

4-variable assessment of risk factors impacting critical metals

# Critical Minerals for Defense Critical Review

Submittal Date: March 11, 2025

Prepared By:

**Andrew Thaler, PhD**  
**Blackbeard Biologic: Science and Environmental Advisors**



---

Table of Contents

**Critical Metals Overview ..... 2**

**Cobalt ..... 4**

**Nickel..... 5**

**Manganese ..... 6**

**Other DSM-derived Critical Metals: Gallium, Niobium, Yttrium, Scandium ..... 7**

**Supply Chain Threats ..... 8**

**Section 6 and the Privileged Markets Argument ..... 9**

**Other (Informal) Considerations and Final Thoughts .....11**

for internal use only

---

## Critical Metals Overview

Of the critical metals commonly associated with deep-sea mining, the United States is 100% import reliant on only 5 – gallium, manganese, niobium, scandium, and yttrium<sup>1</sup>. These deposits include placers and phosphorites, as well as the three major ore bodies, seafloor massive sulphides, cobalt-rich crusts, and polymetallic nodules, targeted for deep-sea mining. China dominates the refining industry for all 5 metals<sup>2</sup>. Cobalt and nickel, the two major economic drivers for deep-sea mining, are produced in limited quantities domestically, but the US is still largely dependent on foreign import to meet its needs.

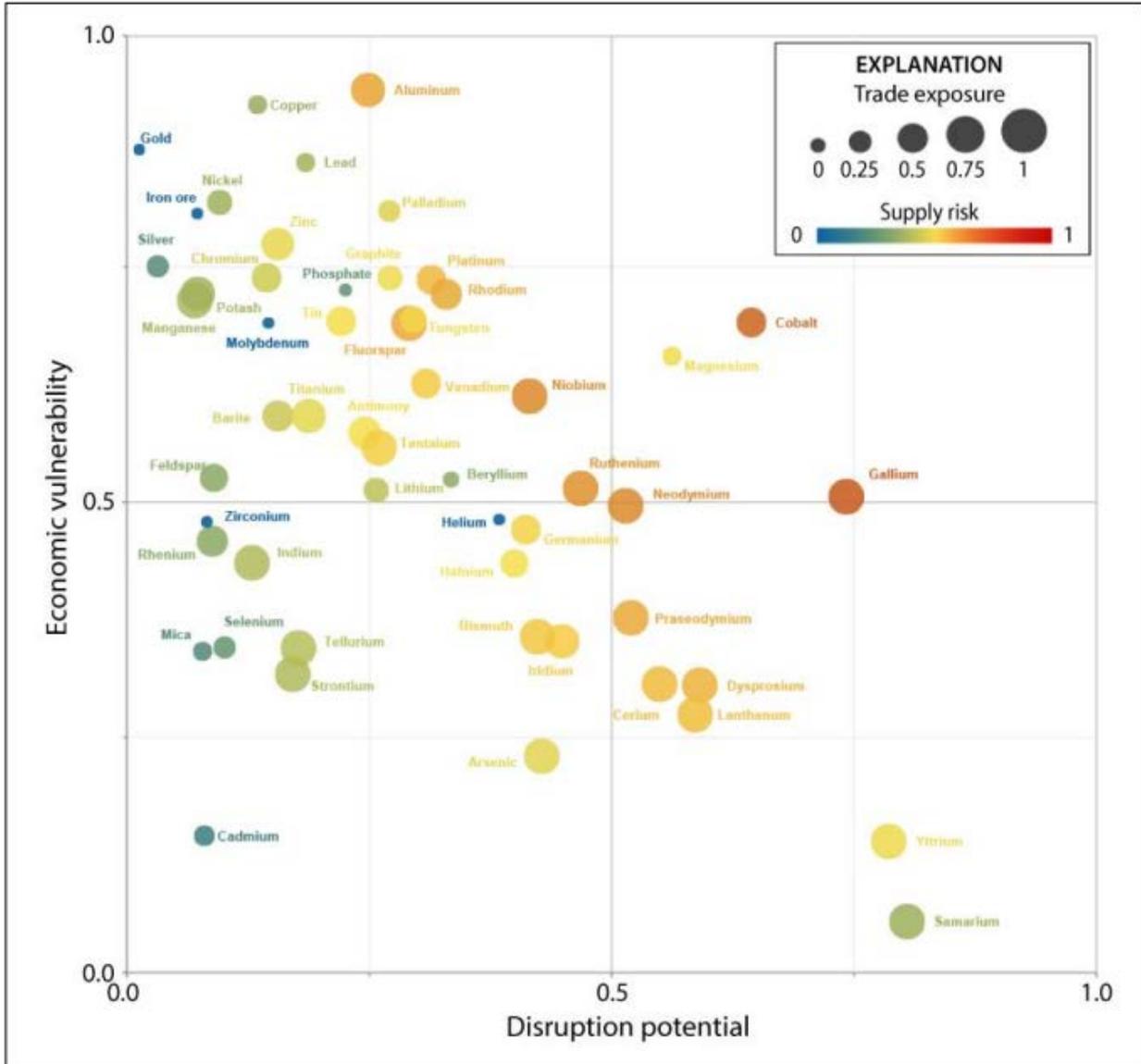
An assessment by the Congressional Research Service examining the potential risk of critical metals to disruption, economic volatility, supply risk, and trade exposure identified gallium and cobalt as the most vulnerable metals across all axes, with nickel and manganese being economically volatile but more resilient to disruption or supply issues. Yttrium and niobium fell in slightly larger risk categories than nickel and manganese<sup>3</sup>. Scandium is produced in such small quantities that it was not assessed.

---

<sup>1</sup> Critical Minerals on the U.S. Outer Continental Shelf: The Bureau of Ocean Energy Management's Role and Issues for Congress - [https://www.everycrsreport.com/files/2024-12-11\\_R48302\\_3701cae83ccd591e8f1c05644b80f58dc6e4c396.pdf](https://www.everycrsreport.com/files/2024-12-11_R48302_3701cae83ccd591e8f1c05644b80f58dc6e4c396.pdf)

<sup>2</sup> Critical Mineral Resources: National Policy and Critical Minerals List - <https://crsreports.congress.gov/product/pdf/R/R47982/3>

<sup>3</sup> Critical Mineral Resources: National Policy and Critical Minerals List - <https://crsreports.congress.gov/product/pdf/R/R47982/3>



Source: Nedal T. Nassar and Steven M. Fortier, Methodology and Technical Input for the 2021 Review and Revision of the U.S. Critical Minerals List, USGS, USGS Open-File Report 2021-1045, 2021, <https://pubs.er.usgs.gov/publication/ofr20211045>.

---

## Cobalt

Cobalt is a grey lustrous metal commonly extracted in conjunction with copper and nickel. The United States uses approximately 6,400 tons of cobalt in 2024. Of that, 50% of cobalt consumed in the United States was used in superalloys, primarily for aircraft engine, 25% is used in chemical applications, 15% in other metallic applications, and 10% in carbides for abrasives and cutting tools.<sup>4</sup> Cobalt has numerous military applications, including for temperature-resistant alloys for jet engines, magnets for stealth technology, electronic warfare, as well as alloys for munitions.<sup>5</sup> Globally, lithium ion batteries are the leading use of cobalt. 76% of cobalt consumption worldwide is for battery applications<sup>6</sup>.

The United States imports Cobalt from Norway (25%), Canada (15%), Finland (13%), and Japan (12%) and produces some cobalt internally. There are nickel-copper mines in Michigan and Missouri, both of which produce cobalt as a secondary product. The US attempted to commission a mine in Idaho, which would be only the second mine in the world whose primary production was cobalt, but production was suspended due to the declining price of cobalt. When running, the mine would produce 2,000 tons of cobalt annually. The United States has approximately 69,000 tons of cobalt reserves and has identified approximately 1 million tons of potential cobalt deposits within the country<sup>7</sup>.

While numbers for pure defense needs are not generally available, and much of the strategic need for cobalt is wrapped up in lithium-ion batteries used for both civilian and military purposes, at the peak of the Cold War, the US maintained a defense stockpile of 13,000 tons. That number has shrunk to an estimated 333 tons<sup>8</sup>. Recycling accounted for approximately 25% of cobalt consumption in 2023.

Of the dominant critical minerals potentially produced by deep-sea mining, cobalt is the most vulnerable to disruption, economic and trade volatility, and supply risk<sup>9</sup>. Even given the volatility of the cobalt supply chain, the United States possess internal production capacity as well as access through long term allies.

---

<sup>4</sup> Mineral Commodity Summaries 2024 - <https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-cobalt.pdf>

<sup>5</sup> Mining for Defense: Unlocking the Potential for U.S.-Canada Collaboration on Critical Minerals - [https://csis-website-prod.s3.amazonaws.com/s3fs-public/2025-02/250218\\_Hernandez-Roy\\_Mining\\_Defense\\_1.pdf?VersionId=MNaujyFkyfCh\\_PGECsqQZxwMdn.ISHaI](https://csis-website-prod.s3.amazonaws.com/s3fs-public/2025-02/250218_Hernandez-Roy_Mining_Defense_1.pdf?VersionId=MNaujyFkyfCh_PGECsqQZxwMdn.ISHaI)

<sup>6</sup> Cobalt Market Report 2023 - [https://www.cobaltinstitute.org/wp-content/uploads/2024/05/Cobalt-Market-Report-2023\\_FINAL.pdf](https://www.cobaltinstitute.org/wp-content/uploads/2024/05/Cobalt-Market-Report-2023_FINAL.pdf)

<sup>7</sup> Mineral Commodity Summaries 2024 - <https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-cobalt.pdf>

<sup>8</sup> US explored adding more cobalt to defence stockpiles - <https://www.mining.com/web/us-explored-adding-more-cobalt-to-defence-stockpiles-sources-say/>

<sup>9</sup> Critical Mineral Resources: National Policy and Critical Minerals List - <https://crsreports.congress.gov/product/pdf/R/R47982/3>

## Nickel

Nickel is a shiny, silver metal that is essential to a variety of industries, but 85% of domestic nickel consumption goes towards the production of stainless steel and other alloys. Electric vehicle batteries require high-grade nickel, which is more expensive to produce. The United States consumed approximately 190,000 tons of nickel in 2024<sup>10</sup>. Nickel is used in military applications for armor and aircraft alloys, but, like cobalt, its most pressing use is in high-capacity batteries for electric vehicles and energy storage.

The United States imports nickel from Canada (46%), Norway (9%), Finland (7%), and Russia, (7%). Worldwide nickel production was 3.3 million tons in 2022<sup>11</sup>. Over half of that production was from Indonesia, whose market dominance is projected to grow throughout the decade. Nearly half US nickel imports come from Canada, with the US Department of Defense awarding significant funding to Canadian nickel producers to increase production<sup>12</sup>. The Russian Federation is the world's third largest nickel producer, accounting for 8% of global production and Russia's ongoing invasion of Ukraine has led to major volatility in the metal commodities market<sup>13</sup>. The United States produces roughly 17,000 tons of nickel from a single mine in Michigan. That nickel is exported to Canada for processing.

As with cobalt, numbers for pure defense spending are not available, however, when President Biden used the Defense Production Act to increase production of nickel (as well as lithium, cobalt, graphite, and manganese), it was explicitly to bolster the supply chain for large capacity batteries<sup>14</sup>. The United States does not maintain a nickel stockpile.

While the cost of nickel can be extremely volatile, it does not have the same supply chain disruption risks as cobalt<sup>15</sup>. Nickel is readily recycled and over 50% of US nickel consumption in 2023 was from recycled nickel<sup>16</sup>.

---

<sup>10</sup> Mineral Commodity Summaries 2024 - <https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-nickel.pdf>

<sup>11</sup> Mine production of nickel worldwide from 2010 to 2022 - <https://www.statista.com/statistics/260748/mine-production-of-nickel-since-2006/>

<sup>12</sup> Nickel mining in North America: it's a US national security issue - <https://theoregongroup.com/commodities/nickel/nickel-mining-in-north-america-its-a-us-national-security-issue/#:~:text=Eagle%20Mine%2C%20the%20only%20operating,resources%20north%20of%20the%20border.>

<sup>13</sup> Nickel production in Russia and major projects - <https://www.mining-technology.com/data-insights/nickel-in-russia/?type=lgp5>

<sup>14</sup> Defense Production Act Title III Presidential Determination for Critical Materials in Large-Capacity Batteries - <https://www.defense.gov/News/Releases/Release/Article/2989973/defense-production-act-title-iii-presidential-determination-for-critical-material/#:~:text=Immediate%20Release-Defense%20Production%20Act%20Title%20III%20Presidential%20Determination,Materials%20in%20Large%20Capacity%20Batteries&text=On%20March%2031%2C%202022%2C%20the,base%20for%20large%20capacity%20batteries.>

<sup>15</sup> Critical Mineral Resources: National Policy and Critical Minerals List - <https://crsreports.congress.gov/product/pdf/R/R47982/3>

<sup>16</sup> Mineral Commodity Summaries 2024 - <https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-nickel.pdf>

---

## Manganese

Manganese was the original economic justification for the development of the deep-sea mining industry. In the early 1970s, where demand for manganese was near its highest, manganese made up over 70% of the value of a polymetallic nodule. The value of manganese relative to other critical minerals has declined since the 1970s, due largely to changes in steel manufacturing, which accounts for approximately 90% of manganese use<sup>17</sup>.

Manganese is one of 14 critical metals, and the only major product of deep-sea mining, for which the United States is wholly dependent on imports. Manganese ore is imported principally from Gabon (62%), South Africa (24%), and Mexico (13%)<sup>18</sup>. The US consumed 690 tons of elemental manganese in 2023.

Manganese is a curious case, as it makes up a large proportion of the intrinsic value of a polymetallic nodule mine, but is in much lower demand compared with cobalt and nickel. Even in the 1970s, forecasters noted that manganese prices were highly volatile and that a relatively modest commercial deep-sea mining operation producing 1 million tons of nodules per year (about a third the annual production volume that the ISA predicts from the first commercial mining leases) would be ten times the annual consumption of manganese in the United States in 1970.

This places economic projections on the value of manganese from the deep sea on tenuous footing. Any deep-sea mining development would nearly double the global supply of manganese in its first year, resulting in a substantial oversupply of the metal. Subsequent deep-sea mining projects would likely result in significant reduction in the value of manganese and the mine as a whole. For comparison, in 2023, a 10% nickel production surplus resulted in a 21% collapse in nickel prices<sup>19</sup>.

Nearly all defense needs for manganese are related to steel production. The United States maintains a stockpile of 322,000 tons of manganese ore in Wenden, Arizona<sup>20</sup>. Manganese recycling is negligible.

---

<sup>17</sup> United States Geological Survey: Manganese Statistics and Information - <https://www.usgs.gov/centers/national-minerals-information-center/manganese-statistics-and-information>

<sup>18</sup> Mineral Commodity Summaries 2024 - <https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-manganese.pdf>

<sup>19</sup> Largest Supply Glut In A Decade Crashes Nickel Prices - <https://oilprice.com/Metals/Commodities/Largest-Supply-Glut-In-A-Decade-Crashes-Nickel-Prices.html>

<sup>20</sup> U.S. Government Looks to Wenden, Arizona to Help End Reliance on China for Critical Minerals - <https://gosar.house.gov/news/documentsingle.aspx?DocumentID=4077>

---

## Other DSM-derived Critical Metals: Gallium, Niobium, Yttrium, Scandium

Gallium is the critical metal most at risk for supply chain disruption. Can be produced from aluminum tailings. Both gallium and niobium and readily available from allies<sup>21</sup>. Investments in gallium production has Canada on track to meet 5% to 10% of global production<sup>22</sup>. Niobium is used in superconductive superalloys for wires, cabling, heat exchangers, and battery cell components. It is also used in hypersonic weapons. Brazil accounts for 82% of global niobium production through mines owned in part by Chinese investors, while Canada is the second largest producer at 10%<sup>23</sup>.

Nearly all yttrium (94%) is imported from China<sup>24</sup>. The United States consumed 200 tons of yttrium in 2023. Yttrium is primarily used in ceramics, though it can be used in electronics as well.

Scandium is a bit of an oddball. Scandium is used to produce lightweight aluminum alloys for aerospace components, as well as, in much lower quantities, in the manufacture of some sporting equipment and firearms. Only a handful of scandium operations exist, producing 30 to 40 tons of scandium per year, often as a byproduct of uranium refining. Scandium occurs in uniquely high quantities in polymetallic nodules and ferromanganese crust off the northern coasts of Alaska within the United States Exclusive Economic Zone<sup>25</sup>. Scandium is so rarely used that its import is not tracked. A deposit of roughly 11,000 tons of scandium was identified in Nebraska<sup>26</sup>.

---

<sup>21</sup> Mining for Defense: Unlocking the Potential for U.S.-Canada Collaboration on Critical Minerals - [https://csis-website-prod.s3.amazonaws.com/s3fs-public/2025-02/250218\\_Hernandez-Roy\\_Mining\\_Defense\\_1.pdf?VersionId=MNaujyFkyfCh\\_PGECsqgZxwMdn.ISHaI](https://csis-website-prod.s3.amazonaws.com/s3fs-public/2025-02/250218_Hernandez-Roy_Mining_Defense_1.pdf?VersionId=MNaujyFkyfCh_PGECsqgZxwMdn.ISHaI)

<sup>22</sup> Rio Tinto progresses the development of a gallium extraction process in Quebec - <https://www.riotinto.com/news/releases/2024/rio-tinto-progresses-the-development-of-a-gallium-extraction-process-in-quebec>

<sup>23</sup> Mining for Defense: Unlocking the Potential for U.S.-Canada Collaboration on Critical Minerals - [https://csis-website-prod.s3.amazonaws.com/s3fs-public/2025-02/250218\\_Hernandez-Roy\\_Mining\\_Defense\\_1.pdf?VersionId=MNaujyFkyfCh\\_PGECsqgZxwMdn.ISHaI](https://csis-website-prod.s3.amazonaws.com/s3fs-public/2025-02/250218_Hernandez-Roy_Mining_Defense_1.pdf?VersionId=MNaujyFkyfCh_PGECsqgZxwMdn.ISHaI)

<sup>24</sup> Mineral Commodity Summaries 2024 - <https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-yttrium.pdf>

<sup>25</sup> Beyond Batteries: exploring the demand for scandium and tellurium from the deep ocean - <https://dsmobserver.com/2020/11/beyond-batteries-exploring-the-demand-for-scandium-and-tellurium-from-the-deep-ocean/>

<sup>26</sup> Mineral Commodity Summaries 2024 - <https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-scandium.pdf>

---

## Supply Chain Threats

The United States imports 15% of its cobalt and 46% of its nickel from Canada. Nordic countries account for 38% of cobalt and 16% of nickel imports. Canada is growing its gallium and niobium production industries. Based on the current supply chains for critical minerals associated with deep-sea mining, it appears that Chinese dominance over refining may not represent the greatest threat to disruption of these critical metals to the United States defense industry. Declining trade relations with Canada, coupled with the antagonism of NATO allies, will likely have a much greater impact on the availability and economic stability of cobalt and nickel, as well as the more exotic gallium and niobium to the US. Though classified as critical metals due to the absence of domestic production, manganese, yttrium, and scandium are used in relatively low quantities and are not particularly vulnerable to disruption.

for internal use

---

## Section 6 and the Privileged Markets Argument

The United States played a key role in the early development of the deep-sea mining industry, through initial financing, material support to US-based mining companies, and ongoing participation in the development of the UN Convention on the Law of the Sea, particularly Part XI. However, President Reagan opposed the adoption of the Convention<sup>27</sup>, opting instead to continue negotiations on Part XI of the treaty while bringing federal law into customary compliance with UNCLOS. While the US did ultimately sign on to UNCLOS following amendments to provisions in Part XI, Congress declined to ratify the treaty, leaving the US in a unique situation as the largest economy that is neither a member of the ISA nor restricted in its high seas activities by UNCLOS.

Two separate federal agencies have jurisdiction over how the US manages seabed resources in areas beyond national jurisdiction. The Deep Seabed Hard Mineral Resources Act<sup>28</sup> gives NOAA the authority to oversee environmental impact assessment, exploration, and commercial exploitation of hard mineral resources of the high seas. Through this act, NOAA has asserted, and continues to reassert, an exploration claim over two regions of the Clarion-Clipperton Zone. The Outer Continental Shelf Lands Acts extends authority over the US continental shelf within the US EEZ but outside state waters as well as any continental shelf claims that extend beyond the US EEZ to the Bureau of Ocean Energy Management (BOEM).

The Chukchi Sea Wedge is a section of high seas surrounded by the EEZs of the United States, Canada, and Russia. The US has asserted its claims over the Chukchi Sea Wedge, further reinforcing its right to the seabed in this high seas pocket<sup>29</sup>. The wedge contains large deposits of polymetallic nodules and cobalt-rich crusts that are unusually rich in scandium. While the Chukchi Sea Wedge could provide an interesting case study, given Russia's current geopolitical status as a nation of concern, it is unlikely that any resource-sharing treaty will emerge in the foreseeable future

Though the likelihood of ratification is practically non-existent, the ISA continues to hold out hope that the United States will ratify UNCLOS. The lease blocks in the Clarion-Clipperton zone that the US asserts ownership over through the Deep Seabed Hard Minerals Resource Act (USA-1 and USA-4) are informally being held in reserve. The ISA has not issued leases for those areas (though some of the region has been classified as an Area of Particular Environmental Concern).

---

<sup>27</sup>Statement on United States Actions Concerning the Conference on the Law of the Sea -

<https://www.reaganlibrary.gov/archives/speech/statement-united-states-actions-concerning-conference-law-sea>

<sup>28</sup> The Deep Seabed Hard Mineral Resources Act - [https://www.gc.noaa.gov/documents/gcil\\_dshmra\\_summary.pdf](https://www.gc.noaa.gov/documents/gcil_dshmra_summary.pdf)

<sup>29</sup> Announcement of U.S. Extended Continental Shelf Outer Limits - <https://www.state.gov/announcement-of-u-s-extended-continental-shelf-outer-limits/>

---

Under Section 6 of Part XI of UNCLOS, ISA member states are barred from discriminating between minerals derived from the Area or other sources or provide preferential access to markets for deep-sea minerals or commodities produced using deep-sea minerals<sup>30</sup>. This places the United States in a unique position where, as a non-member state, it can commodify deep-sea derived metals in a separate marketplace, potentially allowing the greenwashing of DSM products as some flavor of “conflict-free”, and sold at a premium.

---

<sup>30</sup> <sup>30</sup> UNCLOS PART XI - SECTION 6. PRODUCTION POLICY - [https://www.un.org/depts/los/convention\\_agreements/texts/agreement\\_part\\_xi/agreement\\_part\\_xi.htm#section6](https://www.un.org/depts/los/convention_agreements/texts/agreement_part_xi/agreement_part_xi.htm#section6)

---

## Other (Informal) Considerations and Final Thoughts

It is my belief that the aggressive pivot towards promoting the US as a refiner of deep-sea derived metals in the last 2 years represents a fundamental recognition by commercial deep-sea mining companies, particularly TMC, that the inherent financial justification for deep-sea mining no longer holds and that they believe that profit can only be achieved by the creation of a premium market for DSM-derived metals. The National Security argument has less to do with the real-world state of the commodities than it does with the political climate of the United States.

I also believe that the current state of affairs has brought us full circle, back to the initial work with Lockheed and Project Azorian. It is a tacit acknowledgement of the original deep-sea mining paradigm – that the industry cannot sustain itself except as a proxy for great powers conflicts. These are not emerging links, but rather the bedrock foundation of an industry that has never been able to support itself. I have long argued that deep-sea mining is four separate and distinct industries – hydrothermal vent mining, cobalt-rich seamount mining, nodule mining, and geopolitics<sup>31</sup>, with geopolitics being the prime mover.

With that in mind, it is also important to keep the framing around The Metals Company, GSR, and other private contractors limited to the role that they actually play in the development of the industry. It is easy to present TMC as the dominant player in deep-sea mining. They are the company generating all the hype that is pushing the negotiations forward with the trigger mechanism. But private contractors are not the dominant players in this industry. China, India, Japan, Russia, South Korea, and, to some extent, Norway are far more influential in the development of the industry and the pace of the negotiations.

TMC needs its investors to see it as the dominate force in deep-sea mining and I think it is unwise to play into that narrative.

---

<sup>31</sup> Deep-Sea Mining: A whirlwind tour of the state of the industry and current policy regimes - <https://www.southernfriedscience.com/deep-sea-mining-a-whirlwind-tour-of-the-state-of-the-industry-and-current-policy-regimes/>