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From mine to magnet: "Are we nearly there yet?"

BY STEWART PATERSON



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Introduction

It is in the rare earth-to-magnet supply chain that China has cultivated a monopolistic grip, giving it considerable economic and geopolitical leverage over the rest of the world.

In recent years, many governments have initiated programs aimed at alleviating vulnerabilities stemming from trade dependencies in critical minerals. The COVID-19 pandemic, the war in Ukraine, and restrictions on Chinese exports of rare earths have been key catalysts. More recently, the conflict between Israel, the United States, and Iran has highlighted the importance not just of hydrocarbons, but also of derivative products from oil and gas to multiple supply chains, from pharmaceuticals to fertilizers, and their vulnerability to geopolitical events. Furthermore, the depleted arsenal of US weaponry, combined with current uncertainty over rare earth mineral supplies, has been a particular cause for alarm.

While in the past warnings of such vulnerabilities have induced much talk, there is now substantial action. Significant sums of money are being spent by both the private and public sectors to reshape supply chains. The US government has spent or made commitments totaling about US$7.3 billion to 23 projects in the rare earth industry alone.[1] Whether such endeavors will, in fact, increase supply resilience within a relevant time frame is open to debate.

The United States, the European Union, and many other countries have compiled lists of materials or minerals they view as critical. While there is some variation in the lists, rare earth minerals feature in all of them.

Rare earth elements have a multitude of direct applications, but the most prevalent — accounting for about half the volume of rare earths used globally — is their use in permanent magnets. These, in turn, are used in an array of products, from weaponry to medical devices. It is in the rare earth-to-magnet supply chain that China has cultivated a monopolistic grip, giving it considerable economic and geopolitical leverage over the rest of the world. The current "truce" in China's rare earth export restrictions is due to expire on November 1, 2026.

With this in mind, in 2023 US lawmakers set a January 1, 2027, deadline for phasing out Chinese-origin rare earth metals or magnets from use in American weaponry. This proclamation began a race to develop a China-free supply chain for rare earths and magnets.[2]

In this paper, we provide a brief overview of the rare earth-to-magnet supply chain and assess the likely impact of recent investments. We then consider the time frame for bringing new supply online. Finally, we examine the demand side of the equation: how can demand for higher-cost production be sustained when a cheaper alternative is available elsewhere? In simple terms, will the born-again policy goal of weaning off Chinese rare earth, more than 15 years in the making, work this time?

Anyone with small children on a road trip would have heard this refrain: "Are we nearly there yet?"

The adult answer, at this point, appears to be, "No, dear, first we must get real. Here's where we really are."

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Rare earth magnet supply chain

The reality is that large parts of the world have yet to be properly explored for rare earths, and the current investment drive might well lead to a reappraisal of where the best deposits are.

Rare earths are a group of 17 elements used in a vast array of products, not just magnets. They can be found in almost every electronic device that we have come to rely on in everyday life. They can be divided into two broad categories: light rare earths and heavy rare earths. This distinction is important because light and heavy rare earths occur in different ore deposits.

While cerium and lanthanum (both light) are the rare earth elements used in the greatest volume, they account for a small part of the total value of rare earth usage and are not used in magnets. The key elements used in magnets are neodymium, praseodymium, dysprosium, and terbium. Neodymium and praseodymium are both light, while dysprosium and terbium are heavy. These account for just under half the volume of rare earths used but over 90% of the value. The total annual value of rare earths is now about US$7 billion, though even this relatively modest number reflects fairly dramatic price rises in recent years. The rare earth complex is therefore a small industry by global standards.

Rare earths are not particularly geologically rare, but their occurrence in concentrated and, therefore, economically viable deposits is uncommon. Indeed, about half of the world's known reserves are thought to be found in China. This statistic is, however, not entirely reliable. The reality is that large parts of the world have yet to be properly explored for rare earths, and the current investment drive might well lead to a reappraisal of where the best deposits are. The U.S. Geological



Rare earths can be divided into two broad categories: light rare earths and heavy rare earths. This distinction is important because light and heavy rare earths occur in different ore deposits.

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Western countries possess about 9% of global rare earth reserves, while China and Russia possess about 53%, with non-aligned countries making up the remaining 38%.

Survey (USGS), for example, does not include Myanmar in its aggregate statistics for rare earth reserves because of the lack of detailed information, yet Myanmar is emerging as a major producer of ore. Myanmar is, of course, under heavy sanctions from Western governments.

However, using the existing dataset, rare earth deposits outside China are highly concentrated. Brazil, India, and Australia are thought to possess about 23%, 8%, and 7% of the world's ore, respectively, which, combined with China's 49%, account for 87% of global reserves. Russia and Vietnam are thought to have about 4% of global reserves each, with the United States accounting for another 2%. The rest of the world makes up the remaining 3%.

Western countries, therefore, possess about 9% of reserves, while China and Russia possess about 53%, with non-aligned countries making up the remaining 38%. This, of course, could change as new discoveries are made and technology improves, turning speculative resources into economically viable reserves.

For example, in 2023, Sweden's state-owned mining corporation, Luossavaara-Kiirunavaara Aktiebolag (LKAB), announced that it had identified more than one million tons of rare earth oxides (REO) at the Per Geijer deposit in Kiruna.[3] Subsequent exploration in 2024 increased this to 2.2 million tons of REO. Importantly, the resource appears rich in both light and heavy rare earths. Sweden, incidentally, was where the first rare earth was found in 1787. By way of comparison, the Mountain Pass deposit in California, which is the backbone of indigenous US ore supply, is a resource of about 1.8 million tons and is dominated by light rare earths. For context, Bayan Obo in China, the world's largest resource, contains about 40 million tons of REO. The Swedish asset is many years away from production.

A further potential and underexplored source of rare earths is the ocean floor. In February 2026, Japan lifted about 50 tons of rare-earth-bearing mud from 6,000 meters below the surface near Minami-Torishima Island. This was the world's first continuous recovery of rare-earth-rich seabed mud from the deep ocean. Analysis of the recovered mud showed that heavy rare earths make up more than half of the rare earth content. Minerals recovered included yttrium, gadolinium, and dysprosium (which are critical for electric vehicle motors and defense magnets). Estimates put the size of the deposit at about 16 million tons of REO, nine times the size of the Mountain Pass deposit but with the additional advantage of significant heavy rare earth content and not far off half the size of China's massive Bayan Obo reserve. Just the highest-grade zone — the top 10 meters of mud spread over 100 square kilometers — is thought to contain 1.2 million tons of REO, making it two-thirds the size of Mountain Pass.[4] Trial operations are planned for January 2027.

Reserves and ore production are, of course, very different things. USGS data for 2025 put China's production of rare earths at 270 kilotons (kt) out of global production of 390 kt.[5] This gave China a 69% market share, which has been fairly constant in recent years. Myanmar accounted for a further 5.6% of production, which, given Western sanctions, can be assumed to have fed directly into the Chinese supply chain.

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It is in the downstream refining, processing, and metallization parts of the supply chain that there is a chronic need for investment to de-risk from China.

US production has risen from about 41 kt in 2023 to 51 kt in 2025, and Australian production has likewise risen from 16 kt to 29 kt, giving them 2025 market shares of 13% and 7.5%, respectively. Together, these four countries accounted for 95% of global production.

While these are aggregate numbers for rare earths, the situation is markedly different when one considers just heavy rare earths and, in particular, heavy rare earths for magnets: dysprosium and terbium. While China has a large share of about 40%, Myanmar accounts for a further 40% or more. Furthermore, Laos — a communist country over which China has strong influence — makes up much of the rest. Brazil and Australia are the only other two sources, and they account for a few percentage points of the total. In this case, an "ex-China" supply chain is certainly not free from geopolitical risk.

Access to raw materials is just the beginning of the supply chain. Over the past 40 years, China has been particularly effective in the processing, refining, and metallization of rare earth ores. China has then used its monopolistic position in final products to dominate the manufacturing of magnets.

In refining, China is reported by the International Energy Agency (IEA) to have about a 90% market share. Two-thirds of the material mined outside China therefore goes to China for refining. Outside China, there are currently just five refineries operating commercially: Lynas Rare Earths in Malaysia; MP Materials in the United States; Vietnam Rare Earth JSC; Solvay in France; and Neo Performance Materials in Estonia.

It is in the downstream refining, processing, and metallization parts of the supply chain that there is a chronic need for investment to de-risk from China. In addition to the inability to meet current demand, demand for magnet-related rare earths is set to rise dramatically as electrification continues, with electric vehicles and wind turbines being key sources of new demand for rare earth magnets.

The importance of rare earths stems not from the size of the market, but from the size and strategic nature of the industries that rare earths support and make possible. The IEA estimates that the US$6.5 billion annual value of magnet-related rare earths supports industries that contribute about US$6.5 trillion to GDP outside China. So where is the de-risking headed, and which investments have been made that could change the strategic landscape?

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Recent investments

The immediate governmental goal of much of the recent investment in rare earth supply is to create a “mine-to-magnet” supply chain that operates outside China, or perhaps more precisely, outside China’s control.

In recent years, there has been a relative frenzy of new investment in rare earth supply aimed at alleviating China’s grip on supply. The immediate governmental goal of much of this investment is to create a “mine-to-magnet” supply chain that operates outside China, or perhaps more precisely, outside of China’s control. The rare earth magnet supply chain involves multiple processes, and as the IEA has pointed out, the investment taking place by non-Chinese players in the industry is unevenly spread across the various parts of the process.[6]

In the mining space, a few large investments have been made. While Mountain Pass in the United States (operated by MP Materials) and Mount Weld in Australia (operated by Lynas Rare Earths) are the major sources of existing supply outside China, they are insufficient in both size and product mix to seriously diminish China’s control, despite ongoing expansion.

Arafura’s Nolans project in Australia is a US$1.2 billion ore-to-oxide project that will produce magnet-related light and heavy rare earths. Production could be in the region of 5 kt REO but is unlikely to commence until late 2029.

Serra Verde Group in Brazil is notable as the only scaled producer outside Asia of all four key magnetic rare earths: neodymium, praseodymium, dysprosium, and terbium. The mine contains a relatively high proportion of valuable heavy rare earths. It has recently been acquired by USA Rare Earth and has the potential to



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There is plenty of action happening, but capacity is still likely to fall short of what is required to break the dependence on China.

expand. In addition, other Brazilian ion-clay deposits are in the process of being developed, with production coming online from 2028.

In Africa, mines in Tanzania, Namibia, Malawi, and Angola are also in the pipeline. The Longonjo Rare Earths Refinery Project in Angola is targeting production in 2027, while the Kangankunde Rare Earths Project in Malawi is the closest to production in the region, targeting production by the end of 2026. Namibia's projects (especially the Lofdal Heavy Rare Earth Project) are strategically important for heavy rare earth elements and benefit from Japanese partnership, but they remain further from production. Crucially, Tanzania's Ngualla Rare Earth Project, which is reasonably advanced, has been bought by the Chinese and will therefore most likely feed directly into China's rare earth supply chain, doing nothing to loosen China's grip on the industry.

The IEA estimates that new mining investment in rare earths outside China could drive output of magnet-related rare earths from the current level of about 18 kt to about 55 kt by 2035. Of the 37 kt expected increase, about 22 kt will come from Australia, with the remainder coming from the United States, Tanzania, Laos, Brazil, and India. We suspect that, given the rapid flow of announcements, these numbers are likely to be revised upward if execution continues at the pace seen over the past three years.

However, at the separation and refining stage, the investment flow is less likely to produce a sizable enough China-free supply.

When it comes to refining and separation, the announced and planned capacity expansion is significantly smaller. From the current 8 kt in operation, the IEA expects refining and separation capacity to increase to about 33 kt. Of course, this represents massive percentage growth and tonnage growth compared to the starting point, but it is not enough to absorb the predicted mining capacity of 55 kt.

Lynas Rare Earths in Malaysia has been processing light rare earths and has just begun modest heavy rare earth refining. In Western Australia, Lynas Rare Earths has also begun cracking and leaching to somewhat reduce its dependence on Malaysia. Iluka Resources is expected to commission its Eneabba Rare Earths Refinery in 2027, processing both light and heavy rare earths from third-party mines. This will be a major step forward. In addition, Arafura's Nolans project is intended to eventually become a vertically integrated mine-to-oxide facility.

In North America, Mountain Pass is already processing rare earths and that is expanding. USA Rare Earth's Round Top project will focus on processing heavy rare earths, while further down the line, Canada has significant ion-clay deposits of heavy rare earths that are exploitable and aims to become a processing hub.

There is plenty of action happening, but capacity is still likely to fall short of what is required to break the dependence on China. The disconnect is even greater when we get to the magnet production, metallization, and alloying stage. Here, planned capacity again increases dramatically (from 5 kt to 18 kt in rare earth elements (REE) equivalents), but not sufficiently to absorb the expansion in refined REE. It is important to note that the 18 kt of REE that will be used in alloying and

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There is a clear asymmetry in announced investment across the rare earth supply chain, with excess raw material relative to refining capacity and excess refined product relative to what can be utilized outside China.

magnet facilities translates into the production of about 54 kt of neodymium-iron-boron magnets, using a ratio of 0.3 tons of rare earths per ton of magnets.

There appears, therefore, to be a clear asymmetry in the announced investment profile across the rare earth supply chain, with excess raw material relative to refining capacity and excess refined product compared to what can be utilized outside China.

However, it is also important to point out that the investment environment is moving incredibly quickly, with new projects being announced on an almost weekly basis. For example, Lynas Rare Earths announced in July 2026 that it was partnering with Korea's JS Link to build a new magnet manufacturing facility in Malaysia with a capacity of 3 kt of permanent magnets. This comes on top of Lynas Rare Earths' earlier announcement that it would enter into a joint venture with Korea's LS Cable & System to build a metallization plant in Vietnam. In addition, French company Carester has announced plans for a rare earth separation plant in Malaysia and is also keen to partner with local companies to exploit ore reserves. The bottom line is that rapid but uneven progress is being made in building out a non-Chinese supply chain for rare earths and permanent magnets.



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“China-free” does not equate to “risk-free”

While a number of plurilateral groupings have emerged in support of efforts to de-risk supply chains from China, their robustness is open to question in today’s volatile geopolitical climate.

Back in 2018, as China-US competition was heating up, we were of the view that the core US strength that gave it the edge over China was its strong alliance network. That was the theme of our paper “The economic balance of power and need for international alliances.”[7] Since then, the strength of America’s alliance structure has deteriorated. “America First” policies, random tariff regimes, bizarre jurisdictional claims, and what appears at times to be outright hostility toward erstwhile allies have eroded trust and faith in America’s ability to lead the free world.

In consequence, many countries that were non-aligned but with a leaning toward the US have stepped back and are less willing to subjugate their own interests to the cosmopolitan interest. At the same time, even close allies are questioning the dependability of the US. While a number of plurilateral groupings have emerged in support of efforts to de-risk supply chains from China, their robustness is open to question in today’s volatile geopolitical climate.

Hence, crucially, we would point out that the “China-free” supply chain also contains significant geopolitical risks with significant chokepoints. For example, Serra Verde Group’s Pela Ema mine in Goiás state, Brazil, is the only large-scale producer outside Asia of all four magnetic rare earths: neodymium, praseodymium, dysprosium, and terbium. The purchase of the mine by USA Rare Earth looks set to be completed as we write, but the fact remains that, until its Round Top project



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comes on stream, the US heavy rare earth supply chain will run through one project in a country that, under current leadership, cannot be counted as a US-friendly state.

Similarly, Lynas Rare Earths' main rare earth refining capacity is in Malaysia, a country with a long history of non-alignment. The Pentagon's recent offtake agreement with Lynas Rare Earths has sparked debate and protest in Malaysia, with some pointing out that the materials will be used in weapons systems, potentially in the Middle East against Muslim populations. Malaysia is acutely aware of the leverage its control over the Lynas facility gives it.

We have consistently argued that the cost of decoupling from China in supply chains that are both critical and weaponizable will be dramatically reduced by cooperation among like-minded nations. The deterioration in transatlantic and even intra-North American relations in the past couple of years has muddied the waters as to what exactly constitutes an ally. Alliances such as Pax Silica and the various plurilateral critical mineral working groups do not sit easily with the volatile tariff diplomacy of the Trump administration.

When one looks exclusively at US projects based in the US, the picture is not as promising as the global picture. MP Materials is indeed mining at scale, but the output consists of light rare earths. Its magnet manufacturing is targeting 10 kt. The Round Top project (operated by USA Rare Earth) will produce heavy rare earths and is targeting its own mine-to-magnet supply chain. Together with some smaller projects, including some based around recycling, US magnet production might be in the region of 12 kt–14 kt by 2028. Of the 23 projects that have been earmarked for or have received US government backing, only 11 are actually based in the US.



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Time frame for significant reduction in China dependency

If world “ex-China” magnet manufacturing is to rise four-fold, then there is still a considerable way to go to produce a China-free supply chain large enough to accommodate this magnet expansion.

Given the flurry of action that China’s rare earth export controls have helped catalyze, two questions arise: what would a meaningful reduction in dependence on China look like, and in what time frame can we realistically expect to arrive at that destination?

The first problem is that we do not know for sure how many magnets come from China. Chinese direct exports of permanent magnets are one thing, but many products that China exports — electric vehicles, for example — have magnets embedded in them.

Rare Earth Exchanges suggests that, in addition to 58 kt of direct permanent magnet exports, embedded exports could account for a further 40 kt.[8] This would suggest that the rest of the world is dependent on China for nearly 100 kt of permanent magnets. Industry sources put global output at 250 kt, with about 23 kt (9.2%) being made outside China.

If world “ex-China” magnet manufacturing is to rise four-fold to about 100 kt, and this is to be supported by ores, oxides, and metals that do not come from or through China, then there is still a considerable way to go to produce a China-free supply chain large enough to accommodate this magnet expansion.

If the 100 kt of permanent magnets were to use 30% light rare earths and 4% heavy rare earths, the supply chain would need to provide 30 kt of light rare earths and 4 kt of heavy rare earths. Current production of refined heavy rare earths outside China is only a few hundred tons per year. By 2029, planned heavy rare earth plants outside China could supply about 450–500 tons per year of dysprosium and about 120–140 tons per year of terbium. This is a three-fold increase from today’s levels. However, a further eight-to-ten-fold increase in production would be required to eliminate total dependence on China.

Of course, this is an extreme case. It is not in China’s economic or security interests to ban the export of embedded magnets in civilian products. China is increasingly reliant on the exports of electric vehicles and other products containing magnets for employment and income. Halving the targeted “ex-China” supply to 50 kt of magnets is more realistic. Again, heavy rare earths will be the limiting factor, likely pushing the end date beyond 2035.

An even lower threshold would be to set the target at a level at which at least the military-industrial complex is serviced by a China-free supply chain. This, it seems, is achievable, possibly by 2028, with the Pentagon predicting that defense demand for magnets will reach 10 kt per year by 2030.

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How to create a sustainable end demand for higher-cost products

The long-term viability of the "ex-China" supply chain is dependent on either subsidies or a segmented market.

The drive for a mine-to-magnet supply chain that does not touch China is a security-driven program, not an economic one. For decades, China has accumulated technology and know-how, and lax environmental standards add to its cost advantage. The sheer scale of China's magnet production affords it considerable economies of scale.

Lynas Rare Earths, the first company in the past 15 years to take on the Chinese monopoly, has struggled financially in the past. The prices of rare earths are controlled by China, and China has been prepared to squash prices if commercially driven competition has arisen.

With new supply coming on stream across all segments of the supply chain, excess supply will likely result. China is unlikely to close capacity as non-Chinese capacity comes on stream. Therefore, the long-term viability of the "ex-China" supply chain is dependent on either subsidies or a segmented market, where non-Chinese supply is required and can be priced in accordance with the cost curve that non-Chinese producers face.

The Pentagon specifically requires China-free supply from January 1, 2027. It will probably have to grant waivers for a year or two, but if it keeps the pressure on, it will likely achieve its goal. Pentagon demand alone, however, will not support the scale of production required to generate economies of scale or the level of production already planned.

US public investment in magnet-related projects has come with offtake agreements and floor prices in some cases. The China Rare Earth Industry Association reported neodymium-praseodymium oxide at roughly US$64 per kilogram. MP Materials is guaranteed US$110 per kilogram for 10 years by the US government, a 70% premium to the market price in China.

Going forward, a more formal long-term strategy for market segmentation will be required. Given the geographical spread of a comprehensive and sizable supply chain, cooperation with allies to produce an "internal market" is probably the most efficient and robust approach. This could potentially be facilitated through the various critical mineral alliances (the same problem will apply outside the magnet supply chain).

The key to long-term sustainability will be to balance the need to accommodate a higher-cost curve outside China while encouraging a competitive environment to avoid oligopolization and rent-seeking in the "ex-China" industry.

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Conclusion

Production on a scale that would render China's current grip on rare earths untenable is many years away.

The push to produce a China-free "mine-to-magnet" supply chain for rare earth magnets is something of a litmus test of both state capacity and industrial policy in market-oriented economies. It is also a test of their ability to coordinate and cooperate. Driven by national security concerns rather than economics, undoing four decades of neglect in a few years is unrealistic.

Nevertheless, a surprising amount of progress has been made in a short space of time. It is quite possible that the US will have a mine-to-magnet supply chain large enough to support its military needs by the end of 2028. While this is a key strategic goal, it is a very low bar compared to the scale required to immunize the global economy from the weaponization of rare earths by China. Production on a scale that would render China's current grip on rare earths untenable is many years away. The key chokepoints — heavy rare earth separation and metallization — require considerably more investment than has been made so far.

It is probably realistic to think that the gaps in the supply chain needed to at least replace China's direct magnet exports could be filled by 2040, at best a little sooner. Furthermore, there will be considerable benefits in terms of critical mineral security beyond the magnet chain as a result of mining and refining investments that are taking place, but these too will take time to feed through into genuine economic resilience.

As the new supply comes on stream, state aid will have to evolve to ensure that the "ex-China" supply chain can survive and thrive in an oversupplied global market. This will most likely require a more formalized market structure rather than the ad hoc, project-specific assistance that has been provided so far. Getting that right will ensure the continuity of supply at the minimum cost to the taxpayer.

The final adult answer, it would seem, would be, "So, dear, there is a long way still to travel before Western economies arrive at the destination of critical mineral supply resilience."

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Author bio and endnotes

Stewart Paterson spent 30 years in capital markets as an equity researcher, strategist and fund manager. He has worked in London, Mumbai, Hong Kong and Singapore in senior roles with Credit Suisse, Credit Suisse First Boston, CLSA and more recently, as a Partner and Portfolio Manager of Tiburon Partners LLP.

Having started his career with Hill Samuel in London in 1991, Stewart has covered the full spectrum of global markets equity strategy, developed market equities and emerging market equities. In 2007, he co-founded Riley Paterson Investment Management in Singapore, where he ran a macro-driven hedge fund. He returned to the UK in 2012.

Stewart is the author of *China, Trade and Power: Why the West's economic engagement has failed*, a highly acclaimed book supported by the Hinrich Foundation. He holds an MA degree in Economics from the University of Aberdeen.



Stewart Paterson

Senior Research Fellow,
Hinrich Foundation

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