RSIS S. RAJARATNAM SCHOOL OF INTERNATIONAL STUDIES
Nanyang Technological University, Singapore
Ponder the Improbable since 1996

IDSS Paper
Ponder. Analyse. Prepare. Engage. Refresh.

www.rsis.edu.sg No.094– 12 November 2024

No. 094/2024 dated 12 November 2024

Emerging Battleground: China's Critical Minerals Leverage in the Chip War

Hu Xinyue

SYNOPSIS

China's recent export restriction on antimony, effective from September 2024, highlights how the US-China chip war has expanded beyond technology-focused restrictions to include competition over critical resources. China dominates the critical minerals market essential for chip production, both in terms of market share and processing technology, and is increasingly leveraging this advantage to punish countries that impede its technological and economic progress. Consequently, the US-China chip war is poised to intensify, with China prevailing in the critical minerals sector, while the United States faces significant challenges in reducing its dependence on Chinese-supplied minerals.

COMMENTARY

Semiconductors, critical dual-use products essential for national defence, economic growth, and technological independence, are at the centre of the US-China competition for global supremacy. The United States leads globally in key knowledge-intensive stages, including chip design, electronic design automation, semiconductor manufacturing equipment, and core intellectual property. In contrast, China is mainly involved in the downstream stages, including assembly, packaging and testing, and remains highly dependent on imports of products containing US components.

China Hampered in the Chip War

The United States has escalated the chip war by unilaterally blocking advanced semiconductor technology from reaching China to curb the latter's economic and technological growth. In October 2024, the Biden administration announced that it was finalising rules to restrict US investments in advanced AI chip technology in China. The measure was intended to prevent Chinese firms from getting access to high-

bandwidth memory chips, which are crucial for operating AI accelerators. The new measure reinforces US dominance by expanding export controls on advanced AI chips, including Nvidia's A100 and H100 series, which are essential for supercomputing and large-scale AI model training. By blocking China's access to these chips, the United States aims to secure its superiority in this critical technological domain.

Furthermore, the United States is pursuing multilateral strategies to restrict China's access to semiconductor technology across the value chain, with 39 per cent of the value chain in the United States and 53 per cent in allied regions like Japan, Europe, South Korea, and Taiwan. A key US effort is the proposed "Chip 4 Alliance" with East Asian players to isolate China. Additionally, the United States and the European Union have established the Trade and Technology Council to strengthen cooperation on semiconductor supply chains. The Netherlands, under US pressure, has blocked the export of extreme ultraviolet (EUV) lithography equipment to China. In January 2024, these restrictions were expanded to include certain deep ultraviolet (DUV) lithography machines, further limiting China's access to advanced semiconductor manufacturing technology.

Beijing now faces significant bottlenecks in the development and sustainability of its semiconductor industry. The value of China's semiconductor imports declined by 15.44 per cent in 2023 compared to the previous year, marking the largest annual drop recorded since the start of customs data tracking. China's leading chipmaker, Semiconductor Manufacturing International Corporation, which was added to the US Entity List in 2020 to restrict its access to key enabling US technologies, is reportedly unlikely to produce competitive, cutting-edge chips if it continues to lack access to advanced manufacturing equipment. Specifically, in the advanced 7-nanometer and 5-nanometer production areas, Chinese companies face a 40–50 per cent higher cost than its competitors due to restricted access to EUV lithography systems, significantly diminishing their industry status.

Critical Minerals: Durable Chokepoints Enabling China's Retaliation

China is intensifying its retaliation by leveraging its monopoly on critical minerals like antimony, gallium, germanium, and rare earths — key resources for semiconductor production — to create chokepoints for the United States and its allies. China's ability to impose costs on its geopolitical rivals stems largely from its market dominance and advanced mineral separation technologies.

Antimony, used as a dopant in semiconductor devices, is primarily produced by China, which accounts for 48 per cent of global production and supplies 63 percent of US imports. Starting in September 2024, China imposed export restrictions on six antimony-related products, with gold-antimony smelting and separation technologies being banned from export without special permission from the Commerce Ministry.

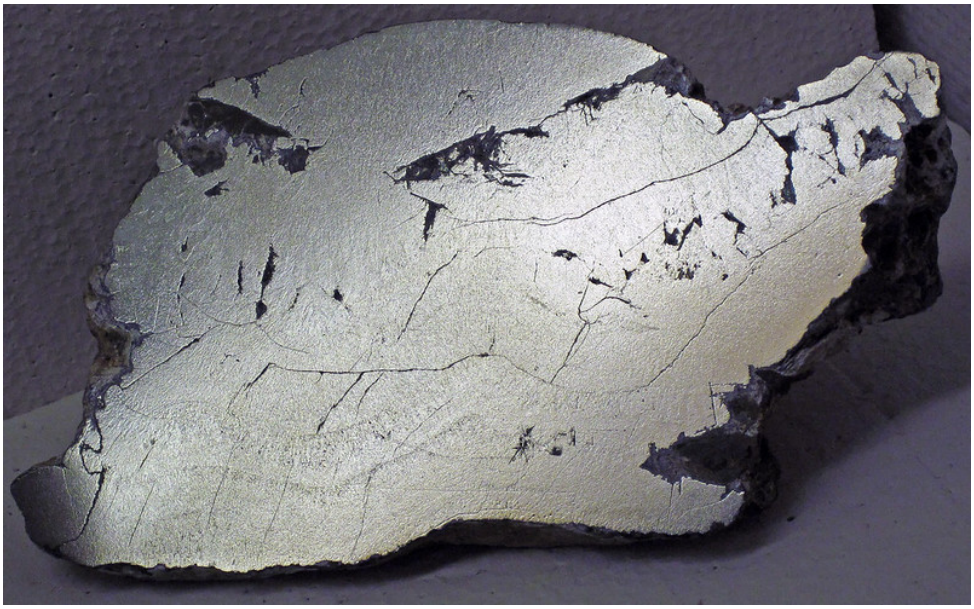
In the short term, the export restriction is expected to significantly impact the United States and its allies as finding alternative sources outside China is challenging.

Domestically, the United States has no active antimony mining and a limited stockpile of 1,100 tons — far short of the 23,000 tons consumed in 2023. Internationally, much

of the antimony mined in other countries is sent to China for refining. For example, Australia, together with Bolivia and Kyrgyzstan, holds 35.5 per cent of global antimony reserves, yet 86 per cent of Australia's antimony exports were directed to China for processing.

The disruptive effects of China's move are likely to be enduring, as evidenced by its earlier export restriction on gallium and germanium, two other vital minerals for semiconductors. China produces 90 per cent of the world's gallium and 60 per cent of its germanium. In July 2023, China imposed controls on the export of eight gallium and six germanium products, causing exports to drop to zero initially and remaining significantly below pre-restriction levels into 2024.

China has also leveraged its dominance in graphite, holding 60 per cent of the global natural flake supply, 99 per cent of uncoated spherical graphite, and over 90 per cent of natural anode material. It also controls 70 per cent of global rare earth reserves and maintains an effective monopoly on processing major heavy rare earths. By the end of 2023, China had imposed export controls on graphite, a material crucial for semiconductor production processes, and banned the export of extraction and separation technologies for rare earth elements, which are widely used in semiconductors.



China has imposed restrictions on antimony exports, a rare metal crucial for semiconductor production, effective from 15 September 2024. *Image by James St. John on Flickr.*

United States Struggles to Respond to Critical Mineral Dependency

Significant concerns have since emerged among the United States and its allies over China's use of its dominance in critical minerals to retaliate and exert pressure in the chip war.

The United States is responding to its critical mineral vulnerability by boosting domestic production and seeking alternative critical mineral supply chains outside

China. However, both approaches face challenges and are unlikely to fully replace China's supply dominance.

One domestic effort involves reopening mines that were shut down decades ago due to the environmental risks of antimony mining: the metal is both toxic and carcinogenic. For instance, in September 2024, the US Forest Service issued a Draft Record of Decision (DROD) to authorise the reopening of the Stibnite Gold Mine in Idaho — the country's largest antimony producer, which ceased operations in the 1990s — in order to re-establish domestic production of antimony trisulfide. However, the Stibnite project is not expected to commence production until 2028 and is still awaiting final permit.

Furthermore, the United States has established the Mineral Security Partnership (MSP) to address supply chain vulnerabilities for critical minerals like antimony, gallium, germanium, indium, natural graphite, and rare earth elements. However, until 2024, the MSP has seen almost no investment, raising concerns about its effectiveness.

Conclusion

China's export controls on critical minerals create significant challenges for its geopolitical rivals, such as the United States and its allies in the chip war. However, these measures serve more as a tit-for-tat strategy rather than effectively compelling these rivals to reduce their restrictions on semiconductor supplies to China or shifting the semiconductor industry away from its alignment with US interests.

The US-China chip war could escalate regardless of who wins the US presidential election of 2024 and which party controls the Congress, as seen in the Biden administration's willingness to follow in the footsteps of the Trump administration in restricting China's access to advanced technology. Both the United States and China are likely to impose more significant chokepoints on each other to increase the suffering of its opponent. To mitigate potential restrictions on critical minerals or technologies, policymakers should promote investments in alternative sources, regions and essential components — whether minerals or technology — to decrease reliance on any single country. Multilateral efforts, such as establishing international alliances to mitigate supply chain disruptions, are expected to gain prominence in international politics. However, a key challenge for all member states will be transforming political intentions into tangible actions, a process that may demand significant state-led investments.

Hu Xinyue *is a Senior Analyst in the China Programme at the Institute of Defence and Strategic Studies (IDSS), S. Rajaratnam School of International Studies (RSIS).*