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Opinion

China's export restrictions on germanium and gallium shake up global order

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Two metallic elements, tucked deep within the periodic table, have emerged as key drivers of world politics. On July 3, China's Ministry of Commerce and China Customs announced export controls on gallium and germanium products (including compounds), effective August 1. This action, aimed at 'safeguarding national security and interests,' according to Chinese officials, has stirred global panic within various industries, governments, and media outlets.

Although these two rare metals only account for several hundred million dollars in global trade – a figure that pales in comparison with the chipmaking industry's value of over $600 billion – they are critical strategic resources in the defence and high-tech sectors. Infrared optics, fiberoptic communications, solar cells, and compound semiconductors are useless without them. Any disruption in the supply of these metals would therefore unsettle downstream markets valued in the trillions of dollars.

Further exacerbating the anxiety is China's dominance in the global supply of these metals. In 2022 alone, China manufactured 90 percent of gallium-related products and 68 percent of germanium-related products. Chinese authorities argue that export restrictions on products involving these metals are standard international practice and not targeted at any specific country.

Weaponising critical minerals

China's role in the technological competition with the United States bears similarities to an apprentice learning from its master by leveraging its dominance in critical technologies or resources. China appears to be employing a 'chokepoint strategy' – weaponising its stronghold over these critical rare metals.

China's strategic use of these minerals conveys a compelling narrative. Despite the chokepoints it faces in its chipmaking supply chain – stemming from limited access to critical technologies, a gap it might close independently over the next five to eight years – the potential disruption in the supply of these essential metals could stymie the United States and its allies' progress in defence-related and high-tech manufacturing.

Although the United States commands a leading role in upstream chip design, intellectual property, manufacturing technology, as well as downstream branding and marketing, its reliance on allies is critical in implementing a chokepoint strategy against China. Unilateral sanctions would push China to alternative suppliers, almost all allies of the US, triggering potential losses in the Chinese market for the United States and rendering its attempts to contain China ineffective. America's regional partners are therefore crucial

for impeding China's access to advanced chipmaking technologies and mitigating threats to US national security, albeit at a substantial cost to the United States and its allies.

At its core, the chokepoint strategy leverages monopoly. It allows those who control a critical technology, resource, or transport route to influence their adversaries without warfare. With a monopoly over the gallium and germanium supply chains, China can enforce export controls without incurring substantial economic backlash.

The Chinese government's export restrictions on these rare metals are unlikely to inflict significant domestic economic damage. First, China's economy consumes a substantial portion of these products. Second, the total export revenue from these metals – 240 million yuan from gallium and 360 million yuan from germanium in 2022 (in total less than $100 million) – is insignificant compared to China's semiconductor expenditure. Lastly, given these rare metal products' unique and non-renewable nature, surplus production can be subsidised and stockpiled indefinitely, preventing significant economic losses for China.

On the flip side, the effects of China's export controls are likely to vary across the countries in the US-led chip alliances, which could challenge the dynamics of the alliances. Intermediate players in the value chain may bear the brunt. Japan, in particular, is at risk, given its high concentration of firms producing chemical compounds from these elements – largely imported in their primary form from China. As a global leader in advanced semiconductor materials and a significant consumer, Japan could face more significant long-term impacts from China's export restrictions on these rare metals.

Short-term solutions and long-term considerations

Refining technologies and facilities for processing gallium and germanium cannot be built overnight, particularly considering the environmental implications of their extraction and mining. As such, for the United States and its allies, constructing an independent supply chain for gallium and germanium processing could require a staggering investment of over $20 billion – considerably more significant than the total trade revenue of the products of these two elements – and potentially years, if not decades, of development. Even then, achieving cost advantages comparable to China's might prove challenging.

One scenario could unfold as follows: China may decide to ease its export controls after significant investments in building infrastructure, such as electricity, and facilities for extracting and processing gallium and germanium. In such a scenario, and given China's efforts to refine its technology and improve the processing efficiency of these metals, businesses may find it financially prudent to revert to sourcing from Chinese suppliers.

Although some might argue that firms from the United States and its allies would opt against reverting to sourcing gallium and germanium from China, even in the face of a more compelling value proposition, we must not discount the sway of economic realities. These factors often shape decision-making in international trade. While shared values can contribute to forming alliances, shared interests – often economic and security-related – primarily drive international cooperation. The relationship between international trade and geopolitics is complex, with economic factors, political alignments, and strategic considerations all playing pivotal roles.

Economic and environmental reality

Towards the end of the twentieth century, Western multinational corporations started manufacturing operations in China, attracted by its low-cost and abundant labor, land, and raw materials. With the advent of internet and communication technologies, the United States spearheaded an industrial revolution, transforming its economy into an 'innovation economy' – a model that can be described as 'Wall Street + Silicon Valley.' This shift involved channelling more resources into research and development, design, branding, and marketing while outsourcing lower-value-added manufacturing jobs to less developed nations, predominantly China. This shift also marked China's entry into global production networks.

Although China has benefited significantly from this wave of globalisation, these benefits have come at a considerable cost, particularly regarding environmental impact. Also, China's restructuring of state-owned

enterprises (SOEs) in the late 1990s resulted in millions of job losses, sparking social unrest and challenging the ruling party's legitimacy. At the same time, China embarked on the most significant urbanisation endeavour in human history. The Western trend of outsourcing production to China solved these urgent issues. During these industrial shifts, China assumed many lower-value-added tasks and many resource-intensive and environmentally damaging aspects of manufacturing. One area where China has assumed a significant role in the global production network is the extraction and refining of many vital minerals, including rare earth and rare metals. This integration into the global production network provided employment opportunities for displaced SOEs and migrant workers, bolstering China's lower-tier supply chains and strengthening its manufacturing capabilities.

Over the past decades, China has refined its abilities in extracting and processing these rare metals, often on a massive scale. This progress was facilitated by industrial policies and subsidies and driven by a trial-and-error innovation process powered by intense internal competition among domestic firms. While China's operations in gallium and germanium processing might sit at the lower end of the value chain, their advantages lie in the sheer scale of production, resulting in unrivalled cost benefits for products related to these metals.

Another critical advantage worth noting is China's command over the natural reserves of these metals. China produces 80 percent of the world's gallium reserves – the highest share globally – and 60 percent of the world's germanium reserves.

Both gallium and germanium are classified as dispersed metals that occur in deficient concentrations in the Earth's crust, rendering extraction highly uneconomical. For instance, gallium primarily exists as a secondary element in bauxite ore, with its production primarily being a by-product of aluminium refining. Likewise, germanium rarely forms independent ores and is typically found within minerals composed of other elements. In China, germanium primarily comes from by-products of germanium-rich coal. As the world's largest producer and consumer of aluminium and coal, China can economically justify the production of gallium and germanium chemical compounds. In fact, the country's leading gallium and germanium producers are industrial mineral corporations, such as Chinalco, the world's largest aluminium producer, which also derives profits from selling other metal products.

Although the United States has extensive natural germanium reserves, the element is mainly found in zinc ores. Extracting heavy metals like lead and zinc can lead to substantial environmental damage. Plus, large-scale mining operations are not financially viable if there is no market for the derived lead and zinc products. Notably, as far back as 1984, the United States halted its own production of germanium for these reasons.

Globalisation at a crossroads

Recognising the risks of overreliance on China for critical minerals, Western countries have adopted a 'de-risking' strategy to reduce their dependence on China's supply through a US-led Minerals Security Partnership, which excludes China. However, challenging China's dominance is proving daunting, not merely due to China's stronghold on the supply of these elements but also the rising competition involving chokepoint strategies that threaten the very fabric of globalisation.

China has established substantial advantages across thirty-six critical minerals, including rare earth elements and metals. These elements are essential for defence and pivotal for emerging technologies in next-generation semiconductors and clean energy transitions – two arenas where Washington and Beijing vie for supremacy. While China's critics point to the unfairness of its industrial policy and fiscal subsidies, other nations are mimicking China's strategy, engaging in policy competition and subsidies to bolster their advantages in critical minerals, prioritising national security over economic efficiency.

The US-China relationship is now characterised mainly by competition and confrontation, overshadowing the potential for cooperation and collaboration. While a direct conflict between a rising power and an established hegemon – Graham Allison's 'Thucydides Trap' – may be unlikely, a period of great power rivalry, especially in the tech domain, will persist and perhaps escalate. Fears of one's adversary gaining the upper hand encourage the use of chokepoint strategies. The outcome of this great power tech war hinges on who holds more 'chips,' the costs involved, and the impacted parties.

How the issues surrounding gallium and germanium are handled could very well dictate the future balance of technological power.

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