets out general principles to be expanded upon, and there is not much guidance in the realm of extraterrestrial property ownership.¹³⁵ The OST flatly denies national appropriation of celestial bodies, but does not contemplate appropriation by private individuals.¹³⁶ Some scholars argue that this is a “loophole,” allowing for unfettered private appropriation.¹³⁷ Others argue that private property is totally denied,¹³⁸ because countries bear responsibility for national activities in space.¹³⁹ In this line of thinking,

¹³¹ KLEIMAN, *supra* note 40, at XIII–XIV. *See also Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, U.N. OFFICE FOR OUTER SPACE AFFAIRS, <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html> [http://perma.cc/DVC8-S5BW] (last visited Nov. 12, 2015).

¹³² LYALL & LARSEN, *supra* note 99, at 57.

¹³³ *See* U.S. STATE DEP’T, *supra* note 130.

¹³⁴ LYALL & LARSEN, *supra* note 99, at 58. *See also* OST, *supra* note 6, at Preamble.

¹³⁵ POP, *supra* note 90, at 36.

¹³⁶ OST, *supra* note 6, at art. II.

¹³⁷ *See, e.g.,* Stephen Gorove, *Interpreting Article II of the Outer Space Treaty*, 37 FORDHAM L. REV. 349 (1969).

¹³⁸ *See, e.g.,* N. Goldman & D.J. O’Donnell, *Astro Law as Lex Communis Spatialis*, in PROC. OF THE 40TH COLLOQUIUM ON THE LAW OF OUTER SPACE 322 (1997).

¹³⁹ POP, *supra* note 90, at 65.

states cannot own property in space and so they could not be responsible for private ownership in space.¹⁴⁰ Further, the UN has issued a regulation applying the OST to both member states and their inhabitants, which was upheld in the United States by the Second Circuit.¹⁴¹

A majority of scholars agree that real property ownership in space is illegal,¹⁴² or at the very least unenforceable.¹⁴³ The OST, however, only bars claims of “celestial bodies,” but not extracted materials.¹⁴⁴ The term “celestial bodies” has never been fully defined in space law,¹⁴⁵ but it applies to planets, moons, and asteroids.¹⁴⁶ It seems clear then that private fee simple ownership is out of the question given the promise in Article II that outer space “shall be free for exploration and use by all States.”¹⁴⁷ What the OST does not rule out is the availability of limited property ownership in extracted minerals.

2. Space Objects—Three Treaties that Expand the OST

The OST provides a mechanism for amendment in Article XV. Any state party to the OST may propose amendments, and those enter into force for each accepting party after a majority of the state parties to the OST accept.¹⁴⁸ The treaties following the OST are elaborations, used to counteract the pace of technological evolution.¹⁴⁹ They take the generalities of the OST and apply them to particular situations.¹⁵⁰ In order to keep astride modern reality, the OST can still be amended to suit our globalized world.

ARRA, the Liability Convention of 1972, and the Registration Convention of 1975 expand the scope of the OST.¹⁵¹ These treaties get at how responsibility should be established, what a state may own in space, and liability in the case of damage.¹⁵² They “provide the responsibilities, the

¹⁴⁰ *Id.*

¹⁴¹ *See* *Filartiga v. Pena-Irala*, 630 F.2d 876 (2nd Cir. 1980).

¹⁴² POP, *supra* note 90, at 65.

¹⁴³ *See generally id.* at 66–69.

¹⁴⁴ OST, *supra* note 6, at art. II.

¹⁴⁵ LYALL & LARSEN, *supra* note 99, at 175.

¹⁴⁶ *Id.*

¹⁴⁷ OST, *supra* note 6, at art. II.

¹⁴⁸ POP, *supra* note 90, at 37.

¹⁴⁹ *Id.* at 36–37.

¹⁵⁰ LYALL & LARSEN, *supra* note 99, at 48.

¹⁵¹ *Id.* at 81.

¹⁵² *Id.* at 82.

boundaries and the main constraints on state activity.”¹⁵³ Although these treaties do not develop a comprehensive scheme of property ownership, they do reveal that ownership of private property is allowed under international law.¹⁵⁴ Further, they frame the issue of amending the OST to provide limited property ownership in space.¹⁵⁵ These treaties reveal a new method of developing international law, “bringing together the different and sometimes divergent legal traditions of the world to cope with new problems in a way that the formulation of earlier international law did not.”¹⁵⁶ Finally, they provide examples of international cooperation employed to avoid major international incidents as nations expanded their reach into space.¹⁵⁷

Under Article VI of the OST, a state party bears responsibility for all activities of its nationals in outer space.¹⁵⁸ Registration is therefore important in order to clearly determine liability. The Registration Convention extends the requirements of OST Article VIII, which requires registration of space objects for purposes of retaining jurisdiction and control over them.¹⁵⁹

ARRA was designed to “develop and give further concrete expression” to the OST.¹⁶⁰ The OST, in broad strokes, requires a state to give all possible assistance to astronauts and imposes a duty to return objects launched into outer space.¹⁶¹ The objects contemplated in ARRA, though, are limited to those that are capable of carrying an astronaut; the treaty

¹⁵³ *Id.* at 81.

¹⁵⁴ *Id.* at 82–84.

¹⁵⁵ *Id.*

¹⁵⁶ LYALL & LARSEN, *supra* note 99, at 81.

¹⁵⁷ *See id.* at 82.

¹⁵⁸ LYALL & LARSEN, *supra* note 99, at 83. *See also* OST, *supra* note 6, at art. IX (“If a State Party to the treaty has reason to believe that an activity or experiment planned by it or its nationals would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space . . . it shall undertake appropriate international consultations before proceeding . . .”).

¹⁵⁹ LYALL & LARSEN, *supra* note 99, at 83–84. *See also* OST, *supra* note 6, at art. VIII; Registration Convention, *supra* note 118, at art. II. Registration did not clearly anticipate the rise of the private space industry. For example, as private companies ferry equipment from Earth to the International Space Station, registration may have to be transferred from one state to another. *See, e.g.*, LYALL & LARSEN, *supra* note 99, at 92. Additionally, partnerships between private companies and states create unclear liability issues. *Id.* at 95 (describing some issues of registration involved with SeaLaunch).

¹⁶⁰ ARRA, *supra* note 116, at Preamble; LYALL & LARSEN, *supra* note 99, at 97.

¹⁶¹ OST, *supra* note 6, at art. V, VIII; LYALL & LARSEN, *supra* note 99, at 97.

does not apply to mined material from space.¹⁶² It does establish, however, that property ownership is enforceable, even when an object owned by a State or an astronaut is left in space.¹⁶³

The Liability Convention¹⁶⁴ expands the OST's liability provisions. OST Article I paragraph 2 and Article III indicate that "ordinary rules of international law" in relation to liability apply.¹⁶⁵ This treaty not only contemplates liability by state actors, but also international, intergovernmental entities.¹⁶⁶ The Preamble defines the scope of the treaty: to strengthen "international cooperation in the field of the exploration and use of outer space for peaceful purposes."¹⁶⁷

These treaties are important to consider for a comprehensive private property scheme in space, because they outline liability and potential ownership issues.¹⁶⁸ They do not, however, extend to private actors.¹⁶⁹ Any property scheme in space would have to take this into account.¹⁷⁰

3. The Moon Treaty

The Moon Treaty entered into force on July 11, 1984.¹⁷¹ As of 2015, only sixteen countries have acceded to it, with the United States conspicuously absent.¹⁷² The treaty thus binds only those sixteen countries, and the United States does not have to abide by its precepts. The treaty took a severe stance regarding property ownership in space.¹⁷³ It has been

¹⁶² See LYALL & LARSEN, *supra* note 99, at 104.

¹⁶³ *Id.* at 97–98.

¹⁶⁴ Liability Convention, *supra* note 113.

¹⁶⁵ LYALL & LARSEN, *supra* note 99, at 104.

¹⁶⁶ *Id.* at 106.

¹⁶⁷ Liability Convention, *supra* note 113, at Preamble; LYALL & LARSEN, *supra* note 99, at 107.

¹⁶⁸ LYALL & LARSEN, *supra* note 99, at 105–06.

¹⁶⁹ *Id.*

¹⁷⁰ The treaties also raise interesting questions outside the scope of this Note. For example: How will a company register the material they extract? Will the material, if somehow lost in space, be returned to the company that extracts it?

¹⁷¹ *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, UNODA, disarmament.un.org/treaties/t/moon (last visited Nov. 12, 2015).

¹⁷² Australia, Austria, Belgium, Chile, Kazakhstan, Kuwait, Lebanon, Mexico, Morocco, Netherlands, Pakistan, Peru, Philippines, Saudi Arabia, Turkey, and Uruguay. *Id.* None of these countries had serious space programs at the time. LYALL & LARSEN, *supra* note 99, at 178.

¹⁷³ See Moon Treaty, *supra* note 114, at art. 11.1.

called "the arch[-]enemy of space development"¹⁷⁴ and considered a failure.¹⁷⁵ The document is important, however, because it is the only international space treaty that actually contemplates property ownership in space, though it ultimately denies any possibility of ownership.¹⁷⁶

The treaty reiterates the OST's designation of space as for the exploration and use of all nations.¹⁷⁷ It places above private property rights the right to explore and use the Moon for scientific benefit.¹⁷⁸ Finally, it establishes the Moon as "the common heritage of all mankind."¹⁷⁹ Any natural resource exploitation would have to be governed by the international community for the benefit of the international community.¹⁸⁰ This provision turned many spacefaring countries off of the treaty,¹⁸¹ and its economic disincentives would have slowed any private interest in space mining.

4. The Law of the Sea and International Custom

The international community treats the sea in much the same way as it does space. Sea faring nations have cooperated in establishing a system of rules for the use of the oceans, culminating in the United Nations Convention on the Law of the Sea.¹⁸² In general, the Law of the Sea developed mainly through custom since the first ships sailed on the oceans.¹⁸³ The convention, however, simply codified some of these customs, including the United States' unilateral appropriation of mineral rights in coastal waters.¹⁸⁴

In 1945, President Harry S. Truman issued an executive order declaring a United States economic zone of interest extending 200 miles beyond the nation's coastline.¹⁸⁵ In part, the President did so to secure domestic oil interests.¹⁸⁶ The order "extended United States jurisdiction

¹⁷⁴ POP, *supra* note 90, at 37 (quoting D.J. O'Donnell, *An archenemy revisited: the 1979 Moon Treaty*, in 'SPACE 98' CONF., April 1998, Albuquerque, NM).

¹⁷⁵ *Id.* (citing G.H. Reynolds, *The Moon Treaty: Prospects for the Future*, 11 SPACE POL'Y 115 (1995)).

¹⁷⁶ See Moon Treaty, *supra* note 114, at art. 11.3.

¹⁷⁷ LYALL & LARSEN, *supra* note 99, at 182.

¹⁷⁸ *Id.* at 186.

¹⁷⁹ Moon Treaty, *supra* note 114, at art. 11.1.

¹⁸⁰ *Id.* at art. 11.5.

¹⁸¹ POP, *supra* note 90, at 37.

¹⁸² *The United Nations Convention on the Law of the Sea*, *supra* note 125.

¹⁸³ *Id.*

¹⁸⁴ *Id.*

¹⁸⁵ *Id.*

¹⁸⁶ *Id.*

over all natural resources on that nation's continental shelf—oil, gas, [and] minerals.”¹⁸⁷ Wanting to protect their own interests, many nations followed suit.¹⁸⁸ The practice thus became established custom.

When dealing with claims of private property in extracted space minerals, the United States could not attempt the same unilateral move. Extending jurisdiction is flatly barred by the OST.¹⁸⁹ It could, however, unilaterally guarantee property rights in extracted minerals within its own borders. As discussed more fully below, however, this solves only part of the problem.

5. The Law of Space Property

The web of treaties and custom does not establish a systematic property rights framework. In space, ownership of real property is forbidden by the OST.¹⁹⁰ Ownership of personal property, however, is allowed under certain conditions, as revealed by registration and liability requirements.¹⁹¹ Properly registered personal property rights are enforceable under current international law.¹⁹² The ambiguity concerns the conversion of real property into personal property.¹⁹³ This Note argues that it should be allowed under certain circumstances. As discussed in the subsequent section, Congress has attempted to iron out the uncertainty.

B. Congress Reacts to Ambiguity: The SPACE Act

On July 10, 2014, Congressmen Bill Posey and Derek Kilmer introduced the American Space Technology for Exploring Resource Opportunities in Deep Space Act (“ASTEROIDS Act”).¹⁹⁴ It was passed by the House of Representatives on May 21, 2015, as the Space Resource Exploration and Utilization Act of 2015 (“SPACE Act”).¹⁹⁵ Its purpose is “[t]o facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating

¹⁸⁷ *Id.*

¹⁸⁸ *The United Nations Convention on the Law of the Sea*, *supra* note 125.

¹⁸⁹ OST, *supra* note 6, at art. II.

¹⁹⁰ *Id.*

¹⁹¹ *Id.* at art. VII, VIII.

¹⁹² *Id.*

¹⁹³ LYALL & LARSEN, *supra* note 99, at 185.

¹⁹⁴ The American Space Technology for Exploring Resource Opportunities in Deep Space Act, H.R. 5063, 113th Cong. (2014) [hereinafter ASTEROIDS Act].

¹⁹⁵ SPACE Act, H.R. 2262, 114th Cong. (2015) [hereinafter the SPACE Act].

more stable and predictable regulatory conditions, and for other purposes.”¹⁹⁶ The law directs the President to:

- facilitate the commercial exploration and utilization of space resources to meet national needs;
- discourage government barriers to the development of economically viable, safe, and stable industries for the exploration and utilization of space resources in manners consistent with the existing international obligations of the United States; and
- promote the right of United States commercial entities to explore outer space and utilize space resources, in accordance with the existing international obligations of the United States, free from harmful interference, and to transfer or sell such resources.¹⁹⁷

A congressional directive to the Executive is exactly what this Note recommends, but there must be more substance behind it.¹⁹⁸ First, the SPACE Act does not address the problem of private ownership of property in space.¹⁹⁹ Second, the Act gives only lip-service to “existing international obligations”—any law granting property rights to private actors in space in the United States must acknowledge the current international law regime.²⁰⁰ Simply put, a unilateral effort to grant property rights to private actors will not be honored by the international community if they are not a part of the discussion.²⁰¹ The SPACE Act is purely aspirational,

¹⁹⁶ *Id.*

¹⁹⁷ *Id.* § 51302(a).

¹⁹⁸ See, e.g., Jeff Foust, *Hearing Raises Questions About Asteroid Mining Bill*, SPACENEWS (Sept. 10, 2014), <http://www.spacenews.com/41825hearing-raises-questions-about-asteroid-mining-bill/> [<http://perma.cc/7LKK-VLJ2>] (“My professional opinion is that the ASTEROIDS Act, as written, is very, very vague,” said Joanne Gabrynowicz, professor emerita of space and remote sensing law at the University of Mississippi.”).

¹⁹⁹ See *Statement of Chairman Lamar Smith (R-Texas): Hearing on Exploring Our Solar System: The ASTEROIDS Act as a Key Step* (2014) (statement of Chairman Lamar Smith discussing the ASTEROIDS Act, which proposed similar language), available at <http://docs.house.gov/meetings/SY/SY16/20140910/102649/HHRG-113-SY16-20140910-SD004.pdf> [<http://perma.cc/BW9E-KN6Q>].

²⁰⁰ Foust, *supra* note 198; Charles Stotler, *The ASTEROIDS Act and Hearing: Some Observations on International Obligations*, THE SPACE REVIEW (Sept. 22, 2014), <http://www.the-spacereview.com/article/2604/1> [<http://perma.cc/L3D3-ZQ52>] (“A legal regime for asteroid mining needs to take into account international treaties, like the Outer Space Treaty.”).

²⁰¹ See *supra* Part II.A. See also *infra* Part II.C.

because it states only a desired goal without any substance as to how to achieve it.²⁰²

Chris Lewicki, president of Planetary Resources, has shown his support of the law, however.²⁰³ DSI also supports the bill, suggesting some further clarifications.²⁰⁴ The commercial industry clearly wants some legislation on point, and will support even vague wording in order to get the ball rolling. This bill, however, does not address the larger problems of property ownership in space. Many scholars have proposed property rights schemes for outer space,²⁰⁵ and the drafters of the SPACE Act would do well to consider them for the reasons they would be successful and why they might fail.

C. Proposed Legal Frameworks

As one scholar rightly argues, “The granting of a property right has been an effective method to incentivize individuals to take on costly, time consuming, and even dangerous ventures.”²⁰⁶ Recently, there have been many proposals for methods of incentivizing space mining through granting property rights.²⁰⁷ Some would be more effective than others. This section examines some proposals.

1. Applying the General Mining Law of 1872

One scholar argues that the United States should use the General Mining Law of 1872 as a basis for a law incentivizing asteroid mining.²⁰⁸ The General Mining Law granted property rights not only in the extracted minerals, but also in the property surrounding the vein.²⁰⁹ However, like the SPACE Act, this approach ignores international law, which is central to any space legislation.²¹⁰ In fact, it ignores much of the nuance

²⁰² Foust, *supra* note 198.

²⁰³ *Id.*

²⁰⁴ *Id.*

²⁰⁵ See *infra* Part II.C.

²⁰⁶ 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, 122 (2013).

²⁰⁷ *Id.* at 140 n.4.

²⁰⁸ *Id.* at 121.

²⁰⁹ *Mining Laws*, DEP'T OF INTERIOR, http://www.blm.gov/wo/st/en/info/regulations/mining_claims.html [<http://perma.cc/J93P-4QB6>] (last visited Nov. 12, 2015).

²¹⁰ HERMIDA, *supra* note 42, at 2 (“[The international] regime imposes enormous burdens on the States for the activities of their nationals . . .”).

of the central issue with granting property rights: is it even possible for a private party to lay claim to property in space?

More fundamentally, the OST strictly forbids the appropriation of celestial bodies by sovereigns.²¹¹ The General Mining Law was a subsidization of mining companies by the United States government; as sovereign, the Government controlled the lands companies wished to mine.²¹² The sovereign thus had the power to grant property rights in extracted minerals and real property.²¹³ The situation in space—where no sovereign may lay claim—is far different from the effort to exploit the American West.

Although the basic concept is logical, it is practically impossible. The first step in creating a property rights scheme in space must lie with the international community. International law relies on cooperation among states, for treaties do not even become law unless countries choose to bind themselves to it. When one nation acts unilaterally, absent any sort of agreement, it could lead to conflict.

2. Change the Legal Definition of Asteroids

Another article proposes a treaty that would change the legal definition of asteroids from a celestial body to chattel.²¹⁴ In making this argument, the author claims that current international law does not allow private ownership of property in space.²¹⁵ While it may be true that one cannot own a celestial body, it is not clear whether international law outlaws limited property rights, i.e., mineral extraction rights.²¹⁶ For that reason, adopting a treaty redefining asteroids as chattel would be unnecessary, and it might lead to unwanted consequences.

This being literally uncharted territory, moving slowly by acknowledging only limited property rights in asteroids—rather than allowing private companies and sovereigns to claim an entire asteroid—will avoid some of these consequences. For example, a private company laying claim to an asteroid large enough to establish a base might make governments wary of individual claims of sovereignty. More worrisome, with no limiting

²¹¹ See *supra* Part II.A.

²¹² Shaw, *supra* note 206, at 147–49.

²¹³ LYALL & LARSEN, *supra* note 99, at 185 (“Since state claims to sovereignty in space cannot exist, neither can title to immovable property on celestial bodies in space.”).

²¹⁴ Feinman, *supra* note 3, at 222.

²¹⁵ *Id.* at 219 (“[T]he OST, as it is currently phrased, will not allow for companies to claim rights for mining asteroids . . .”).

²¹⁶ See *supra* Part II.A.

principle it could lead to a space race among sovereigns—for they, too, could appropriate space chattel.

The author argues that Article IV of the OST—which places international liability on the states of origin of private actors—will deter governments from acknowledging private rights in space material, unless it is amended.²¹⁷ Considering the United States’ current reliance on private industry to help NASA, this fear is unfounded.²¹⁸ In the same vein, another concern of his is the devolution of asteroid mining into an all-out gold rush.²¹⁹ The author’s concern of a lawless asteroid mining venture—harkening back to California’s gold rush²²⁰—seems premature. At the moment, only well-established companies with the capital and resources to invest in asteroid mining will be able to mine asteroids.²²¹ Poor farmers will not be loading up their trucks to take advantage of platinum on a distant asteroid. Miners lusting for gold will not be threatening each other over small claims on a rock in space.²²² Any legislation aimed toward protecting private claims of property in space need not concern itself—at the moment—with a rush of private individuals exploiting these resources.

3. Adopting Principles of First Possession

On the opposite end of the spectrum, one author proposes incorporating the principles of first possession to encourage the development of outer space.²²³ This may be the future of space property law, but for now is too distant in the future to develop. As the author argues, “First possession

²¹⁷ Feinman, *supra* note 3, at 216.

²¹⁸ See *supra* Part I.B.

²¹⁹ Feinman, *supra* note 3, at 202, 220. Feinman is not the only person who holds this view. See, e.g., Markus Hammonds, *Asteroid Mining: Booming 21st Century Gold Rush?*, DISCOVERY NEWS (Feb. 4, 2013, 12:20 PM), <http://news.discovery.com/space/asteroids-meteors-meteorites/could-asteroid-mining-drive-21st-century-space-industry-130204.htm> [<http://perma.cc/EQD4-BRSE>].

²²⁰ Feinman, *supra* note 3, at 210–14.

²²¹ See Mike Wall, *Asteroid Mining is Just Latest Billionaire’s Club Space Project*, SPACE.COM (April 25, 2012, 06:00 AM), <http://www.space.com/15419-asteroid-mining-billionaires-private-spaceflight.html> [<http://perma.cc/9TRR-5J8C>].

²²² See Feinman, *supra* note 3, at 212 (“[W]hile working a claim, McKeeby [a Gold Rush miner] and his crew found a group of ‘Southerners’ working McKeeby’s land. When they attempted to move the men off the land, the conversation became extremely heated. The Southerners vowed to return the next day ‘and work that claim or die.’”) (quoting *The Memoirs of Lemuel Clarke McKeeby*, 3 CAL. HISTORICAL SOC’Y Q. 126, 145 (1923)).

²²³ Brandon C. Gruner, Comment, *A New Hope for International Space Law: Incorporating Nineteenth Century First Possession Principles Into the 1967 Space Treaty for the Colonization of Outer Space in the Twenty-First Century*, 35 SETON HALL L. REV. 299, 306 (2005).

is the preeminent system for establishing initial property rights in land or a resource, as it accords claimants with legitimate ownership over territory and resources before other prospective claimants can do the same."²²⁴ This is certainly true. But there are many reasons to approach property ownership in space slowly. In this case, the wisdom of the OST's prohibition of national appropriation of celestial bodies should not be cast aside lightly.

First possession works well in the context of Earth, because a sovereign has claim to the property first.²²⁵ In all of the author's examples, including *Johnson v. M'Intosh*,²²⁶ homesteading, and the General Mining Statute of 1872, private individuals came into possession of property after a sovereign—through principles of law—granted those claims.²²⁷ They can protect private claims, because the property is within the umbrella of the sovereign.²²⁸ Applying the principles of first possession without limitation in space at this junction will be confusing and very difficult to sell to other nations. It may result in a space race and colonialism in a situation that requires limitation and prudence.

Of course, the author is a proponent of "an aggressive space program," and his proposal would absolutely ensure that.²²⁹ To avoid the conflicts inherent between rivalrous nations, though, acknowledging only limited rights in property through first possession is the appropriate first step. By ensuring that private property will be enforced once a mining venture has brought space material back to Earth, many of the practical consequences of total first possession incorporation may be avoided.

4. Montreal Protocol as a Framework

Finally, another scholar proposes a system based on the Montreal Protocol for mining the Moon.²³⁰ Under this proposal, "each country would be allocated a certain amount of lunar mining credits, which would allow the holder of the credits to engage in mining certain tonnage of natural resources on the Moon for a given period."²³¹ This system would limit the

²²⁴ *Id.* at 344.

²²⁵ *Id.* at 345.

²²⁶ 21 U.S. 543 (1823).

²²⁷ Gruner, *supra* note 223, at 346.

²²⁸ LYALL & LARSEN, *supra* note 99, at 185 ("Since state claims to sovereignty in space cannot exist, neither can title to immoveable property on celestial bodies in space.").

²²⁹ Gruner, *supra* note 223, at 346.

²³⁰ Edwin W. Paxson, III, *Sharing the Benefits of Outer Space Exploration: Space Law and Economic Development*, 14 MICH. J. INT'L L.J. 487 (1993).

²³¹ *Id.* at 514.

amount of resources any given country could exploit on the Moon.²³² Although likely a sound idea as applied to the Moon, for the purposes of this Note, it is instructive to consider why this should not be considered for asteroids.

The number of asteroids—and the minerals therein—exceeds the size of the Moon by many times.²³³ At this stage in the development of asteroid mining, there is no reason to worry about depleting resources. Of course, that does not mean it should be ignored entirely—but that is a consideration for when a more comprehensive space law program is in place. As of now, the law simply needs to guarantee private industry of their claims in extracted minerals.

The failure of the Moon Treaty should be enlightening in this instance. It failed because spacefaring nations were unwilling to accept the limitation on future claims of property.²³⁴ To illustrate the point, the Law of the Sea Convention was easily accepted, because every nation with a coastline stood to gain from the extension of coastal jurisdiction.²³⁵ Similarly, states and private individuals stand to benefit from the possibility of unlimited mineral extraction to properly incentivize the activity. The practical difficulties of traveling to space and carting minerals back to Earth is self-limiting enough to prevent any one company from obtaining more than its fair share. While prudence in this area of space law is wise, dramatic limitations on the amount of minerals that may be appropriated by private companies would continue to disincentivize such an expensive venture.

Ultimately, many of these proposals are undesirable because they either attempt to do too much or over-regulate. In such a new area of law, technology, and human development, the prudent choice is to approach things piecemeal.

III. THE SOLUTION: AMENDING THE OUTER SPACE TREATY TO RESOLVE LEGAL AMBIGUITY

The OST already provides a framework in which a scheme of limited private property ownership in extracted asteroid minerals may be developed to incentivize private asteroid mining.²³⁶ The problem, however, is the

²³² *Id.*

²³³ *See generally* Bonsor, *supra* note 62.

²³⁴ POP, *supra* note 90, at 37.

²³⁵ *See supra* Part II.A.4.

²³⁶ *See generally supra* Part II.

ambiguity inherent in such a broad, idealistic treaty. The OST therefore must be amended to resolve all legal ambiguity.²³⁷ The problem with such an undertaking is the difficulty in getting all signatories to the amendment to agree. The treaties that came after the OST were elaborations—they more clearly define ambiguities and resolve any potential areas of dispute.²³⁸ With that in mind, it is certainly reasonable to expect the international community to resolve the ambiguities surrounding the OST's position on personal property in space. Simplicity and a tried-and-true avenue for international space legislation is the best way to approach this issue.

Amending the OST is fairly straight forward. An amendment comes into force when it is accepted by a majority of the OST signatories, and it binds only those states that accept it.²³⁹ By doing this, the international community avoids the legal limbo of a treaty that has yet to reach customary status and avoids the failure of a treaty such as the Moon Treaty.

Further, the United States is in a unique position as one of the most advanced spacefaring nations.²⁴⁰ The United States Congress should pass a law guaranteeing American companies' property rights in extracted minerals unilaterally, as well as directing the President to treat with the signatories to amend the OST. For the reasons outlined above, the ASTEROIDS Act is severely deficient and does not provide any guidance. Such an act must be more robust.

A. *The Proposal*

Congress should pass a law including two components: a domestic provision and an international provision. First, the law should guarantee property rights in extracted minerals on a first-in-time basis, within the borders of the United States. This could be accomplished by declaring all private claims to extracted minerals, brought from outer space, to be respected within the United States, much like Truman declared when he established the 200-mile economic zone.²⁴¹ This would protect United States' economic interests, as well as the interests of its private space companies.

²³⁷ Some scholars have proposed new treaties altogether. *See, e.g.*, Feinman, *supra* note 3, at 220. The failure of the Moon Treaty should be viewed as a cautionary tale. *See supra* Part II.A.3.

²³⁸ *See supra* Part II.A.4.

²³⁹ LYALL & LARSEN, *supra* note 99, at 2 (citing the Outer Space Treaty at art. XV).

²⁴⁰ Gruner, *supra* note 223, at 355.

²⁴¹ *See supra* Part II.A.4.

Further, such a law would attract more investment and spur technological development within the United States.

Second, to comply with international obligations, the law should direct the President to treat with OST signatories to guarantee private property rights in extracted minerals from asteroids. Again, based on a first-in-time theory of possession, the private actors would come into ownership through converting real property into personal property and bringing it back to Earth. This is necessary in order to clearly define the liability of individual nations with respect to their private companies that venture to asteroids. It will also allow private companies to register their minerals, providing them with security in their possession while in outer space. It further decreases the ambiguous limbo many companies see as a barrier to a viable asteroid mining operation.

The environmental benefits alone should be enough to warrant such a law. For three reasons, however, a more robust version of the ASTEROIDS Act should be passed: first, the Outer Space Act already allows limited rights to private property in space.²⁴² The OST and its progeny provide a framework upon which the international community can easily build a regime for private property ownership in extracted material. Second, the proposal is inherently self-limiting. It avoids many of the potential consequences of other property right schemes discussed above.²⁴³ Finally, amending the OST to flatly state that private rights in minerals extracted from asteroids are enforceable benefits all mankind, because of its environmental consequences. These points are discussed below.

1. Limited Rights to Private Property Are Already Possible Under the Current Regime of Space Treaties

The examples described above reveal that limited property rights in materials brought from outer space may be respected by the international community.²⁴⁴ The OST's ambiguity, therefore, has served as an avenue for property rights in material brought to Earth from outer space. It is still far from clear, though, whether a private company's claim may be respected or enforced. Further, with the vast economic prospects of asteroid mining, countries with limited means of space travel may not be as acquiescent as with the U.S. government appropriating moon rocks.

²⁴² See Foust, *supra* note 198.

²⁴³ See *supra* Part II.C.

²⁴⁴ See *supra* Part II.

The simplest way to incentivize asteroid mining is to iron out the ambiguities of the OST with respect to property rights. Avoiding new treaties, new definitions, and radical changes to the conception of space law will allow the international community to proceed slowly, testing the legal implications of private property ownership in space. Clearly, international custom already accepts some form of property ownership of space material.²⁴⁵ The uncertainty as to how far this property ownership may extend disincentivizes any mining venture at the present.

For any amendment establishing limited property rights in space unambiguously, the drafters must consider two provisions of the OST in particular: the freedom of exploration for all states,²⁴⁶ and the provision against national appropriation.²⁴⁷ Any program incentivizing asteroid mining would benefit inherently all of mankind because of the environmental consequences. A reduction in mining would be felt the world over.

As for the provision against national appropriation, an amendment to the OST would guarantee only limited property rights. The concern of the OST signatories was the domination of celestial bodies by the space-faring, nuclear weapon-toting superpowers at the time: the United States and the USSR.²⁴⁸ By granting property rights only in the extracted material, national sovereignty would still not extend to celestial bodies.

2. The Proposal Is Inherently Self-Limiting

The various schemes outlined above have the potential to either extend sovereign claims in space, precipitate a space race and colonialism, or promote conflict in general. To avoid those consequences, any law extending private property rights in space must be developed with prudence. The international community's main goal of the OST was the propagation of peace and the limitation of any sovereign's power in space.²⁴⁹ That should not be forgotten, because it has succeeded in keeping space free of nuclear weapons and warfare.²⁵⁰

The proposal outlined in this Note provides a means to slowly test property rights as applied to space. First of all, the sheer number of

²⁴⁵ *Id.*

²⁴⁶ OST, *supra* note 6, at art. I.

²⁴⁷ *Id.* at art. II.

²⁴⁸ See U.S. STATE DEP'T, *supra* note 130.

²⁴⁹ *Id.*

²⁵⁰ See Amy Shira Teitel, *The Outer Space Treaty Promised Peace in Space*, DISCOVERY (Oct. 10, 2013), <http://news.discovery.com/space/history-of-space/the-outer-space-treaty-promised-peaceful-exploration-of-space-131010.htm> [<http://perma.cc/6M5J-GSCU>].

asteroids—and the quantity of minerals contained within—limits potential disputes over claims of property. Most problems during the California Gold Rush arose because both real estate and minerals were limited.²⁵¹ Second, the expense of sending mining ventures to an asteroid is so prohibitive that only those companies that have the requisite funding will be able to enter the market.²⁵² Finally, the amount of material any one project can ferry from an asteroid and back will necessarily be limited due to the size of spacecraft.

These limitations also have the benefit of keeping supply of precious minerals at a reasonable level. One might argue that unlocking an abundance of minerals such as platinum and gold will only serve to flood the market, which will cause prices to drop and remove any incentive to send a mining venture into space. Due to the high cost and practicalities of space travel, however, the amount of minerals shipped from asteroids to Earth will necessarily be limited, at least for the time being.

3. Amending the Outer Space Treaty Will Benefit the Environment

The proposal will benefit the Earth's environment in two significant ways: it will reduce mining on Earth and preserve the Earth's limited resources. Scholars typically look to technological improvement and renewable resources to alter the environmental impact of Earth-based mining.²⁵³ Most do not consider the consequences of removing part of the mining industry from Earth altogether. Solid waste on Earth will decrease, and the massive destruction of ecosystems and societies in concentrated areas will be totally avoided.²⁵⁴

Although some authors are concerned with the environment of outer space, the fear is largely overblown.²⁵⁵ Astroenvironmentalism seeks

²⁵¹ See *supra* Part II.C.1–3.

²⁵² See Wall, *supra* note 221.

²⁵³ See, e.g., Glaister & Mudd, *supra* note 17, at 449 (“Given the dominance of electricity in energy consumption, there are perhaps unique opportunities available for PGM mining to investigate the use of renewable energy technologies, and thereby reduce greenhouse gas emissions.”).

²⁵⁴ See *supra* Part I.A.

²⁵⁵ Compare J.H. Huebert & Walter Block, *Space Environmentalism, Property Rights, and the Law*, 37 U. MEM. L. REV. 281, 281 (2007) (arguing that astroenvironmentalism is “philosophically ill-founded” and “economically and pragmatically unjustified”) with Ryder W. Miller, *Astroenvironmentalism: The Case for Space Exploration as an Environmental Issue*, 1 ELEC. GREEN J. 1, 1 (2007) (arguing that, for any privatized space exploitation, the space environment must be considered).

to apply “the values of environmentalism and preservationism to developments in space exploration, commercialization, and militarization.”²⁵⁶ While astroenvironmentalism is a laudable goal in some areas of commercial space ventures,²⁵⁷ it does not apply to the exploitation of asteroids. Asteroids are uninhabitable.²⁵⁸ They have zero gravity,²⁵⁹ no atmosphere, and are found in “the ‘perfect vacuum.’”²⁶⁰ Exploiting asteroids “damages no ecospheres since they are lifeless rocks left over from the formation of the solar system.”²⁶¹

Ultimately, all of humanity stands to benefit from the relocation of Earth-based mining ventures to near-Earth asteroids for the environmental benefits alone. In the name of the OST’s guarantee of the use of space for the benefit of all nations, this proposal would certainly help.

CONCLUSION

While mining the Moon or other celestial bodies will require much finer tuning, incentivizing asteroid mining can be achieved relatively simply. In the epic scramble to preserve the Earth’s resources and limit consumption to provide for future generations, most people do not consider space as a potential venue of resources. Since mankind has ventured outside of Earth’s atmosphere, commercial activity in space has been the realm of science fiction. For many, this view has not changed. Technological and economic reality, however, provides a far different view. Investors are willing to provide capital for ventures to one day mine an asteroid. To make that a reality, the law must reflect those ambitions. Private property in space should not be feared. Quite the contrary, it should be embraced. By guaranteeing rights in extracted minerals taken from space, private industry could usher all of humanity into a new technological era.

²⁵⁶ Miller, *supra* note 255, at 1.

²⁵⁷ The Moon and other planets could certainly benefit from these ideas, and this Note by no means disputes that. That is a subject outside of the scope of this argument, however.

²⁵⁸ *Asteroid Miners in a Race for Rare Metals*, ENVTL. NEWS SERV. (Jan. 23, 2013), <http://ens-newswire.com/2013/01/23/asteroid-miners-in-a-race-for-rare-metals/> [<http://perma.cc/EEC2-X5YG>] (quoting Mark Sonter, a member of the Deep Space Board of Directors) (internal quotation marks omitted).

²⁵⁹ O’Leary, *supra* note 67, at 363.

²⁶⁰ Choudhury, *supra* note 83.

²⁶¹ ENVTL. NEWS SERV., *supra* note 258.