# T-Mining Isn’t Appropriation

#### A] Interpretation: appropriation means a claim of sovereignty- affs may only defend claims of sovereignty by private entities as unjust

#### Violation: they only defend asteroid mining, which is simply extraction

#### Appropriation refers to sovereign claims of land, not using or extracting resources- proven by OST’s guidelines, nation’s interpretations, and prior property regimes

Wrench 19 [Wrench, John. 2019. “Case Western Reserve Journal of International Law Non-Appropriation, No Problem: The Outer Space Treaty Is Ready for Asteroid Mining Non-Appropriation, No Problem: The Outer Space Treaty Is Ready for Asteroid Mining,” n.d. <https://scholarlycommons.law.case.edu/cgi/viewcontent.cgi?article=2546&context=jil>.] WL

It is unlikely, however, that the non-appropriation principle is an absolute ban on the ownership of resources extracted in outer space. An interpretation of Article II supporting a blanket ban on resource ownership is unwarranted by the text of the OST and illfounded on account of the international community’s common practices. Scholars have noted that the international community has never questioned whether scientific samples harvested from celestial bodies belong to the extracting nation.60 Furthermore, space-faring members of the international community rejected the Moon Treaty precisely because it prohibited all forms of ownership in resources extracted from celestial bodies.61 The space-faring nations’ support for the OST, coupled with their rejection of an alternative set of rules governing extracted resources, is at the very least an indication of what those nations believe the non-appropriation principle to stand for. It is equally improbable that the international community drafted the non-appropriation principle to be merely idealistic rhetoric. The OST leaves no room for interpretations to squirm out from under its ban on sovereign claims of land.62 The following section illustrates, however, that the distinction between sovereign ownership of land, and the vestment of property rights in resources extracted from that land, is nothing new. Although the OST does not provide a comprehensive guideline for resource extraction in outer space, its foundational logic provides a workable distinction between ownership and use. This part explores three property regimes developed under the same fundamental constraints as the non-appropriation principle: the United Nations Convention on the Law of the Sea (“UNCLOS”), the Antarctica Treaty System, and the prior appropriation doctrine as applied in United States water law.63 Under each regime, parties may establish some form of ownership in extracted resources despite being restricted from claiming sovereignty over the underlying land. Each section includes a brief discussion of the property regime’s history, its major traits and their relationship to the overarching characteristics of the non-appropriation principle. This part further describes how each property regime fits within the non-appropriation principle’s prohibition on claims to land, while prohibiting waste, separating land ownership from rights to extracted resources, enforcing liability for destruction or damage, and establishing a simple regulatory system to manage claims.

**Presume neg – all parties to the outer space treaty prohibit “appropriation” of resources by private entities.**

Melissa J. **Durkee**, J. Alton Hosch Associate Professor of Law, University of Georgia, **’19**, "Interstitial Space Law," Washington University Law Review 97, no. 2 423-482

Those answering this question in the affirmative have access to a strong textual argument. Article II of the Outer Space Treaty specifically references "national" **appropriation**.17 9 The context surrounding that appears to confirm that the prohibition of "national" appropriation is directed at nations, as only a nation could have a legitimate "claim of sovereignty." 180 Moreover, "occupation" refers to old international legal doctrines that once allowed nations to claim territory based on occupation. The historical context within which the treaty was drafted supports this position, as the concern of the time was colonization, not commercial use of space resources. As for private parties, they are specifically anticipated by the treaty: **Article VI states that States Parties bear international responsibility for activities by "non-governmental entities" as well as governmental agencies**.' 8 1 The fact that they are anticipated by the treaty but not included in the Article II prohibition on appropriation suggests that the treaty intended to prohibit only national appropriation of outer space resources.18 2 Those claiming that the treaty prohibits both national appropriation and appropriation by private parties can marshal their own textual argument. Article VI defines "national activities in outer space" to include both "activities . .. carried on by governmental agencies" and those carried on by "non-governmental entities." 8 3 This definition of "national" must inform Article II's prohibition on "national" appropriation and thus extend to a nation's citizens **and commercial entities** as well as governmental activities. Moreover, a contrary interpretation defies logic: **if nations themselves may not claim property rights to outer space objects, they have no power to confer those rights on their nationals.**184

#### This applies to the res – 1] Upward entailment test – “appropriation by private entities is unjust” doesn’t imply that “anything done by private entities is unjust” because extraction might not apply 2] Adverb test – "general appropriation by private entities" doesn’t substantially change the meaning of the res

#### B] Vote neg—

#### 1] Semantics outweigh --

#### A] Topicality is a constitutive rule of the activity and a basic aff burden, they agreed to debate the topic when they came to the tournament

#### B] It’s the only stasis point we know before the round so it controls the internal link to engagement, and there’s no way to use ground if debaters aren’t prepared to defend it.

#### 2] Limits:

**A] Quantitative – the topic is literally too big to count – every specific thing that could be defined as “appropriation” from private entities helping out NASA to them mining some asteroids– unlimited ways appropriation could be defined incentivize obscure affs that negs won’t have prep on – limits are key to reciprocal prep burden**

**B] Qualitative – spec kills unified generics like the innovation DA because you could just say you’re still allowing entities to make claims of sovereignty and go out into space**

#### D] Paradigm Issues –

#### 1] T is DTD – their abusive advocacy skewed the debate from the start

#### 2] Comes before 1AR theory -- A] If we had to be abusive it’s because it was impossible to engage their aff B] T outweighs on scope because their abuse affected every speech that came after the 1AC C] Topic norms outweigh on urgency – we only have a few months to set them

#### 3] Use competing interps on T – A] topicality is a yes/no question, you can’t be reasonably topical B] reasonability invites arbitrary judge intervention and a race to the bottom of questionable argumentation

#### 4] No RVIs – A] Forcing the 1NC to go all in on the shell kills substance education and neg strat B] discourages checking real abuse C] Encourages baiting – outweighs because if the shell is frivolous, they can beat it quickly

#### International mining regimes are inefficient, corrupt, and enable exploitation/private development as much as they claim to prevent it

Roach 11-8-21

Anna Bianca Roach (she/they, degree in conflict studies from munk school of global affairs), 11-8-2021, "The Obscure Organization Powering a Race to Mine the Bottom of the Seas," PassBlue, https://www.passblue.com/2021/11/08/the-obscure-organization-powering-a-race-to-mine-the-bottom-of-the-seas/, // HW AW

On the seafloor, anemones with eight-foot-long tentacles live alongside [blind crabs](https://www.mbari.org/discovery-of-yeti-crab/) that cultivate food in their arm hair, sharks with glow-in-the-dark bellies and [glass sponges](https://www.mpg.de/5595233/climate_archive_deep-sea_sponge#:~:text=Researchers%20at%20the%20Max%20Planck,living%20animal%20species%20existing%20today.) that have been thriving since before the invention of the wheel. “Because of the lack of light and the fact that creatures do need to see each other to eat each other, you get these amazing photoluminescent animals down there,” said Helen Rosenbaum, the coordinator of the [Deep Sea Mining Campaign,](http://www.deepseaminingoutofourdepth.org/) an association of nongovernmental organizations located in Australia, Canada, the United States and the Pacific Islands. “We’re just starting to discover them!” The emerging industry of deep-sea mining is eyeing these otherworldly creatures’ home with keen financial interest: the potato-shaped rocks that provide a foothold for many of these animals in the otherwise silty, slippery environment of the ocean floor contain myriad metals that miners say are needed for a global eco-transition. At the heart of primary decision-making on deep-sea mining ventures is the [International Seabed Authority](https://www.isa.org.jm/), an autonomous organization based in Jamaica that critics say has little public oversight. “Our journey is to drive humankind through a wonderful adventure, which is to go very deep in the ocean to extract some minerals that are necessary for human activity on earth,” says Marie Bourrel-McKinnon, a special assistant to the secretary-general of the Authority, in one of its promotional [videos](https://www.youtube.com/watch?v=tzP-WqTJR_w&t=55s). The ISA, which was established through the 1982 [United Nations Convention on the Law of the Sea](https://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm#:~:text=by%20%22*%22.-,The%20United%20Nations%20Convention%20on%20the%20Law%20of%20the%20Sea,the%20oceans%20and%20their%20resources.&text=The%20Convention%20also%20provided%20the,the%20law%20of%20the%20sea.), is led by the idea of a “common heritage of mankind,” a phrase that is used to explain that the wealth of the ocean floor should belong to all of humanity. Michael Lodge, the Authority’s secretary-general, says in the same video that the ISA’s focus on equity and common resources is what makes the organization special. “This is something that has never been done before,” he says. “It’s actually a unique experiment in human civilization.” **Critics balk at the organization’s lack of transparency and worry that the humanitarian intentions behind the Law of the Sea treaty aren’t enough to ensure that the monetary benefits of the minerals on the seafloor will reach everyone**. Some critics see an inherent contradiction in the Authority’s dual mandate to promote the development of deep-sea minerals while also protecting the environment. King among the coveted metals is cobalt, a mineral used for batteries in phones, electric cars and other electronics. Other minerals include nickel, manganese and copper. On land, these minerals — particularly cobalt — are shrouded in [controversy](https://www.youtube.com/watch?v=tzP-WqTJR_w&t=55s) related to child slavery and the environmental impacts of terrestrial mining, but they’re also in high demand. Large companies like the Canadian-based Metals Company and the American-based Lockheed Martin see these metals as the key to transitioning away from fossil fuels and contend that procuring these metals from the deep sea is a cleaner, more ethical alternative to digging them on land. “We’re on a quest for a more sustainable future, and we need metals to get there,” says [Gerard Barron](https://www.linkedin.com/in/gerardbarron), chief executive of the Metals Company, in an [advertisement](https://vimeo.com/286936275) for what was then called DeepGreen. “I don’t want to see more deforestation. I don’t want to see child labor. And I want to see us access the most sustainable supply of these important metals.” But scientists warn that disturbing these slow-moving ecosystems could hurt the biological pump — a process through which the ocean sequesters a substantial amount of carbon — in ways that can’t be remedied within generations. With the COP26 climate conference underway in Glasgow, Scotland, until Nov. 12, and the UN classifying the 2020s as the “Decade of Oceans,” leaders have been turning their eyes to the health of the seas and to the human activities that damage them. Peter Thomson, a Fijian diplomat and former president of the UN General Assembly who was president of the International Seabed Authority’s decision-making body twice, wrote an [open letter](https://ocean.economist.com/governance/articles/cop26-and-the-ocean-climate-nexus) calling for COP26 to devote attention to sustainability in the blue economy. “What the ocean gives, it can take away,” Thomson writes. “While our understanding of the ocean’s properties is still limited, we know it is the planet’s largest carbon sink, so that closely protecting the special places within it has become urgent work at hand.” Thomson is also the [UN’s envoy for the ocean.](https://sdgs.un.org/topics/oceans-and-seas/SpecialEnvoy) Other diplomats and advocates have spoken to similar concerns, including Monaco’s Prince Albert II. “We still need to avoid overexploitation of the ocean’s natural resources and the ocean floor,” he says in an [interview](https://people.com/royals/prince-albert-urges-bold-action-cop26-united-nations-climate-change-conference/) right before launching the most recent [Because the Ocean initiative](https://www.fpa2.org/en/initiatives/because-the-ocean-005) at COP26. “We cannot allow countries or large corporations to jump on every opportunity they see to exploit oil, gas or precious metal nodules protruding from the seabed without strict regulation.” Some experts and scientists who have worked with the ISA warn that harvesting metals from the mostly untouched ecosystems in the seafloor holds as much potential for global ecological devastation as it does for profit. The Authority has so far sold 31 licenses for companies and governments to explore the bottom of the high seas and is being [pressured](https://news.mongabay.com/2021/07/canadian-miner-looms-large-as-nauru-expedites-key-deep-sea-mining-rules/#:~:text=Nauru%2C%20which%20sponsors%20a%20company,whether%20regulations%20have%20been%20written.) by the small Pacific island nation of Nauru to authorize the beginning of mining operations within two years. Observers, civil society members and former employees of the ISA are raising alarms about **potential conflicts of interest in the organization and a lack of transparency surrounding funding for and profits from mining**. PassBlue’s investigation into the ISA’s operations has involved interviewing eight scientists, researchers and lawyers familiar with deep-sea mining as well as four former ISA employees and scouring documents from the Authority, embassy cables, civil society reports, academic papers and from the UN Appeals Tribunal, which is hearing [disputes](https://www.un.org/en/internaljustice/files/unat/orders/order-unat-2018-328.pdf) from employees who have left the organization. **The portrait that emerges is of an organization with a vested interest in promoting the work of the underwater mining industry, a consistent habit of alienating international marine scientists whose findings favor a more cautious approach to exploiting the ocean floor and a lack of good-faith engagement with civil society.** “If you guys are the first to mine, the first to extract nodules from international waters, it’s opening oceans earthwide,” Adrian Hellman, an Australian environmental scientist, says in an [ad](https://vimeo.com/user79094991) for the Metals Company. “What happens initially is going to affect everything down the track.” Although the push to speed up the start of undersea mining has been triggered by a two-year clause initiated by Nauru, it doesn’t mean that the Authority has to finalize the necessary legislation within two years, Duncan Currie of the [Deep Sea Conservation Coalition](http://www.savethehighseas.org/) says. The group consists of more than 80 international organizations that promote the conservation of biodiversity in the high seas. “**Once regulations are adopted, the voting requirements make it extremely difficult to disapprove a mining application, so it’s likely numerous 30 year contracts will be approved,**” Currie added in an email, noting that the contracts cannot be amended or canceled without the consent of the mining contractor. “Under the two-year rule, contracts can even be approved without regulations being in place. And it is likely they cannot be cancelled or amended without the contractor’s agreement.” PassBlue [published the first of its two-part investigation](https://www.passblue.com/2021/09/29/pressure-builds-to-mine-international-waters-amid-questions-about-ecosystems-and-profit-sharing/) on the ISA on Sept. 29, focusing on the efforts by Nauru to trigger deep-sea mining licenses. A spokesperson for the ISA declined an interview on the topic after repeated requests from PassBlue. A delegate of Nauru, Margo Deiye, attending the 26th session of the ISA, Feb. 18, 2020. The small Pacific island nation has triggered a clause at the ISA giving its member states the ability to demand that the process of granting mining permits to begin soon, possibly jeopardizing the delicate ecosystems of the oceans. ISA Navigating with good intentions? “A lot of idealists go into the International Seabed Authority thinking, ‘Oh wow, this is a place where there’s actually a statement about ensuring effective protection of the marine environment from harmful effects of seabed mining, and making sure that all states can participate in these activities,'” says Kristina Gjerde, who represents the [International Union for Conservation of Nature](https://www.iucn.org/) at ISA meetings. But she says that **the Authority is led more by corporate interests** than for “the benefit of all mankind,” the Authority’s stated goal. “It’s difficult for states to put on their hats as representing the global community interests, as opposed to one particular economic sector or another,” Gjerde told PassBlue. “Now that interest in seabed minerals is rising, this gives rise to very serious concerns about potential conflicts of interest.” The members of the ISA consist of 167 countries and the European Union. Formally, the organization is made up of five bodies: the Secretariat; the Assembly, where member countries are represented; the Council, elected by the Assembly; the Finance Committee; and the Legal and Technical Committee. The latter is tasked with making recommendations to the Council about approving legislation; together with the Secretariat, this committee is the most influential of the Authority’s organs. Longtime observers say that the Legal and Technical Committee has also never turned down an application for an exploration license. Critics of the ISA, including former employees who spoke to PassBlue confidentially, point to its leadership and revenue structure as the source of many of its problems. When deep-sea mining may actually begin, the ISA plans to receive a cut of the profits from the mining operations to cover its operating expenses. Until then, the organization receives money in two ways: through sales of exploration licenses and member states’ voluntary donations or assessed contributions. The ISA collects a $500,000 application fee for each exploration license that it grants as well as a yearly administrative fee of $47,000 per contractor doing the exploring, according to a 2019 [presentation](https://isa.org.jm/files/files/documents/dec-analysis_0.pdf) on the ISA’s payment regime. A [2020 report](https://isa.org.jm/files/files/documents/ISBA_26_FC_4-2006697E.pdf) by the Finance Committee to the Authority’s Secretary-General Lodge expressed concern that many member states haven’t been paying their assessed contributions. Outstanding contributions currently total just over $1.1 million, representing more than a month of the organization’s yearly budget. According to a former finance officer, who spoke to PassBlue but asked to remain anonymous because of the sensitivity of the information, the ISA depends heavily on the exploration license fees for its roughly $10 million annual operating budget. PassBlue has been unable to verify how much of the budget comes from contractor fees, as the Authority did not share audited financial statements after repeated requests to do so. The ISA also has a track record of dismissing scientists or employees who raise concerns about the speed at which decisions surrounding deep-sea mining are being taken, several former employees and longtime observers to the organization said. “I decided to speak out about the fact that, you know, we didn’t have enough science to be making informed decisions about how to manage this activity, unless the decision was not to proceed,” says Diva Amon, a marine biologist who [received](https://www.isa.org.jm/news/isa-secretary-general-presents-inaugural-edition-award-excellence-deep-sea-research-dr-diva) the ISA’s Award for Excellence in Deep Sea Research in 2018, referring to the writing of the Authority’s regulations around deep-sea mining. “That was when the relationship [with the Authority] switched.” Amon says she no longer gets invitations to the workshops that the ISA hosts on environmental management. The workshops are one way that the ISA consults scientists to inform members of the Legal and Technical Committee on policy decision-making. But some scientists who attend the workshops question whether their advice is being heeded. [Pradeep Singh](https://de.linkedin.com/in/pradeeparjansingh), a researcher at the University of Bremen, in Germany, who specializes in the Law of the Sea treaty, said that the reports on the workshops have gotten less substantive and sometimes fail to include the recommendations made by scientists at the gatherings. “If all this scientific input is not included in the workshop report,” he told PassBlue, “it won’t come to the attention of the Legal and Technical Committee.” Singh also said the organization’s selection of scientists attending the meetings isn’t transparent. Sabine Christiansen, a senior researcher at the German-based Potsdam Institute for Advanced Sustainability Studies, agreed. She has been studying the ISA since 2001 and attending the organization’s meetings since 2009, and says that it has a tendency to invite mostly “like-minded” scientists, a sentiment that other observers have also echoed. Who’s steering the ship? The relationship between Lodge, the secretary-general of the Authority, and the Metals Company, the Canadian company that holds three of the 31 current exploration licenses, especially concerns critics of the ISA. Lodge sparked controversy when he [tweeted](https://twitter.com/mwlodge/status/984626856384221185) a photo of himself in 2018, wearing a hard-hat branded DeepGreen, the previous name of the Metals Company, on one of its exploration cruises. Lodge also represented the ISA in an [ad](https://vimeo.com/286936275) for DeepGreen, where he said that mineral resources on Earth are dwindling and becoming more expensive and environmentally damaging to mine. [Baron Divavesi Waqa,](https://en.wikipedia.org/wiki/Baron_Waqa) the president of Nauru from 2013 until 2019, is also featured in the ad as well as in Lodge’s tweeted photos of the deep-sea cruise. [Lodge](https://www.isa.org.jm/secretary-general) is a British lawyer with a background in ocean law and fisheries management and has worked extensively in the South Pacific, where he was a lead negotiator for the 1995 [Fish Stocks Agreement](https://www.un.org/depts/los/convention_agreements/convention_overview_fish_stocks.htm), part of the Law of the Sea treaty. He has been with the ISA as a legal counsel since 1996 and was elected secretary-general in 2016. He did not respond to repeated requests for an interview from PassBlue. Christiansen of the Potsdam Institute says the climate at the ISA has become “less open” since Lodge’s election, citing less-thorough public reports. The Metals Company has been the most active corporation pushing for deep-sea mining to begin. It holds an exploration contract sponsored by Nauru through a local subsidiary. Gerard Barron, chief executive of DeepGreen (and now heading its renamed Metals Company), [represented](https://enb.iisd.org/events/1st-part-25th-annual-session-international-seabed-authority-isa/highlights-and-images-main-1) Nauru at the ISA’s Assembly meeting in 2019. In March 2021, the Metals Company [released](https://metals.co/deepgreen-combines-to-form-the-metals-company/) a $2.9 billion initial public offering stating that it would begin producing metals — and mining the ocean — as soon as 2024. Today, the company appears to be struggling, however, with one major investor [suddenly pulling out](https://www.ft.com/content/6675ac1e-a9a0-48d8-b4e9-aee2ef27c7be) his capital and a [class-action lawsuit](https://www.businesswire.com/news/home/20211028005874/en/EQUITY-ALERT-Rosen-Law-Firm-Files-Securities-Class-Action-Lawsuit-Against-TMC-the-metals-company-Inc.-fka-Sustainable-Opportunities-Acquisition-Corp.-%E2%80%93-TMC-TMCWW-SOAC-SOAC.U-SOACWS) accusing the company of misleading information in documents for investors. Lodge’s public statements on mining also raise questions about his commitment to protecting the environment when that work contradicts the interests of mining companies. Scientists, including the ISA awardee Diva Amon, have for years been calling for a moratorium on deep-sea mining to give scientists and miners more time to understand its potential consequences and devise mitigation strategies. During a [June 2020 hearing](http://www.dekamer.be/media/index.html?sid=55U0739) in Belgium’s parliament, Lodge said he had not heard a “powerful” call for a moratorium and called such an initiative “anti-science, anti-knowledge, anti-development and anti-international law.” In September 2021, 81 governments, more than 500 civil society organizations and several multinational companies, including Google, [jointly called](https://www.iucncongress2020.org/motion/069) for the moratorium. They also called on the ISA to improve its transparency and accountability. A deep-sea jellyfish collected by a remotely operated vehicle from a depth of at least 4,920 feet in the Celebes Sea of the western Pacific Ocean. The red color is common among deep-sea medusas, as it is invisible in the perpetual darkness and at the same time masks any bioluminescence of prey in the jelly’s gut. NOAA-OFFICE OF OCEAN EXPLORATION AND RESEARCH Sharing the profits The ISA was established “with this amazing principle as its fundamental legal basis to act on behalf of humankind,” Gjerde of the International Union for the Conservation of Nature says. The ISA contends that it is committed to prioritizing the interests of developing nations through the financial and economic frameworks that it writes for the exploitation of the riches that lie at the ocean floor. Though the US is not a party to the Law of the Sea treaty, American organizations still have influence over the ISA. Through subsidiaries, the weapons manufacturer Lockheed Martin holds two exploration contracts. The ISA also relies heavily on research by the Massachusetts Institute of Technology for its economic predictions. A [leaked US embassy cable](https://wikileaks.org/plusd/cables/05KINGSTON2220_a.html) from 2005 describes the involvement of the US in the Authority’s meetings, noting that the choice of an “acceptable” candidate to succeed then-secretary-general Satya Nandan would be an issue that the US would “want to address in the near future.” The 31 exploration licenses that the Authority has sold so far are held by a total of 23 governments, nationally owned entities and private companies. Seven of the contracts are set aside as “reserved areas,” which are donated by wealthy countries and meant to benefit developing countries. A closer look at the complex web of the parties involved with the exploration licenses, however, raises questions as to whether the mechanism is working as intended. “Sponsoring states need to think carefully, because if they fail to exercise due diligence and the company causes environmental damage because of that, they can be held liable,” Gjerde says, paraphrasing an [advisory opinion](https://www.asil.org/insights/volume/15/issue/7/advisory-opinion-seabed-disputes-chamber-international-tribunal-law-sea-) of the International Tribunal for the Law of the Sea. Of the contracts reserved for developing countries, three are owned by the Metals Company; one is a Chinese state company; one is a joint venture among Lockheed Martin, the Singaporean conglomerate Keppel and an investment company whose ownership is unknown; one is a joint venture between the Cooks Islands government and the Belgian dredging company DEME; and one is Blue Minerals Jamaica, of which little is known except its association with Peter Henrik Jantzen, a Dane. Indeed, as pressure increases for the Authority to speed up the process of allowing the mining of the deep sea, it remains an obscure body with little public oversight. The next meetings for the ISA Council and the Assembly, postponed last year due to the Covid crisis, are planned for December. “We have all these other activities in the high seas,” Christiansen of the Potsdam institute says. “The ISA is adding new pressures on the ocean, and nobody’s looking.”

# case

### Inherency

#### Even though the OST doesn’t bind private entities, governments still already restrict and regulate them to ensure just compliance in the squo

Eijk 20 [Cristian van Eijk is finishing an accelerated BA in Law at the University of Cambridge. He holds a BA cum laude in International Justice and an LLM in Public International Law from Leiden University, and has previously worked at the T.M.C. Asser Institute and the International Commission on Missing Persons. “Sorry, Elon: Mars is not a legal vacuum – and it’s not yours, either.” Voelkerrechtsblog. May 11, 2020. <https://voelkerrechtsblog.org/sorry-elon-mars-is-not-a-legal-vacuum-and-its-not-yours-either/>] HW AL

Two provisions of the Outer Space Treaty (OST), both also customary, are particularly relevant here. OST article II: “Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.” OST article III: “States… shall carry on activities in the exploration and use of outer space, including (…) celestial bodies, in accordance with international law”. SpaceX is a private entity, and is not bound by the Outer Space Treaty – but that does not mean it can opt out. Its actions in space could have consequences for the United States in three ways. First, the US, as SpaceX’s launch state, bears fault-based liability for injury or damage SpaceX’s space objects cause to other states’ persons or property (OST article VII, Liability Convention articles I, III). Second, the US, as SpaceX’s state of registry, is the sole state that retains jurisdiction and control over SpaceX objects (OST article VIII, Registration Convention article II). Both refer to objects in space and are irrelevant. According to article VI OST, States “bear international responsibility for national activities in outer space”, including Mars, including those by “non-governmental entities”. The US, as SpaceX’s state of incorporation, must authorise and continuously supervise SpaceX’s actions in space to ensure compliance with the OST (OST article VI) and international law (OST article III). In practice, this task is done by the US Federal Communications Commission, which licenses and regulates SpaceX. Article VI OST sets a specific rule of attribution, supplementing the customary rules of state responsibility (Stubbe 2017, pp. 85-104). SpaceX acts with US authorisation, and its conduct in space within and beyond that authorisation is attributable to the US (ARSIWA articles 5, 7). In the absence of circumstances precluding wrongfulness, the result is straightforward. If SpaceX breaches a US obligation under international law, the US bears responsibility for an internationally wrongful act.

### Asteroid Mining

#### Asteroid mining enables space colonization – even if Earth species goes extinct, we can escape if we mine asteroids

Ravisetti 21

Monisha Ravisetti (science writer @ CNET BA in philosophy NYU), 10-4-2021, "Rare asteroids near Earth may contain precious metals worth $11.65 trillion," CNET, https://www.cnet.com/news/rare-asteroids-near-earth-may-become-targets-for-space-mining/, // HW AW

Scientists just calculated that one of two metallic asteroids floating in Earth's vicinity may contain precious metals worth about $11.65 trillion. The expensive nugget, in fact, could boast more iron, nickel and cobalt than the entirety of our global metal reserves. Called metal-rich near-Earth asteroids, these rare, hefty mineral deposits measure over a mile wide. The one reckoned to be a metal motherlode is labeled 1986 DA, and the other, 2016 ED85. The duo "could be possible targets for asteroid mining in the future," according to the [new analysis published Friday](https://iopscience.iop.org/article/10.3847/PSJ/ac235f) in The Planetary Science Journal. Space mining has gained traction in the scientific community because experts believe the feat could provide [cost-effective metals](https://science.howstuffworks.com/asteroid-mining.htm) for a lunar or Mars-based colony, ultimately extending humanity's reach in exploring space. With a cosmic mine, building materials wouldn't have to withstand the expensive shuttle from Earth to space. Further, the team behind the math suggests these unique floating orbs may shed much-needed light on the authenticity of another metallic treasure NASA is [headed to in 2022](https://www.jpl.nasa.gov/missions/psyche) -- the mysterious shiny space globe known as 16 Psyche. 16 Psyche has its own allure for space mining enthusiasts. An artist's illustration shows what asteroid 16 Psyche might look like. Maxar/ASU/P.Rubin/NASA/JPL-Caltech Instead of trees, oceans or stretches of soil, the bizarre body is thought to consist of hills and valleys made of pure metal. Scientists contend it's the remaining core of an ancient rocky planet that was once destroyed. Interestingly, Earth's covered-up core looks awfully similar. Aptly dubbed "mini Psyches," the valuable smaller asteroids described in the new study are presumably pieces that have broken off from a similar naked center, though the research team notes they don't think these fragments are offshoots of 16 Psyche in particular. Still, 16 Psyche has become a rather hot topic of discussion among [scientists](https://earthsky.org/space/asteroid-psyche-metal-or-rubble-pile/) and even the [public](https://www.forbes.com/sites/jamiecartereurope/2020/12/05/a-bizarre-trillion-dollar-asteroid-worth-more-than-our-planet-is-now-aligned-with-the-earth-and-sun/?sh=689f08431c9a) -- it's suspected to hold minerals worth $10,000 quadrillion. Let that sink in. The exorbitant figure, however, has generated [considerable doubt](https://www.cnet.com/news/10000-quadrillion-asteroid-psyche-may-not-be-as-valuable-as-first-thought/) because scientists can't be sure what 16 Psyche is made of until a spacecraft inspects it. It's too far away for precise spectrum analysis, a scientific method that leverages electromagnetic emission and absorption signals to learn about objects' compositions. Until such an examination can happen, something NASA's mission intends to perform, researchers have to consider the option that it's merely some sort of rubble. That's what makes data from the "mini Psyches" indispensable -- they may offer a first look at their namesake's features. Proximity to our home planet deems it much easier for scientists to capture the rocks' spectral info from Earth. "It is rewarding that we have discovered these 'mini Psyches' so close to the Earth," Vishnu Reddy, associate professor at the University of Arizona's Lunar and Planetary Laboratory and principal investigator of the NASA grant that funded the work, said [in a statement](https://www.eurekalert.org/news-releases/930288). Sifting through the collected data, researchers found the orbiting blocks are made of 85% metal, such as iron and nickel, and only 15% silicate, which is basically regular rock. As such, some ambiguity about 16 Psyche might soon be alleviated thanks to the baby versions of it -- including whether it'll add to the crew of treasure troves for future space miners. Regardless, while the trio of metallic hunks definitely seem to hint at our sci-fi fantasies of space mining inching toward reality, one thing is absolutely certain: They're a pretty hard-core squad.

#### Asteroid mining is critical to future survival – it can fund more space exploration, eliminate resource scarcity, build space cities to house millions, and manufacture organs to save lives

Elvis 21 [Martin Elvis is a senior astrophysicist at the Center for Astrophysics | Harvard & Smithsonian. He is the author of Asteroids: How Love, Fear, and Greed Will Determine Our Future in Space (2021). “Riches in space.” Aeon. July 2, 2021. <https://aeon.co/essays/asteroid-mining-could-pay-for-space-exploration-and-adventure>] HW AL

Asteroids are the remnants of our solar system’s youthful exuberance, the leftover crumbs from when the planets formed. For much of the space age, asteroids were ignored in favour of the far more glamorous planets, and the Moon. The asteroids – dark, misshapen rocks, hard to see and hard to find – have long flown beneath our notice. But that was a mistake. They have a crucial role to play in the future of our species – in fact, the survival and flourishing of humanity are tied up with asteroids. There are three reasons. They bear messages from the beginnings of the solar system, before our Earth came into being, and how we got here matters to where we’re going. They are also hoards of resources that might lead us to a future without scarcity. And last – a minor detail – a single asteroid could wipe us off the face of our planet. Let’s look at each in turn. Asteroids are the remnants of collisions between some of the first mini-planets (called ‘planetesimals’) that formed in abundance when the solar system was no older than a few million years. As a result, many asteroids are just piles of broken rubble held together by their own weak gravity, about a million times more feeble than the gravity we feel here on Earth. Untangling the eventful history of the solar system is easier with asteroids because they’re unsullied envoys from those turbulent early times. Unlike the planets, nothing much has happened to the asteroids in the past few billion years. And there are millions of them, the vast majority orbiting the Sun between Mars and Jupiter in a band called the ‘Main Belt’. An animation depicts a mapping of the positions of known near-Earth objects at points in time over the past 20 years, and finishes with a map of all known asteroids as of January 2018. Courtesy of JPL/NASA Perhaps 10,000 asteroids the size of sports stadiums are on orbits that swing close to Earth. As the dinosaurs would attest, our planet occasionally gets hit. But the results aren’t always a bad thing: it’s looking likely that Earth’s oceans were filled by water brought by asteroids. Along with water, asteroids might even have brought the ingredients of life to Earth in the form of so-called ‘prebiotic’ molecules, including amino acids and, as recently found, components of proteins and sugars. Learning more about asteroids means learning more about our origins. What can we actually do with asteroids? That brings us to my favourite thing about them: their resources. Being an idealistic astrophysicist, my interest is in the money to be made from them. That really is idealistic because, if we can make a profit mining the asteroids, then doing bigger things in space will become a lot cheaper. Capitalism has its faults, but one thing it does well is to make things cheaper. I want to use it as a tool so that we can build far bigger telescopes than we could practically realise today. What do astronomers want? More light! Bigger telescopes! Asteroid mining could make that dream a reality. The siren call of asteroids for miners is that the Main Belt asteroids contain vast amounts of resources. The iron found in asteroids adds up to some 10 million times the iron that we have in proven reserves on Earth. That’s a lot. It’s enough to build many rings of iron girders all the way around Earth’s orbit, along the lines of the science fiction novel Ringworld (1970) by Larry Niven. Not that a ringworld is a sensible thing to make, but it is a really big ring. More plausibly, with that much iron we could build cities in space, as envisaged by the physicist Gerard K O’Neill in the 1970s. Each of these cities would be big enough for a million people to live in. They would be rotating cylinders, and as a citizen of one you would be walking around inside the cylinder’s surface, feeling a fake gravity from the centrifugal force. That’s the scale of resources we’re talking about. These vast material supplies could make for an era that people call ‘post-scarcity’, where there’s plenty for everyone, just as there is in the 23rd century of the Star Trek science fiction franchise. The starship crew on Star Trek don’t work to keep themselves fed and housed, that’s taken for granted. They work for adventure and exploration. Asteroid wealth could help all of us take a step towards that happy state. The problem is how to get started. Iron in space is not going to make for giant profits in the short run. On the ground, it sells for less than $200 a ton. It would be worth more in space, but unfortunately there’s no one to buy huge tonnages of iron in space. To adapt the tagline from the Alien movies – ‘In space, no one can hear you sell.’ It certainly isn’t worth bringing space iron back to Earth since the cost of doing so would far exceed the price it could command. Starting to mine space for resources will have to begin with something so valuable that the cost of obtaining it in space is small by comparison. For now, the best bets are precious metals and – surprise – water. Precious metals are obvious. Platinum sells for about $33.5 million a ton, and we know from meteorites that some asteroids are richer in platinum than any mine on Earth. That sounds promising. Platinum sales run at about 200 tons, or billions of dollars, per year. The bad news is that ‘richer than any mine on Earth’ is still concentrations of just tens of grams per ton, and extracting those precious grams isn’t easy. We can’t just bring an asteroid near to Earth to start extracting the platinum where we can have heavy machinery to work on it. That would take way too much fuel because, to carry more mass, rockets have to carry exponentially more fuel; unlike airplanes, they don’t get the oxygen for free from their surroundings, they have to pull it along with them. Any refining of platinum will have to be done robotically out in the native orbit of the asteroid. That’s quite a challenge. Water is a less obvious money-maker. The surprise is that water is also worth millions per ton – if it’s sold in space. Water in space is really useful. It’s good for drinking, and the oxygen in it is good for breathing. You can split the hydrogen from the oxygen in H2O and you’ve got rocket fuel, and water is good at absorbing radiation to protect people from cancer-causing cosmic rays. So, in principle, water in orbit is pretty valuable. The good news is that up to 10 per cent of a water-rich asteroid can be water. It won’t be simple ice, most likely, but will be bound into clays and other rocks. Even better, water is much easier to extract than precious metals. Simply heating up the rock will release water that can then be captured. How much is space water worth? Until recently, it cost $20 million to get a ton of water into even a low orbit – say, to the International Space Station (ISS). To get a ton of water to a high orbit, like the 24-hour orbit of TV transmitting satellites, would cost about three times as much. SpaceX has started to cut that cost; for now, it’s charging about $3 million a ton to a low orbit on a Falcon 9 rocket. Water from asteroids might be able to compete with those prices and still return a nice profit. But the bad news is that, right now, there’s no one in space who wants to buy water. At least not yet. That might be about to change. We won’t get to build cities in space unless we can build simpler space stations first, and do so at an affordable cost that can scale. If we have space stations, they will need supplies, especially of water and perhaps construction materials. That demand could create a business delivering these supplies from space instead of from Earth. In this case, the asteroids would have the most to offer. So space stations – particularly commercial space stations – are the key to acquiring asteroid resources. Why build space stations? There are three primary uses: research, manufacturing and tourism. Research has always been done on the ISS, but facilities and time have been in short supply. In recent years, the equipment has improved a lot, but astronaut time is still scarce. Each astronaut has to look after multiple experiments. Multitalented and smart as the astronauts all are, they simply can’t have all the experience of the scientists whose experiments they’re operating. A lot of effort goes into automating those experiments so that the astronauts aren’t overwhelmed. It would be far more efficient if the scientists who invent the experiments also get to be the ones who carry them out in space. Then their years of experience could be put to good use operating and watching over their studies. Spotting subtle anomalies that could be a sign of a failure, or of a discovery, is much better done in person by experts. But, until now, scientists didn’t have that opportunity, and they would have likely declined it if offered the chance. That’s because training for a mission to the ISS takes more than two years full-time and requires learning Russian. If you take two years off from doing your research, then you’re no longer at the forefront and you’ll have lost your edge. Few top scientists would risk that, however much fun it might be to float in space. We scientists live for our research. Fortunately, the new commercial stations will be much easier to train for, taking a couple of months or so, because they’ll have a single manufacturer with consistent, uniform interfaces, and a separate professional crew to deal with maintenance and emergencies. The companies with advanced plans so far are all US-based, so English will be the language used. As English is the lingua franca of science, it poses little challenge to scientists worldwide. Manufacturing in space has always seemed like a fool’s errand. Whatever you make out there would have to be worth outrageous amounts to cover the shipping costs back to Earth. Now, though, those costs have come down almost 10-fold, with more reductions promised. As a result, a few items do pass that test. Already, there are first tests taking place on the ISS to see if the advantages of manufacturing in almost zero gravity (‘micro-gravity’) are really as great as some have suggested. The most popular idea is to make super-powerful optical fibres that could carry far more data traffic than current transoceanic fibres can. They could potentially do so more cheaply because they would be simpler: they wouldn’t need repeater stations. Certainly, the demand is there, since there’s no limit to the number of cat videos we must share. These ‘ZBLAN’ optical fibres showed dramatic improvements when small amounts were made during brief, half-minute long intervals of weightlessness on a parabolic flight. There are a few companies already trying to make ZBLAN fibres on the ISS. The results must be promising because they went back after their first attempt. A kilogram of fancy optical fibres already sells for about $1 million to $20 million. That will pay for the postage and still give you change! Another idea is to 3D-print human organs in space. Why? Printing ears on Earth has been done, using a scaffolding that later dissolves away. But some organs are trickier, and scaffolds don’t always work. Without that support, the layers of cells tend to slip and slide out of position, which is not the desired effect for something meant to keep you alive. In micro-gravity, the slipping and sliding should be much smaller. The goal is eventually to be able to print a human heart. A heart weighs less than a kilogram. Even with packaging to keep it healthy, **the transport cost of bringing a new heart down to Earth is going to be far less than it’s worth to the recipient.** Again, first experiments toward this goal are underway on the ISS.

#### Only asteroid mining can provide us with the research and understanding to prevent extinction

Elvis 21 [Martin Elvis is a senior astrophysicist at the Center for Astrophysics | Harvard & Smithsonian. He is the author of Asteroids: How Love, Fear, and Greed Will Determine Our Future in Space (2021). “Riches in space.” Aeon. July 2, 2021. <https://aeon.co/essays/asteroid-mining-could-pay-for-space-exploration-and-adventure>] HW AL

If knowledge or greed isn’t motivation enough to set your sights on the asteroids, then the one thing virtually all people agree on is that having humanity wiped off the face of Earth would be bad, at least for us. Of all the multiple threats to humanity’s existence, the only one that we can definitely eliminate is that of a large asteroid slamming into our home planet and killing us off, together with most other species, following the lead of the dinosaurs who were made extinct by an asteroid slamming into the ocean. There’s a T-shirt popular among space cadets that has the slogan ‘Asteroids are nature’s way of saying “How’s that space programme coming along?”’ If we can find all the killer asteroids, then we can divert them to render them harmless. Best to play it safe. There are several searches underway for undiscovered, potentially dangerous asteroids. Thanks to the first big survey, Spaceguard, 90 per cent of the dinosaur-killer-sized asteroids out there have already been found. None of them pose any danger for the next century at least. That still leaves an uneasily large number of about 100 extinction-event-sized rocks out there that we haven’t found yet. Smaller, city-killer asteroids are much less well-surveyed for. To remedy this concern, two new surveys will begin in the next few years, and they will both be more or less done by 2030. They are the Vera C Rubin Observatory ‘Legacy Survey of Space and Time’, which will start scanning the whole sky every few nights from 2023 onwards. Its mission has been complicated by the mushrooming constellations of thousands of internet satellites now being launched by several companies, with SpaceX being the most visible. Hopefully a solution will be found. The Vera C Rubin Observatory, on a mountain in Chile, will record its image using normal visible light. For asteroids, that light is reflected sunlight. But many asteroids are pitch black, reflecting only a few percent of the sunlight pouring on to their surfaces. How do you find those dark asteroids? The answer is to use the long wavelength – infrared – light they emit because they’re warm: their ‘black body radiation’. NASA is building a special mission just for this purpose. Developed by a team lead by Amy Mainzer, now of the University of Arizona, Tucson, it’s called the Near-Earth Object Surveillance Mission. Starting around 2025, it will scan the sky repeatedly for five years looking for moving objects that are bright in infrared light, and has wavelengths some 10 to 20 times longer than we can see with our eyes. The team’s tagline is ‘Finding Asteroids Before They Find Us.’ Good idea! This will be the first time that humanity has deliberately changed the orbit of any celestial body An advantage of using the black body radiation is that it also tells us quite accurately how big each asteroid is. That helps in assessing their threat, as well giving us a first guess at how much they might yield in resources. Combining the two surveys will indicate how much sunlight each asteroid reflects – its ‘albedo’ – and that’s a clue to what they’re made of. We want to know that because a metal asteroid of a given size is more dangerous than one made of rock, and is more difficult to push out of the way. The composition also helps us explore all two dozen types of asteroid out there, the better to decipher the history of our solar system. As a side product, the surveys will pin down their potential value. By 2030, we’ll have better rockets than we have today. Several are set to fly within five years. They’ll let us reach many more asteroids with more massive payloads to deflect them, study them or mine them. Also by 2030, several more asteroids will have been visited by our exploration spacecraft. JAXA, the Japanese space agency, and NASA each had recent missions to return samples from carbonaceous asteroids. The Japanese Hayabusa2 went to the spinning-top-shaped asteroid named Ryugu, and NASA’s OSIRIS-REx went to the asteroid called Bennu. Such carbonaceous asteroids are the least changed, we believe, from the time of their formation at the beginning of the solar system’s formation. They are called carbonaceous because they are chockfull of organic (carbon-containing) molecules; many of them also contain quite a lot of water. There are more missions planned to more distant asteroids such as Psyche, a metal asteroid in the Main Belt, and to the Trojan asteroids trailing Jupiter’s orbit. OSIRIS-REx samples and leaves asteroid Bennu. Courtesy of NASA **Every time we visit an asteroid, it surprises us.** Bennu was found to be throwing rocks off its surface as it spun around its axis, and when OSIRIS-REx put down its outstretched arm to grab a sample off the surface, the arm sank half a metre into the asteroid; it stopped going deeper only when the retrorockets fired to stop it. That’s really not how rubble behaves on Earth! The more we know about asteroids, the more confident we can be that we can deflect their path away from Earth. A NASA mission called DART will make a high-speed impact on the small moon of the asteroid Didymos in late 2022 to see if we can slow down a dangerous asteroid to stop it causing devastation on Earth. (Don’t worry: the target was chosen to be a safe one for us.) This will be the first time that humanity has deliberately changed the orbit of any celestial body. It isn’t likely to be the last. Once all the good-sized accessible asteroids have been found, their orbits mapped, their sizes known, and at least a good clue found as to what they’re made of, the barriers to mining them will be much lower. **After visiting a half dozen asteroids up close, we’ll have learned a great deal about their origins, how to deflect them should one be headed our way, and how to handle them.** That will put us in a good place to begin to extract their resources. I predict this will happen right around 2030, when demand for in-space materials should be picking up. **The stars seem to be aligning for mining the asteroids. Mining will expand our capabilities in space, especially making it easier to deflect a dangerous asteroid.** In a virtuous cycle, those new capabilities will lead us on to greater exploration of the many worlds in our solar system and, with bigger, better telescopes, to the Universe beyond. It should be fun.

#### We’re still lightyears away from lunar mining — even Elon acknowledges the immense difficulties that we’re nowhere near solving

Mining Technology 17

Mining Technology (mining news and in-depth feature articles on the latest mining company deals and projects covering trends in mineral exploration); “Mining the Moon”; *Mining Technology*; December 4, 2017; <https://www.mining-technology.com/features/mining-the-moon/>; HW-EMJ

The concept of mining on the Moon has been around for decades, and while political and scientific endeavour has ebbed and flowed, it has never gone away. Almost all current space exploration programmes – American plans to go back to the Moon and Elon Musk’s SpaceX programme included – factor in mining resources in some way or another. “The basic idea is to extract materials from the Moon that create new capabilities in space,” says lunar scientist Paul Spudis. “To this end, people have envisioned a wide variety of mining and resource utilisation activities on the Moon. Broadly, most plans involve the collection of granular material, running it through some type of processing, e.g. thermal, chemical – the extraction of useful stuff and the discarding of the waste.” Scientific advances are bringing commercial space travel ever closer. At the same time, terrestrial resources are beginning to wane and dreams of making use of the 7.3 x 1022kg of material circling the Earth that make up the Moon have gained greater traction. So, realistically, how close are we to mining the Moon? Water, metals and REMs The Moon’s resources could be put to a number of uses, such as a source of fuel for farther flung journeys through space, or providing an alternate source of rare metals and minerals for use on Earth. “There is a hierarchy of material resources, arranged according to their ease of acquisition and their utility,” says Spudis. “The easiest stuff is bulk regolith (lunar soil), which can be used to backfill installations on the moon and to make shielding to protect habitats thermally and from radiation.” Regolith would not be transported to Earth, but for missions such as SpaceX’s, which include building a lunar base, it could be very beneficial. When, in 2008, samples from the 1970s Apollo 15 and 17 missions were re-examined, the presence of water brought greater hope of establishing lunar habitations. Since then, multiple studies have confirmed that the Moon has water in abundance. “Water ice (and other volatile substances) is found in the dark areas near the poles and have many uses, including life support and rocket propellant,” says Spudis. For any future mining activities water will be necessary, both for operations and for sustaining a crew. “Water is the oil of the solar system and those companies who are able to harvest and harness extraterrestrial deposits of water will make Exxon look like a lemonade stand,” says founder and CEO of Moon Express, Robert Richards. Along with water, the Moon has a number of other materials which would be useful for space exploration. “Metals can be extracted from the oxides in the soil by chemical reduction – iron, titanium and aluminium are the principal useful metals to be manufactured on the Moon,” says Spudis. But like regolith, it wouldn’t be profitable to bring these metals back to Earth where they can be mined far more easily. Currently, China produces more than 90% of the rare earth metals (REM) we need for electronics. But reserves are running out fast with some elements, including dysprosium, neodymium and lanthanum, expected to be depleted within the next 20 years. In order to feed the world’s seemingly insatiable appetite for technology, new sources of REMs must be found, as recycling alone will be unable to meet demand. “Rare and unusual elements and isotopes (rare earths, thorium, helium-3) may be accessed and mined,” says Spudis. “Some of these uncommon materials may be of such high value as to merit their importation back to Earth for sale in terrestrial markets. But these are in very low concentrations and will likely be the targets for mining in the future, after a long-term presence on the Moon has been established.” It is these which provide the greatest hope for profitable mining companies and shipping to Earth. There and back again Many hurdles remain before mining the Moon can happen, not least getting there. In all of human history only 12 people have ever walked on the Moon. This is, in part, due to the colossal expense of such a venture, so the cost must come down before industry can proceed. Conventional thinking is to create reusable rockets, something SpaceX is currently working on with its Dragon craft. “If one can figure out how to effectively reuse rockets just like airplanes, the cost of access to space will be reduced by as much as a factor of a hundred,” says SpaceX founder and CEO Elon Musk. “A fully reusable vehicle has never been done before. That really is the fundamental breakthrough needed to revolutionise access to space.” Once commercially affordable lunar transport has been developed and the Moon reached, then the challenges intensify. Crews working in the hostile environment of the Moon will have to endure living in “a vacuum with extremes of heat and cold, hard radiation and the ubiquitous presence of abrasive, angular dust grains”, explains Spudis. The temperature on the Moon varies from 123°C to -233°C because there is no atmosphere, making human habitation and activities very difficult. Furthermore, there is only about a sixth of the gravity on the Moon that we experience on Earth, complicating mining operations substantially. Bases will need to be established, probably with the use of 3D printing, which would enable the construction of infrastructure on the Moon. Mining lunar material will also require self-sufficient and reliable robotics to minimise human exposure to the Moon’s environment. “Mining machines could be automated for simple tasks and teleoperated for complex tasks requiring human supervision, but complex machines will require self-maintenance, high reliability and long lifetimes,” says Spudis. “The exposure of humans to the harsh environment must be minimised.” Furthermore, raw materials harvested will need to be processed on the Moon. Transferring lunar soil to Earth for processing is simply impractical, and much of the materials would be required for activities taking place on the Moon itself, such as those necessary for building and maintaining the moon base. For elements worth transporting back, there is a third phase of complications: returning to Earth. This particular challenge could be resolved by way of reusable space crafts, which would have to be capable of not only withstanding the immense heat and pressure of re-entering Earth’s atmosphere with enough control to land safely in a specific location, but to do all of this whilst carrying an extremely heavy cargo of REM.

#### Asteroid mining is impractical and no one is going to try any time soon

Fickling 20

David Fickling (columnist covering commodities and industrial and consumer companies, reporter for Bloomberg, Dow Jones, WSJ, Financial Times, Guardian.; “We’re Never Going to Mine the Asteroid Belt”; *Bloomberg News*; December 21, 2020; <https://www.bloomberg.com/opinion/articles/2020-12-21/space-mining-on-asteroids-is-never-going-to-happen>; HW-EMJ

It’s wonderful that people are shooting for the stars — but those who declined to fund the expansive plans of the nascent space mining industry were right about the fundamentals. Space mining won’t get off the ground in any foreseeable future — and you only have to look at the history of civilization to see why. One factor rules out most space mining at the outset: gravity. On one hand, it guarantees that most of the solar system’s best mineral resources are to be found under our feet. Earth is the largest rocky planet orbiting the sun. As a result, the cornucopia of minerals the globe attracted as it coalesced is as rich as will be found this side of Alpha Centauri. Gravity poses a more technical problem, too. Escaping Earth’s gravitational field makes transporting the volumes of material needed in a mining operation hugely expensive. On Falcon Heavy, the large rocket being developed by Elon Musk’s SpaceX, transporting a payload to the orbit of Mars comes to as little as $5,357 per kilogram — a drastic reduction in normal launch costs. Still, at those prices just lofting a single half-ton drilling rig to the asteroid belt would use up the annual exploration budget of a small mining company. Power is another issue. The international space station, with 35,000 square feet of solar arrays, generates up to 120 kilowatts of electricity. That drill would need a similar-sized power plant — and most mining companies operate multiple rigs at a time. Power demands rise drastically once you move from exploration drilling to mining and processing. Bringing material back to Earth would raise the costs even more. Japan’s Hayabusa2 satellite spent six years and 16.4 billion yen ($157 million) recovering a single gram of material from the asteroid Ryugu and returning it to Earth earlier this month. What might you want to mine from space? Water is an essential component of most earth-bound mining operations and a potential raw material for hydrogen-oxygen fuel that could be used in space. The discovery in October of ice molecules in craters on the Moon was taken as a major breakthrough. Still, the concentrations of 100 to 412 parts per million are extraordinarily low by terrestrial standards. Copper, which typically costs about $4,500 per metric ton to refine, has an average ore grade of about 6,000 ppm. The more promising commodities are platinum, palladium, gold and a handful of rare related metals. Because of their affinity for iron, these so-called siderophile elements mostly sunk toward the metallic core of our planet early in its formation, and are relatively scarce in the Earth’s crust. Estimates of their abundance on some asteroids, such as the enigmatic Psyche 16 beyond the orbit of Mars, suggest concentrations several times higher than can be found in terrestrial mines. Still, human ingenuity is all about cutting our coat according to our cloth. If such platinum-group metals are going to justify the literally astronomical costs of space mining, they’ll need to count on sustained high prices for the decade or so that would be needed to get such an operation up and running — and that sort of situation is all but unheard-of in the materials industry. When prices of an essential commodity get excessively high, chemists get extraordinarily good at finding ways to avoid using it, scrap merchants improve their recycling rates, and miners discover new deposits that wouldn’t have been viable at lower prices. Even criminals get in on the game. That eventually pushes supply up and demand down, so that prices rebalance — a dynamic we’ve seen play out in the markets for rare earths, lithium and cobalt in recent years. The world mines about three times more platinum than it did in the early 1970s, but prices have barely changed once adjusted for inflation. That might sound a disappointing prospect to those looking for excuses for humanity to colonize space — but really it should be seen as a tribute to our ingenuity. Humanity’s failure to exploit extraterrestrial ore reserves isn’t a sign that we lack imagination. If anything, it’s a sign of the adaptive genius that put us in orbit in the first place.

### Climate

#### Space exploration is k2 ending climate change

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Space developments in the last two decades have greatly contributed to our understanding of our planet’s climate. Satellite imaging, space exploration, and new technologies give us an idea of the big picture and how we can adapt to address climate change. For example, satellites in space have played a critical role in our understanding of the causes of global warming by providing us with a large body of data to examine the variations in the Earth’s orbit. Data from these capabilities were essential inputs into the Intergovernmental Panel on Climate Change’s (IPCC) recent report that focused on how the physical science of climate change informs likely impacts under five different emissions scenarios. The report also found that climate change is happening quicker than we thought, making the need to reduce emissions imminent. To address this, space infrastructure such as positioning, navigation, and timing (PNT) can help identify efficient transportation routes and sources of emissions, ultimately aiding mitigation efforts.

### Private Entities

#### Private entities are uniquely crucial to space exploration especially since governments are no longer interested after the space race

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Jeff Bezos, the richest man on earth, has said that he has been funding his space technology firm Blue Origin at the rate of $1 billion a year and will continue to pump in his “Amazon lottery winnings into a much lower price of admission so we can go explore the solar system." He can afford it — with a net worth of $131 billion, he is richer than two-thirds of the countries of the world. And, along with Elon Musk, the founder of SpaceX, he is the face of the next giant leap of capitalism — into space. Science fiction predicted most of humanity’s technological advancements — from submarines to television, from rockets to robots. But even the most clairvoyant of sci-fi authors failed to foresee that **planet earth would lose interest in manned space exploration after putting a man on the moon.** The space race of the 1950s and 1960s had a grandiose political purpose. **When that battle had been settled, placing communication satellites in orbit became by far the major activity.** Yes, space shuttles were launched, an International Space Station (ISS) is up there, but this was hardly space exploration. The US National Aeronautics and Space Administration’s (NASA) budget, in constant 2014 dollar terms, peaked at $43.6 billion in 1966; it was $18.9 billion in 2017. There were huge potential pay-offs — the obvious one being mining minerals on asteroids and other planets, **but to governments, the returns on investments were too far-off to commit the massive upfront cash outlays.** And thus it stayed for 40 years, till a new breed of capitalists emerged — whose dreams sought frontiers beyond earth. “Our planet is finite," Bezos has said. The turning point was the retirement of the space shuttle in 2011. As a result, NASA awarded billions of dollars of contracts to private companies to carry astronauts and cargo to the ISS. **The industry suddenly bloomed; there are more than a thousand space companies in the US today.** Investment bank Goldman Sachs estimates that space start-ups have, globally, attracted $13.3 billion of investment since 2010. In 2015, President Barack Obama signed the US Commercial Space Launch Competitive Act into law, guaranteeing private companies rights to own, sell and profit from resources extracted from asteroids and other “celestial bodies". In August 2017, Luxembourg became the first European country that officially allows space resources to be “appropriated" by commercial groups based in the country. Many companies have since then set up shop in Luxembourg. Bezos’ Blue Origin has successfully launched and landed several sub-orbital flights. In February this year, SpaceX launched Falcon Heavy into orbit around the sun. The company is aiming to have manned flights by the end of the year, and says that Big Falcon Rocket (BFR), its spaceship for interplanetary travel that may carry up to 100 passengers, will be ready in 2019. Meanwhile, Bigelow Aerospace, owned by Robert Bigelow, who made his billions from his budget hotel chain, plans to set up hotels that will orbit earth. Among start-ups that are focused on space mining, Planetary Resources points out that just one little near-earth asteroid called 3554 Anum has $8 trillion worth of platinum reserves, while our current annual output is $12 billion, of which 88% comes from three mines in South Africa.

#### Private entities are critical to exploring space – public governments alone are not enough and don’t have incentive

Baumann 17 [Michael Baumann is a staff writer at The Ringer. University of South Carolina-Columbia. “Who Gets to Own Outer Space?” The Ringer. December 27, 2017. <https://www.theringer.com/2017/12/27/16812048/future-of-space-x-nasa-elon-musk-donald-trump>] HW AL

Contracting out ISS delivery insulates NASA from cost overruns — if a vehicle takes longer to build or goes over budget, the company makes it up out of its own coffers. That represents a departure from the traditional contractor model, which has resulted in just that — delays and cost overruns — for the Department of Defense. That’s also why NASA made a point to select not just one capsule design but one from Boeing and one from SpaceX: Capitalism promises increased innovation and lower costs through competition, but in order for that to happen, there has to be, in so many words, competition. **Private companies have been taking care of the American end of supply runs to the ISS for the past five years, generating a burgeoning industry that now includes several contractors.** SpaceX, the splashiest of the group, was founded 15 years ago by Musk with civilian and commercial spaceflight in mind, and furnishes both the spacecraft, the Dragon, and the rocket (known as the Falcon) that sends it to orbit. Orbital ATK is the result of a 2015 merger between Orbital Sciences Corporation, which has been building rockets and satellites since the 1980s, and defense contractor Alliant Techsystems. Orbital ATK’s Cygnus spacecraft has been launched to the ISS from both Antares rockets, built by Orbital ATK itself, and Atlas rockets, built by United Launch Alliance, a partnership of Lockheed Martin and Boeing. Sierra Nevada, another defense contractor with a 50-year history, will also send its planelike Dream Chaser into orbit on Atlas rockets. Commercial resupply services missions have guaranteed at least one reliable and lucrative customer — NASA — for a variety of companies, from newcomers like SpaceX, to aerospace giants, like Lockheed Martin and Boeing, which have diverse products and a lineage that dates back to the first years of powered flight. **Multiple private companies are making enough money to not only enter a market with high barriers to entry, but to make enough money to want to stay there**, while NASA enjoys lower costs and offloads some of the logistical burden, and at the same time sparking a burgeoning industry that creates high-paying jobs in the United States. Which raises an obvious question: Why did we ever do it any other way? “For these big military or aerospace contracts, generally the government is asking some subset of industries to make something that has never been made before, and no one knows how to make it,” Dreier said. “What company would say, ‘We will build the largest rocket ever and send it to the moon, having no idea how to begin with the materials, and we’ll assume all of that risk. And if we go over budget, then we go out of business and you no longer have a company to work on this rocket, and you have to start over’?” Nowadays, Dreier says, low-earth-orbit flights like satellite launches and ISS resupply missions are known quantities, so companies know what they can promise NASA and still meet deadlines and budget expectations. And while they’d probably prefer a blank check and a practically unlimited timeline, NASA is using its own leverage to demand a better deal. Public investment in spaceflight still grossly outstrips private money, so even the limited commercial resupply services missions — six in 2017 — are significant financial opportunities for a contractor. And the benefits extend beyond the CRS contracts. SpaceX, for instance, developed the Falcon 9 rocket not just for CRS missions but for commercial satellite launches — most notably communications satellites — and is adapting its technology for crewed missions. Transporting people into orbit isn’t exactly the same as transporting cargo — NASA requires greater reliability, because while losing a satellite is an expensive failure, losing a crew is an international tragedy — but the overlap between the two is obvious. NASA also requires CRS contractors to attract private investment, which is easier to get when the company has steady government work to show off.

#### Private entities are the only ones who can get the job done quickly and efficiently, they are quickly surpassing the government

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“We’re starting to see advances made by private entities that are more significant than any advances in the last three years that were made by the government,” Chris Lewicki, CEO and President of Planetary Resources, tells Futurism. Amazon CEO Jeff Bezos’s Blue Origin and Tesla CEO Elon Musk’s SpaceX are arguably the two companies that are setting the pace. In November 2015, the former completed the first successful vertical rocket landing after sending their New Shepard 100 kilometers (62 miles) into the air. SpaceX landed its own rocket a month later, only they did so with a craft twice as heavy as Blue Origin’s and traveled all the way into space first. A month after that, in January 2016, Bezos’s company became the first entity to re-launch and re-land a previously used rocket. SpaceX followed suit in 2017. “The government was never able to [build reusable rockets], but now, two private companies within the space of the same year have done that,” points out Lewicki. Not only are private companies already surpassing their government counterparts, several are poised to widen their lead in the coming months and years. If all goes according to plan, when SpaceX’s Falcon Heavy launches in September, it’ll take the title of the world’s most powerful rocket away from NASA’s Saturn V. Virgin Galactic is already selling tickets for what it expects to be the first private spaceflights, which will take place aboard the sleek VSS Unity. SpaceX plans to send space tourists to the Moon in 2018, and then in 2024, the company hopes to launch a system that will take people all the way to Mars…roughly 5-15 years before NASA expects to do the same.