HOUSE COMMITTEE ON
NATURAL RESOURCES
CHAIRMAN BRUCE WESTERMAN

To:	Subcommittee on Oversight and Investigations Republican Members
From:	Subcommittee on Oversight and Investigations Staff, Michelle Lane (michelle.lane@mail.house.gov) and Thomas Knecht (thomas.knecht@mail.house.gov)
Date:	Tuesday, December 12, 2023
Subject:	Oversight Hearing on "*The Mineral Supply Chain and the New Space Race*"

The Subcommittee on Oversight and Investigations will hold an oversight hearing titled "*The Mineral Supply Chain and the New Space Race*" on **Tuesday, December 12, 2023, at 10:15 a.m. in 1324 Longworth House Office Building**.

Member offices are requested to notify Cross Thompson (Cross.Thompson@mail.house.gov) by 4:30 p.m. on December 11th if their Member intends to participate in the hearing.

I. KEY MESSAGES

- Exponential growth in global mineral demand and China's dominance of mineral supply chains threaten America's national security and economic interests.
- While there is uncertainty over the feasibility for space mining, accelerating investments from our foreign adversaries, notably China, to extract minerals from celestial bodies (such as the Moon, Mars, and asteroids) exacerbates America's fragile mineral supply chains.
- The eventual volume and value of space mining will provide immeasurable benefits to whomever controls the celestial mineral supply chain and will prove calamitous for those who choose to ignore the opportunities of space mining.
- America must take the necessary steps to secure our mineral supply chains by increasing domestic mineral development and leading the development of space mining activities.
- As in the past, the United States must continue to lead, rather than cede, its position on both mining and territorial control over expanding resources beyond Earth's orbit.

II. WITNESSES

- ***Mr. Eric Sundby***, Co-Founder & CEO of TerraSpace, Executive Director of the Space Force Association, Boerne, TX
- ***Dr. Greg Autry***, Director and Clinical Professor, Space Leadership, Policy, and Business, Thunderbird School of Global Management, Arizona State University, Phoenix, AZ
- ***Dr. Moses P. Milazzo***, Owner of Other Orb, Chief Scientist for NASA's Planetary Data Ecosystem, Flagstaff, AZ *[Minority Witness]*
- ***Ms. Michelle Hanlon***, Executive Director, Center for Air and Space Law, The University of Mississippi School of Law, University, MS

III. BACKGROUND

The Global Demand for Minerals Will Rise Exponentially in the Years Ahead

Minerals—including copper, lithium, cobalt, and dozens of others—are integral to our modern way of life. They are used in almost all high-tech applications, including smart phones, satellites, and missile defense systems. They are also essential for the function of renewable energy technologies, electric vehicles, and battery storage.

The global demand for minerals is expected to exponentially rise in the decades ahead. Notably, according to the World Bank, the growing demand for minerals will increase by nearly 500% by 2050.[1] The global demand for minerals specifically used in electric vehicle (EV) batteries, such as lithium and graphite, will increase by even more, up to 4,000% in the decades ahead.[2] The growing demand for minerals is strongly correlated to the growing demand for low-carbon technologies, such as EV batteries, solar photovoltaic (PV), wind, and geothermal energy sources, which are more mineral intensive compared to fossil fuel technologies.[3] Climate goals further drive the demand for minerals. For instance, to achieve net-zero emissions globally by 2050, the world will require a sixfold increase in mining just by 2040.[4]

The U.S. has a Dangerous Foreign Dependence for Minerals, Especially Critical Minerals

The United States has an alarming reliance on foreign nations to meet our demand for minerals. Most concerning, today's mineral supply chains are unquestionably controlled by China.[5] This is true for both raw materials and refined products.

Through its Belt and Road Initiative and other efforts, China dominates the global critical mineral supply chains, accounting for approximately 60% of world-wide production and 85% of processing and refining capacity.[6] The United States is import-reliant on China for 26 of the 50

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[1] Climate Smart Mining Facility, *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition*, THE WORLD BANK (2020), https://pubdocs.worldbank.org/en/961711588875536384/Minerals-for-Climate-Action-The-Mineral-Intensity-of-the-Clean-Energy-Transition.pdf.

[2] Center for Sustainable Systems, *Critical Materials Factsheet*, UNIVERSITY OF MICHIGAN (2023), https://css.umich.edu/publications/factsheets/material-resources/critical-materials-factsheet#:~:text=Global%20demand%20for%20critical%20materials,4%2C000%25%20and%202%2C500%25%20respectively.

[3] Climate Smart Mining Facility, *supra* note *1* at 11.

[4] James Marshall, *Insufficient minerals threaten energy transition —report*, E&E NEWS (May 5, 2021), https://www.eenews.net/greenwire/stories/1063731805.

[5] Ernest Scheyder, *China set to control rare earth supply for years due to processing dominance*, REUTERS, (May 29, 2019), https://www.reuters.com/article/us-china-usa-rareearth-refining/china-set-to-control-rare-earth-supply-for-years-due-to-processing-dominance-idUSKCN1T004J.

[6] Bonnie S. Glaser & Abigail Wulf, *China's Role in Critical Mineral Supply Chains*, GERMAN MARSHALL FUND (Aug. 2, 2023), https://www.gmfus.org/news/chinas-role-critical-mineral-supply-chains.

minerals[7] designated as critical by the Department of the Interior.[8] China also dominates the mineral refining process, accounting for 85-90% of global rare earth element mine-to-metal refining.[9] Notably, China refines 80% of the world's cobalt, 60% of the world's lithium, [10] and 65% of the world's nickel,[11] critical minerals that are integral for modern technology and electric vehicles.

The U.S. also is alarmingly reliant on Russia, specifically for enriched uranium. Indeed, American companies are paying around $1 billion per year to Russia's state-owned nuclear agency to buy the nuclear fuel that generates more than half of America's emissions-free energy.[12]

Relying on foreign nations for minerals has clear economic and national security implications. Further, the labor and environmental standards in the U.S. are among the best in the world, while other mineral suppliers are among the most egregious violators of human rights and the environment. One of the most notorious examples of labor exploitation in the mining industry is the Congo, which produces about two-thirds of the world's cobalt.[13] Tragically, the Congo has well-documented cases of forced and child labor in the mining sector, with labor practices often labeled "modern-day slavery."[14] Unfortunately, despite the Labor Department's designation of lithium-ion batteries as potential products of child or forced labor,[15] the Biden administration recently signed a misguided memorandum of understanding to help build an electric vehicle battery supply chain in the Democratic Republic of the Congo and the Republic of Zambia.[16]

The United States has the choice of how to respond to the exponential demand for minerals—we can support domestic production, where we are certain of our responsible development practices, or we can allow foreign nations with unacceptable labor and environmental standards to dominate the global market. It is in the best national security, economic, and environmental interests of the United States to maximize the domestic mineral production.

With China already dominating mineral supply chains on earth, the Chinese Communist Party (CCP) is now looking to the next frontier. The CCP has ambitious, aggressive, and long-term plans to establish a permanent presence on the Moon and begin space mining on the Moon

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[7] Zongyuan Zoe Liu, *How to Secure Critical Minerals for Clean Energy Without Alienating China*, COUNCIL ON FOREIGN RELATIONS (May 25, 2023), https://www.cfr.org/blog/how-secure-critical-minerals-clean-energy-without-alienating-china.
[8] U.S. Geological Survey, *2022 Final List of Critical Minerals*, 87 Fed. Reg. 10381, DEP'T OF THE INTERIOR (Feb. 24, 2022), https://www.federalregister.gov/documents/2022/02/24/2022-04027/2022-final-list-of-critical-minerals.
[9] Jared Cohen, *Resource realism: The geopolitics of critical mineral supply chains*, GOLDMAN SACHS (Sep. 13, 2023), https://www.goldmansachs.com/intelligence/pages/resource-realism-the-geopolitics-of-critical-mineral-supply-chains.html.
[10] Steven P. Bucci, *America's National Security Is Dependent on Critical Rare Earth Minerals—and Worse, on China*, THE HERITAGE FOUNDATION (Nov. 8, 2022), https://www.heritage.org/defense/commentary/americas-national-security-dependent-critical-rare-earth-minerals-and-worse.
[11] Cohen, *supra* note 9.
[12] Max Bearak, *The U.S. is Paying Billions to Russia's Nuclear Agency. Here's Why*, N.Y. TIMES, (June 14, 2023), https://www.nytimes.com/2023/06/14/climate/enriched-uranium-nuclear-russia-ohio.html.
[13] Victoria Beaule, *Artisanal cobalt mining swallowing city in Democratic Republic of the Congo, satellite imagery shows*, ABC NEWS (Feb. 8, 2023), https://abcnews.go.com/International/cobalt-mining-transforms-city-democratic-republic-congo-satellite/story?id=96795773.
[14] Terry Gross, *How 'modern-day slavery' in the Congo powers the rechargeable battery economy*, NPR (Feb. 1, 2023), https://www.npr.org/sections/goatsandsoda/2023/02/01/1152893248/red-cobalt-congo-drc-mining-siddharth-kara.
[15] Jael Holzman and David Iaconangelo, *U.S. shift on child labor may scramble EV sector*, E&E NEWS (Oct. 5, 2022), https://subscriber.politicopro.com/article/eenews/2022/10/05/u-s-shift-on-child-labor-may-scramble-ev-sector-00060305.
[16] David Iaconangelo *U.S. strikes at China with EV battery deal*, E&E NEWS (Jan. 20, 2023), https://subscriber.politicopro.com/article/eenews/2023/01/20/u-s-strikes-at-china-with-ev-battery-deal-00078603.

and, eventually, asteroids.[17] Allowing China to dominate the celestial mineral supply chain as it does mineral supply chains on Earth will prove calamitous for the United States. As a result, the United States must take steps to secure the celestial mineral supply chain and ensure that China does not gain superiority over mining in space.

Overview of Space Mining

Space mining refers to mining for resources on celestial bodies like moons, asteroids, and planets. Specifically, the term "space mining" refers to two categories of activities:

1. *Extractive Mining for Commercial Purposes*: The extraction of resources from asteroids, the Moon, Mars, or other celestial bodies and their return to the Earth for commercial purposes. Examples include mining asteroids for critical minerals and precious metals, such as lithium, platinum, and rhodium.

2. *In-Situ Resource Utilization (ISRU)*: Resources are extracted from a celestial body to be used for other in-space activities.[18] An example includes mining for water on the Moon to make fuel for lunar activity or a permanent Moon presence.[19]

Domestic Governance Frameworks for Space Mining

51 U.S.C. §51302 directs the federal government to facilitate and promote "commercial recovery of space resources" and to discourage government barriers to such activities. Per 51 U.S.C. §51303, U.S. commercial entities are entitled to any space resources they obtain, including the use or sale of those resources. Executive Order 13914, *Encouraging International Support for the Recovery and Use of Space Resources*, was issued in April 2020 and directed the Department of State, Department of Commerce, and National Aeronautics and Space Administration (NASA) to take appropriate actions to encourage international support for public and private recovery and use of space resources.[20] Other countries have also "enacted domestic legislation permitting and regulating space mining activities," such as Japan, Luxembourg, the United Arab Emirates.[21]

International Governance Frameworks for Space Mining

There are three main international governance frameworks for space mining—the Outer Space Treaty, the Moon Agreement, and the Artemis Accords.[22]

1. *Outer Space Treaty*: The Outer Space Treaty, executed in 1967, is the foundational treaty governing space activities, with over 100 countries as

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[17] Bret Baier & Amy Munneke, *Lunar mining raises key legal questions as new space race heats up*, FOX NEWS (Dec. 1, 2023), https://www.foxnews.com/politics/lunar-mining-raises-key-legal-questions-new-space-race-heats-up.
[18] *See Using Space-Based Resources for Deep Space Exploration*, NASA, https://www.nasa.gov/overview-in-situ-resource-utilization/ (last updated July 26, 2023).
[19] Nicholas James Bennett, et al., *Commercial viability of lunar In-Situ Resource Utilization (ISRU)*, 182 PLANETARY AND SPACE SCIENCE (Mar. 2020), https://www.sciencedirect.com/science/article/abs/pii/S0032063319301163; Gerald Sanders, *In Situ Resource Utilization (ISRU) – Surface Excavation & Construction*, NASA (Jan. 21, 2021), https://www.nasa.gov/wp-content/uploads/2015/03/jsanders_lunar_isru_tagged_0.pdf.
[20] EXEC. ORDER NO. 13914, 85 Fed. Reg. 20381 (Apr. 6, 2020), https://www.federalregister.gov/documents/2020/04/10/2020-07800/encouraging-international-support-for-the-recovery-and-use-of-space-resources.
[21] Melissa de Zwart, et al., *Space resource activities and the evolution of international space law*, 211 ACTA ASTRONAUTICA, (Oct. 2023), https://www.sciencedirect.com/science/article/pii/S0094576523002977.
[22] *Id*.

signatories.[23] Articles I and II of the Outer Space Treaty pertain to space mining and ISRU. These Articles establish outer space as the "province of all mankind" and prevent claims of sovereignty in space.[24]

2. *Moon Agreement*: The Moon Agreement, signed in 1979 and executed in 1984, is a multilateral agreement with eleven signatories.[25] Article 11 of the Agreement states that the surface and subsurface of the Moon and its resources cannot become property of any country, intergovernmental organization, or non-governmental entity.[26] The United States, Russia, and China have not signed the Moon Agreement.

3. *Artemis Accords*: The Artemis Accords, initiated in 2020, are a U.S.-led, non-binding multilateral agreement among nations that establishes a set of principles and guidelines for space exploration.[27] Signing the Artemis Accords is a prerequisite for participation in NASA's Artemis program, a robotic and human lunar exploration program.[28] Section 10 of the Artemis Accords directs signatories to extract and utilize space resources in a manner that complies with the Outer Space Treaty.[29]

Space Mining Has Almost Limitless Potential

Natural resources on the Moon, Mars, and asteroids may improve conditions on Earth and allow humanity to expand further into space.[30] Celestial bodies, such as moons and asteroids, contain potentially enormous amounts of metals and minerals. For example, the average geological abundance of certain metals is much higher in metallic asteroids than on Earth.[31] Researchers at the Colorado School of Mines and the International Monetary Fund found evidence that this is especially the case for critical minerals such as cobalt and nickel, platinum, and other metals.[32] Notably, the study found that metallic asteroids contain more than a thousand times as much nickel as the Earth's crust, in terms of grams per metric ton.[33]

The density and abundance of minerals on celestial bodies makes the economic potential for space mining almost incomprehensible. Asterank, an asteroid database project that studies asteroid composition and measures the potential value of over 6,000 asteroids that NASA

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[23] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, G.A. Res. 2222, (Jan. 27, 1967), https://treaties.un.org/doc/Publication/UNTS/Volume%20610/volume-610-I-8843-English.pdf.
[24] *Id*. at 207.
[25] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, G.A. Res. 34/68, A/RES/34/68 (Dec. 5, 1979), https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXIV-2&chapter=24&clang=_en.
[26] *Id*. at 25.
[27] *Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes*, NASA & THE U.S. DEP'T OF STATE (Oct. 13, 2020), https://www.nasa.gov/wp-content/uploads/2022/11/Artemis-Accords-signed-13Oct2020.pdf.
[28] Christian Davenport, *NASA unveils new principles for space exploration*, WASH. POST (May 15, 2020), https://www.washingtonpost.com/technology/2020/05/15/moon-rules-nasa-artemis/.
[29] *Artemis Accords*, *supra* note 27.
[30] *See* Philip T. Metzger, et al., *Affordable, Rapid Bootstrapping of the Space Industry and Solar System Civilization*, 26 JOURNAL OF AEROSPACE ENGINEERING (Apr. 2, 2012), https://ascelibrary.org/doi/10.1061/%28ASCE%29AS.1943-5525.0000236.
[31] Kevin M. Cannon, et al., *Precious and structural metals on asteroids*, 225 PLANETARY AND SPACE SCIENCE (Jan. 2023), https://www.sciencedirect.com/science/article/pii/S0032063322001945#bib41.
[32] Max Fleming, et al., *Mining in space could spur sustainable growth*, 120 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, (Oct. 2023), https://www.pnas.org/doi/10.1073/pnas.2221345120.
[33] *Id*.

currently tracks, has determined that mining just the top 10 most cost-effective asteroids—those that are both closest to Earth and greatest in value—would produce a profit of around $1.5 trillion.[34] Indeed, researchers project that the vast abundance of minerals obtained through asteroid mining could cause a rapid devaluation of minerals and raw materials on earth.[35]

The Debate Over the Feasibility of Space Mining

Despite the potential mineral abundance from space mining, there is debate over the feasibility of mining for minerals on celestial bodies. Generally, there are three camps on the prospects for space mining: (1) proponents, (2) limited optimists, and (3) skeptics.

Proponents of space mining argue that the extraction of precious metals and critical minerals from celestial bodies for sale on Earth will be profitable given the high value of the resources of interest.[36] Proponents also argue that space mining on celestial bodies is an environmentally sustainable addition to terrestrial mining activities.[37]

Separately, there are limited optimists who have a more restrained view on the potential for space mining. The limited optimists believe space mining is viable in the context of space exploration, but extraction of space resources for sale on Earth will not be profitable.[38] That is, ISRU may be economically viable, but space mining for terrestrial use likely will not be viable.[39] Such limited optimists point to the significant costs of space transportation—in both transporting equipment to destinations and returning resources to Earth—as likely outweighing the potential value of extracted resources. Limited optimists point to space transportation costs as the rationale for extracting space resources to use in-situ, allowing space explorers to transport less resources from Earth and, unlike space mining for terrestrial purposes, not transporting resources back to Earth.[40]

Conversely, skeptics argue that any form of space mining is not economically viable.[41] Skeptics focus on the potential costs of space mining, the value and demand of resources of

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[34] *See* Shriya Yarlagadda, *Economics of the Stars: The Future of Asteroid Mining and the Global Economy*, HARVARD INTERNATIONAL REVIEW (Apr. 8, 2022), https://hir.harvard.edu/economics-of-the-stars/.
[35] *Id*.
[36] *See generally Id*.; Luisa Corrado, et al., *Space exploration and economic growth: new issues and horizons*, 120 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (Oct. 2023), https://www.pnas.org/doi/10.1073/pnas.2221341120; Ramin Skibba, *Things Are Looking Up for Asteroid Mining*, *WIRED* (Oct. 20, 2023), https://www.wired.com/story/things-are-looking-up-for-asteroid-mining/; Andy Greenspan, *Precious metals in peril: Can asteroid mining save us?*, HARVARD UNIVERSITY'S GRADUATE SCHOOL OF ARTS AND SCIENCES (Oct. 25, 2016), https://sitn.hms.harvard.edu/flash/2016/precious-metals-peril-can-asteroid-mining-save-us/.
[37] *Id*.
[38] *See generally* Joe Reagan, *Mining asteroids will benefit the space economy—but not on Earth*, SATNEWS (Nov. 2, 2023), https://news.satnews.com/2023/11/02/mining-asteroids-will-benefit-the-space-economy-but-not-on-earth-opinion/; Leonard David, *Moon mining gains momentum as private companies plan for a lunar economy*, SPACE.COM (July 30, 2023), https://www.space.com/moon-mining-gains-momentum; Laurence Tognetti, *What is ISRU, and How Will it Help Human Space Exploration?*, UNIVERSE TODAY (Aug. 30, 2022), https://www.universetoday.com/157365/what-is-isru-and-how-will-it-help-human-space-exploration/; Thomas Colvin, et al., *Assessing the economics of asteroid-derived water for propellant*, 176 ACTA ASTRONAUTICA (Nov. 2020), https://www.sciencedirect.com/science/article/abs/pii/S009457652030312X.
[39] *Id*.
[40] *Id*.
[41] *See* Javier Blas, *If Gold Surges 140,000-Fold, Then Asteroid Mining Works*, BLOOMBERG (Sep. 28, 2023), https://www.bloomberg.com/opinion/articles/2023-09-28/commercial-asteroid-mining-has-a-astronomical-cost-issue#xj4y7vzkg; Keith W. Crane, et al., *Measuring the Space Economy: Estimating the Value of Economic Activities in and for Space*, INSTITUTE FOR DEFENSE ANALYSES, SCIENCE AND TECHNOLOGY POLICY INSTITUTE (Mar. 2020), https://www.ida.org/-/media/feature/publications/m/me/measuring-the-space-economy-estimating-the-value-of-economic-activities-in-and-for-space/d-10814.ashx; Thomas J. Colvin, et al., *Demand Drivers of the Lunar and Cislunar Economy*, INSTITUTE FOR DEFENSE ANALYSES,

interest, logistical and technological hurdles, and the uncertainty associated with space mining.[42] As a result, skeptics argue that space mining will not become an alternative to terrestrial mining, even if specific barriers are addressed. Notably, skeptics state that the development costs required for space mining are unknown. In addition, skeptics point to the significant launch costs and unknown, but potentially substantial, development costs as likely surpassing the value of the resources extracted.[43] Such assessments also state that the price of rare and expensive metals is highly inelastic, and, as a result, a surge in supply would significantly reduce market prices and may make space mining unprofitable.[44]

Regardless of Current Feasibility, China, Russia, and Private Companies are Developing Space Mining Operations

Given the enormous potential for space mining, governments and private companies are moving forward with plans for space mining regardless of the uncertainty over its current feasibility. Simply put, mining in space is the new space race.

China has made clear that its ambitions for space and space mining are an integral part of its long-term vision for international dominance.[45] In doing so, China plans to establish a permanent space presence, which would provide long-term economic benefits for the country and its citizens back on Earth.[46] In 2022, China published its space program plan with Xi Jinping, leader of the CCP, stating that the goal is to "build China into a space power."[47] Notably, China, with its "remarkable" and rapidly accelerating space program,[48] currently has plans to construct a nuclear-powered Moon base by 2028.[49] Additionally, China, with Russia's support, has plans to operate a mining program on the Moon base.[50] China also has developed an asteroid monitoring system and, in 2021, it launched the first commercial spacecraft dedicated to the mining of space resources.[51]

The United States government currently has a less ambitious plan and vision for space mining. NASA is studying and exploring the composition of the Moon and asteroids for a potential Moon presence and space mining activities.[52] Earlier this year, in February 2023, NASA issued a solicitation for university researchers to explore using metal extracted from the surface layer of the Moon in 3D printing and other material sciences technologies.[53] Yet, NASA

SCIENCE AND TECHNOLOGY POLICY INSTITUTE (Apr. 2020), https://www.ida.org/-/media/feature/publications/d/de/demand-drivers-of-the-lunar-and-cislunar-economy/d-13219.ashx.

[42] *Id*.

[43] *Id*.

[44] *Id*.

[45] Namrata Goswami, *What China Wants in Outer Space*, GLOBAL FORUM (May 2019), https://www.thecairoreview.com/wp-content/uploads/2019/05/cr33-global-forum.pdf.

[46] *Id*.

[47] Tim Marshall, *China's Bid to Win the New Space Race*, WIRED (Apr. 4, 2023), https://www.wired.co.uk/article/china-space-race.

[48] Andrew Jones, *China outlines pathway for lunar and deep space exploration*, SPACE NEWS (Nov. 28, 2022), https://spacenews.com/china-outlines-pathway-for-lunar-and-deep-space-exploration/.

[49] Robert A. Manning, *Who Owns the Moon?*, FOREIGN POLICY (May 2, 2023), https://foreignpolicy.com/2023/05/02/moon-outer-space-ownership-united-states-china-competition-resources-mining/.

[50] Marshall, *supra* note 47.

[51] Ariel Cohen, *China's Space Mining Industry Is Prepping For Launch – But What About The US?*, FORBES (Oct. 26, 2021), https://www.forbes.com/sites/arielcohen/2021/10/26/chinas-space-mining-industry-is-prepping-for-launch--but-what-about-the-us/?sh=63600e3c2ae0.

[52] *See* Clare Skelly, *NASA Invests in Tech Concepts Aimed at Exploring Lunar Craters, Mining Asteroids*, NASA (June 11, 2019), https://www.nasa.gov/news-release/nasa-invests-in-tech-concepts-aimed-at-exploring-lunar-craters-mining-asteroids/.

[53] Caleb Harshberger, *NASA Speeds Up Quest to Beat China to Mining Metals on the Moon*, BLOOMBERG LAW (Feb. 22, 2023), https://news.bloomberglaw.com/federal-contracting/lunar-mining-dreams-prod-nasa-to-explore-space-tech-advancements.

is still not preparing for future asteroid mining. In October 2023, NASA launched a spacecraft to study Psyche, the largest of the several metal-rich asteroids known in our solar system.[54] While Psyche is believed to consist largely of iron, nickel, gold, and other metals—with a collective hypothetical monetary value placed at $10 quadrillion—the mission has "nothing to do with space mining" and is instead studying clues about Earth's formation.[55]

Analysts declare that China has the edge on procuring space resources given its ambitious, aggressive plans to develop a Moon base and vision for asteroid mining.[56] If America doesn't act now to develop a strategic, bold vision with increased investment to match, "it will be hard to play catch up in the subsequent ten to twenty years" once China establishes a permanent presence in space, dominates space mining, and controls access to routes to space and key celestial areas.[57]

Commercial space mining enterprises also have their eyes to the sky. Previously, companies such as Deep Space Industries and Planetary Resources attempted to develop a market for space mining but were unable to generate a profit and were subsequently acquired by other companies who re-purposed their technology for other applications.[58] Nonetheless, given the enormous potential and economic windfall of space mining, there still a plethora of private companies—such as AstroForge, Karman+, Blue Origin, and Trans Astronautica Corporation—that intend to mine space resources. Private space mining companies are still fundraising and in the early stages of technological development.

IV. CONCLUSION

Exponential growth in global mineral demand and China's dominance of mineral supply chains on Earth threaten America's national security and economic interests. While there is uncertainty over the feasibility for space mining, accelerating investments from our foreign adversaries, notably China, to extract minerals from celestial bodies exacerbates America's fragile mineral supply chains. Eventually, the volume and value of space mining will provide immeasurable benefits to whoever controls the celestial mineral supply chain and space mining will prove calamitous for those who ignore it. America must take the necessary steps to secure our mineral supply chains by increasing domestic mineral development and leading the development of space mining activities.

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[54] Steve Gorman, *NASA launches spacecraft to explore metal-rich asteroid Psyche,* REUTERS (Oct. 13, 2023), https://www.reuters.com/technology/space/nasa-set-launch-spacecraft-explore-metal-rich-asteroid-psyche-2023-10-13/.
[55] *Id*.
[56] Goswami, *supra* note 45.
[57] *Id*.
[58] Atossa Araxia Abrahamian, *How the asteroid-mining bubble burst, MIT Technology Review (*June 26, 2019), https://www.technologyreview.com/2019/06/26/134510/asteroid-mining-bubble-burst-history/.