Sustainable Mining: Incentivizing Asteroid Mining in the Name of Environmentalism

Kevin MacWhorter
SUSTAINABLE MINING: INCENTIVIZING ASTEROID MINING IN THE NAME OF ENVIRONMENTALISM

KEVIN MACWHORTER*

INTRODUCTION

Long a part of the science fiction imagination, mining in space has attracted interest both seriously and for amusement. 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. 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. Companies therefore have little incentive to invest in asteroid mining at all, given the high costs of space flight and development of proper technology. The Outer Space Treaty (the “OST” or the

---

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.

645
“Treaty”), dedicated as it is to the common use of space for all nations, is laudable. It was adopted in 1967, 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. 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.


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; the private space industry is booming with investment and government contracts; 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. 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. Many of these have no synthetic alternative, unlike chemical elements such as oil or diamonds. Liquid-crystal display (“LCD”) televisions, cellphones, and laptops are among the various consumer technologies that use precious metals. Further, green technologies—including wind turbines, solar panels, and catalytic converters—require these rare elements. As demand rises for both types of technologies, and as reserves of rare metals fall, prices skyrocket. Demand for nonrenewable resources creates conflict, and consumerism in rich countries results in harsh labor treatment for poorer countries.

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

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.\textsuperscript{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."\textsuperscript{22} Poor regulations and oxymoronic corporate definitions of "sustainability," however, make it unclear as to just how much waste the industry actually produces.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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."\textsuperscript{26} Scholars do not expect demand to slow any time soon.\textsuperscript{27} Among other technologies, industries use platinum in products such as catalytic converters, jewelry production, various catalysts for chemical processing, and hydrogen fuel cells.\textsuperscript{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.\textsuperscript{29}

\textsuperscript{23} Glaister & Mudd, \textit{supra} note 17, at 448. See Kirsch, \textit{supra} note 19, at 87–88 (describing the corporate practice of redefining "sustainable mining" to manipulate public opinion).
\textsuperscript{24} \textit{Market for Metals, supra} note 1; see also discussion \textit{infra} Part I.C.
\textsuperscript{25} See Glaister & Mudd, \textit{supra} note 17, at 439, fig. 1.
\textsuperscript{26} \textit{Market for Metals, supra} note 1.
\textsuperscript{27} Glaister & Mudd, \textit{supra} note 17, at 438.
\textsuperscript{28} \textit{Id.} For a look at the main industries for which platinum is used, measured against the rate platinum is recycled, see \textit{id.} at 442.
\textsuperscript{29} Compare Gordon et al., \textit{Metal Stocks and Sustainability}, 103 \textit{PROC. NAT'L ACAD. SCI.} 1209, 1209 (2006) (arguing that platinum resources could be depleted in a matter of decades), \textit{with} Glaister & Mudd, \textit{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. Relocating 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, and private companies have been launching their own satellites into orbit for decades. In May 2012, SpaceX docked with the International Space Station—the first private company to do so.

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. The private space industry has seen dramatic growth as a result. Since NASA retired its shuttle fleet in 2011, the agency has turned to private actors to design and build spacecraft. 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. More companies, such as Orbital Sciences, have followed suit.

Space mining in particular has been a focus of private investment. The promise of abundant rare Earth resources creates the possibility of vast wealth for intrepid investors. For example, Google founders Larry Page and Eric Schmidt have invested heavily in private space flight. 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. The purpose behind the contest should be apparent: investors think private space flight and

42 Kleiman, supra note 40, at X.
44 See generally Summers, supra note 5.
45 Id.
46 Id.
47 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.
48 See Summers, supra note 5.
49 Market for Metals, supra note 1; see also supra Parts I.A & I.C.
51 Google Lunar X Prize, supra note 2.
mining could be extremely lucrative. Rare metals, such as platinum, could become far more accessible.

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. 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.” To that end, many companies are focused on the idea of asteroid mining.

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. Companies therefore cannot be sure whether their property claims will be enforced after they extract minerals in space and bring them back to Earth. When investing large sums of money such a consideration is absolutely critical. 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!” Certain types of asteroids—including X-type and S-type asteroids—contain both precious and base metals in quantities sufficient to make any entrepreneur

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.”).
salivate. Current estimates count around two million asteroids in the solar system that are a kilometer or more in diameter. 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. To put that in economic terms, the value of each asteroid could be “somewhere in the trillions [of dollars] or higher.”

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. The technology needed to extract resources from asteroids, however, is a very recent phenomenon. 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.

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. First of all, two companies are developing the technology needed to mine asteroids. Planetary Resources

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/
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).
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.”).
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).
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 vacuum . . . . \(^{86}\)

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.

---


\(^{81}\) Id.

\(^{82}\) Id.

\(^{83}\) Id.

\(^{84}\) Id. (quoting Chris Lewicki) (internal quotation marks omitted).

\(^{85}\) 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. Because of this, many areas of space law are ambiguous—in particular, the status of property in space. 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. 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. For example, Gregory Nemitz—a very entrepreneurial sort of man—filed with the Archimedes Institute in order to claim the asteroid Eros. When NASA landed the NEAR Shoemaker probe on the asteroid on February 12, 2001, he decided to charge twenty dollars for parking. NASA, of course, told him he could have no claim to a celestial body. Another example, which is perhaps more telling, involves the Apollo astronauts. Several of them brought moon rocks back to Earth. NASA declared the rocks to be the property of the U.S. government. For four decades, the international community has...

94 Id.
95 Id. at 2432.
96 Id.
acquiesced—albeit tacitly—to the United States’ claim of ownership over rocks harvested from the Moon.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{100} Many principles of space law, therefore, have been adopted from other fields of law, such as commercial contracting, and applied to exotic circumstances.\textsuperscript{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.”\textsuperscript{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.”\textsuperscript{103} As technology develops, governments have had to create new regulations and procedures.\textsuperscript{104} The unfortunate truth is that the law

\textsuperscript{97} Id.

\textsuperscript{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.").

\textsuperscript{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).

\textsuperscript{100} LYALL & LARSEN, supra note 99, at 2.

\textsuperscript{101} Id.

\textsuperscript{102} Id.

\textsuperscript{103} Id. (quoting M. Bourbonniere, National-Security Law in Outer Space: The Interface of Exploration and Security, 70 J. Air L. & COMM. 3, 3 (2005)) (internal quotations omitted).

\textsuperscript{104} Id.
will never keep up with the development of technology, especially in space. Indeed, following the launch of Sputnik, many feared an obvious outer space legal vacuum. Much like the property issue faced today, Sputnik’s orbit raised questions about the ambiguity associated with space exploration.

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. 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 1958 to promote international cooperation in space and promote its peaceful use. UNOOSA oversees the UN’s Committee on the Peaceful Uses of Outer Space (“COPUOS”) and implements its decisions. The UN founded COPUOS to avoid international rivalries in space. The OST, the Liability Convention, and the Moon Agreement are all within the jurisdiction of COPUOS. There are

---

105 Id. at VIII–IX.
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.

108 Id. at VIII–IX.
111 UNOOSA, supra note 109.
112 Feinman, supra note 3, at 214–15.
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.\(^{123}\)

\(^{115}\) OST, supra note 6.
\(^{117}\) Liability Convention, supra note 113.
\(^{118}\) G.A. Res. 3235 (XXIX), U.N. Doc. A/RES/3235 (XXIX) (Nov. 12, 1974) [hereinafter Registration Convention].
\(^{120}\) Id. at 42 (quoting Art. 38.1.b of the ICJ Statute).
\(^{121}\) Id. (quoting Art. 38.1.b of the ICJ Statute).
\(^{122}\) Id., supra note 99, at 44.
\(^{123}\) Id. at 42 (quoting Art. 38.1.b of the ICJ Statute).
conventions offer some guidelines, though they do not formally establish a property regime.\textsuperscript{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.\textsuperscript{125} Space law, however, is far more recent.\textsuperscript{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.\textsuperscript{127}

1. The Outer Space Treaty, 1967

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

\textsuperscript{124} Id.
\textsuperscript{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.).
\textsuperscript{127} See LYALL & LARSEN, supra note 99, at 84.
\textsuperscript{129} LYALL & LARSEN, supra note 99, at 53; PoP, supra note 90, at 37 (describing the OST as a “‘Constitution’ for outer space”).
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,
states cannot own property in space and so they could not be responsible for private ownership in space.\textsuperscript{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.\textsuperscript{141}

A majority of scholars agree that real property ownership in space is illegal,\textsuperscript{142} or at the very least unenforceable.\textsuperscript{143} The OST, however, only bars claims of “celestial bodies,” but not extracted materials.\textsuperscript{144} The term “celestial bodies” has never been fully defined in space law,\textsuperscript{145} but it applies to planets, moons, and asteroids.\textsuperscript{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.”\textsuperscript{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.\textsuperscript{148} The treaties following the OST are elaborations, used to counteract the pace of technological evolution.\textsuperscript{149} They take the generalities of the OST and apply them to particular situations.\textsuperscript{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.\textsuperscript{151} These treaties get at how responsibility should be established, what a state may own in space, and liability in the case of damage.\textsuperscript{152} They “provide the responsibilities, the

\textsuperscript{140} Id.
\textsuperscript{141} See Filartiga v. Pena-Irala, 630 F.2d 876 (2nd Cir. 1980).
\textsuperscript{142} POP, supra note 90, at 65.
\textsuperscript{143} See generally id. at 66–69.
\textsuperscript{144} OST, supra note 6, at art. II.
\textsuperscript{145} LYALL & LARSEN, supra note 99, at 175.
\textsuperscript{146} Id.
\textsuperscript{147} OST, supra note 6, at art. II.
\textsuperscript{148} POP, supra note 90, at 37.
\textsuperscript{149} Id. at 36–37.
\textsuperscript{150} LYALL & LARSEN, supra note 99, at 48.
\textsuperscript{151} Id. at 81.
\textsuperscript{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 L Y A L L & L ARSEN, supra note 99, at 81.
157 See id. at 82.
158 L Y A L L & L ARSEN, 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 L Y A L L & L ARSEN, 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., L Y A L L & L ARSEN, 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).
161 O S T, supra note 6, at art. V, VIII; L Y A L L & L ARSEN, supra note 99, at 97.
does not apply to mined material from space. It does establish, however, that property ownership is enforceable, even when an object owned by a State or an astronaut is left in space.

The Liability Convention 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. This treaty not only contemplates liability by state actors, but also international, intergovernmental entities. 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.”

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

3. The Moon Treaty

The Moon Treaty entered into force on July 11, 1984. As of 2015, only sixteen countries have acceded to it, with the United States conspicuously absent. 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. 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.
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” and considered a failure. 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.

The treaty reiterates the OST’s designation of space as for the exploration and use of all nations. It places above private property rights the right to explore and use the Moon for scientific benefit. Finally, it establishes the Moon as “the common heritage of all mankind.” Any natural resource exploitation would have to be governed by the international community for the benefit of the international community. This provision turned many spacefaring countries off of the treaty, 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. In general, the Law of the Sea developed mainly through custom since the first ships sailed on the oceans. The convention, however, simply codified some of these customs, including the United States’ unilateral appropriation of mineral rights in coastal waters.

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. In part, the President did so to secure domestic oil interests. The order “extended United States jurisdiction

---

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 POF, supra note 90, at 37.
183 Id.
184 Id.
185 Id.
186 Id.
over all natural resources on that nation’s continental shelf—oil, gas, [and] minerals."\textsuperscript{187} Wanting to protect their own interests, many nations followed suit.\textsuperscript{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.\textsuperscript{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.\textsuperscript{190} Ownership of personal property, however, is allowed under certain conditions, as revealed by registration and liability requirements.\textsuperscript{191} Properly registered personal property rights are enforceable under current international law.\textsuperscript{192} The ambiguity concerns the conversion of real property into personal property.\textsuperscript{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").\textsuperscript{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").\textsuperscript{195} Its purpose is "[t]o facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating

\textsuperscript{187} Id.
\textsuperscript{188} \textit{The United Nations Convention on the Law of the Sea}, supra note 125.
\textsuperscript{189} OST, \textit{supra} note 6, at art. II.
\textsuperscript{190} Id.
\textsuperscript{191} Id. at art. VII, VIII.
\textsuperscript{192} Id.
\textsuperscript{193} \textit{LYALL & LARSEN, supra} note 99, at 185.
\textsuperscript{195} SPACE Act, H.R. 2262, 114th Cong. (2015) [hereinafter the SPACE Act].
more stable and predictable regulatory conditions, and for other purposes." 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.

A congressional directive to the Executive is exactly what this Note recommends, but there must be more substance behind it. First, the SPACE Act does not address the problem of private ownership of property in space. 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. 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. 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/41825/hearing-raises-questions-about-asteroid-mining-bill/ ("'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.").
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.
207 Id. at 140 n.4.
208 Id. at 121.
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. 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. The sovereign thus had the power to grant property rights in extracted minerals and real property. 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. In making this argument, the author claims that current international law does not allow private ownership of property in space. 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. 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 immoveable 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.\textsuperscript{217} Considering the United States’ current reliance on private industry to help NASA, this fear is unfounded.\textsuperscript{218} In the same vein, another concern of his is the devolution of asteroid mining into an all-out gold rush.\textsuperscript{219} The author’s concern of a lawless asteroid mining venture—harkening back to California’s gold rush—\textsuperscript{220} 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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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

\begin{footnotesize}
\begin{itemize}
\item[\textsuperscript{217}] Feinman, supra note 3, at 216.
\item[\textsuperscript{218}] See supra Part I.B.
\item[\textsuperscript{220}] Feinman, supra note 3, at 210–14.
\item[\textsuperscript{221}] See Feinman, supra note 3, at 212 (“While working a claim, McKeely [a Gold Rush miner] and his crew found a group of ‘Southerners’ working McKeely’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 McKeely, 3 CAL. HISTORICAL SOC’Y Q. 126, 145 (1923)).
\end{itemize}
\end{footnotesize}
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.\footnote{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.\footnote{225} In all of the author's examples, including Johnson v. M'Intosh,\footnote{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.\footnote{227} They can protect private claims, because the property is within the umbrella of the sovereign.\footnote{228} Applying the principles of first possession without limitation in space at this juncture 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.\footnote{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.\footnote{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."\footnote{231} This system would limit the

\footnote{224} Id. at 344.  
\footnote{225} Id. at 345.  
\footnote{226} 21 U.S. 543 (1823).  
\footnote{227} Gruner, supra note 223, at 346.  
\footnote{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.").  
\footnote{229} Gruner, supra note 223, at 346.  
\footnote{231} Id. at 514.
amount of resources any given country could exploit on the Moon.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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. \textsc{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.\textsuperscript{236} The problem, however, is the

\begin{itemize}
  \item \textsuperscript{232} Id.
  \item \textsuperscript{233} See generally Bonsor, \textit{supra} note 62.
  \item \textsuperscript{234} \textit{Pop}, \textit{supra} note 90, at 37.
  \item \textsuperscript{235} See \textit{supra} Part II.A.4.
  \item \textsuperscript{236} See generally \textit{supra} Part II.
\end{itemize}
ambiguity inherent in such a broad, idealistic treaty. The OST therefore must be amended to resolve all legal ambiguity. 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. 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 straightforward. 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. 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. 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. This would protect United States’ economic interests, as well as the interests of its private space companies.

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.

See supra Part II.A.4.

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

Gruner, supra note 223, at 355.

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. 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. 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. 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. 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, and the provision against national appropriation. 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. 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. That should not be forgotten, because it has succeeded in keeping space free of nuclear weapons and warfare.

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.

\(^{246}\) Id.

\(^{247}\) Id.

\(^{248}\) See U.S. STATE DEP’T, supra note 130.

\(^{249}\) Id.

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. See supra Part II.C.1–3. 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. See Wall, supra note 221. 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. 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.”). 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.

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

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

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.
259 O’Leary, supra note 67, at 363.
260 Choudhury, supra note 83.
261 ENVTL. NEWS SERV., supra note 258.