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## RARE EARTHS AS A GEO-ECONOMIC STAKE IN MODERN INTERNATIONAL RELATIONS

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**Abstract:** Will future international relations be determined by the rivalry and geoeconomic and geopolitical war surrounding rare earth elements? "The world map seems to be redrawn around natural resources," and China has secured its dominance over rare earths. Africa, still rich in natural resources, appears to be an important resource for the EU, which is rather poorly endowed with deposits. These rare metals are relatively abundant in the Earth's crust. However, their extraction is complicated, and their refining is very expensive and polluting. These minerals, with chemical properties essential for manufacturing key technologies of the energy and ecological transition, as well as electronic and digital devices, number 17. Given their wide range of uses, the available quantities of rare earths are low, while demand is constantly increasing due to global population growth, improving living standards, industrialization, and innovation. This growing demand is expected to put pressure on global rare earth reserves in the future. Furthermore, the low recycling rate of "urban mines" (1%) and the low substitution rate of rare earth elements with iron phosphate or molecular sponge (0.87%) do not mitigate the effects of this growth.

**Keywords:** Rare earth elements, Geoeconomics, China, United States, European Union

### 1. INTRODUCTION

Rare Earths are used in many electronic and digital devices. Why are rare earths important? Light rare earths are used for their exceptional magnetic properties, while heavy rare earths (the most valuable) are used to raise the temperature point at which magnets lose their magnetism. Why have rare earths become essential to the economy? Rare earths are used in many areas of advanced technology: wind turbines, electric vehicles, smartphones, and even in weapons such as missiles. They are also used for their role as catalysts and magnets, as well as in metallurgy and polishing. Why does the United States need rare earths? Heavy rare earths are used in many military areas, such as missiles, radars, and permanent magnets. The CSIS report shows that defense technologies such as the F-35 aircraft, Tomahawk missiles, and Predator drones depend on these minerals. For example, neodymium is used to make powerful magnets used in speakers and computer hard drives. Yttrium and europium are used in television and computer screens because of the way they display colors. "Anything you can turn on or off probably works with rare earth elements," says Thomas Krummer, director of Ginger International Trade and Investment. Rare earth elements are also essential for the production of medical technologies such as laser surgery and MRI scans, as well as key defense technologies. For its part, the trade war between China and the United States is intensifying after a months-long truce - this time over rare earths. China holds powerful trump cards and is exerting strong pressure on minerals used in electric cars, electronics and military weapons. In recent months, it has stepped up its pressure on rare earth exports and is now requiring Chinese companies to get government approval before shipping these minerals abroad. The restrictions have dealt a blow to the United States, whose industries depend heavily on imports of the precious metal. Analysts say China is using its dominance as a powerful tool in trade talks with Washington. But why are rare earth elements so important, and how could they derail a trade war? What are rare earth elements and what are they used for? Rare earth elements are a group of 17 chemically similar elements<sup>1</sup> that are essential to the production of many high-tech products. Most are abundant in nature, but they are known as rare because they are too rare to find in pure form and too dangerous to extract. While you may not be familiar with the names of these rare earth elements — such as neodymium, yttrium, and europium — you are very familiar with the products they are used in. For example, neodymium is used to make powerful magnets used in speakers, computer hard drives, electric vehicle motors, and jet engines, allowing them to be smaller and more efficient. Where are the rare earth reserves located? In 2021, the USGS estimated global rare earth reserves at 120 million tons, 90% of which are located: • in China: 44 million tons, or 37%; • in Vietnam: 21.6 million tons, or 18%; • in Brazil: 20.4 million tons, or 17%; • in Russia: 20.4 million tons, or 17%. At the current production rate (280,000 tons) and given these reserves, the world has at least 430 years of rare earth consumption ahead of it. This data is evolving as exploration progresses. The Arctic is

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<sup>1</sup> La | Lanthanum Sc | Cerium Pi | Praseodymium Nd | Neodymium Pm | Promethium Sm | Samarium Eu | Europium Gd | Gadolinium Tb | Terbium, Dy | Dysprosium Ho | Holmium Er | Erbium Tm | Thulium Yb | Ytterbium Lu | Lutetium Y | Yttrium Sc | Scandium And also include, due to their similar physical and chemical properties: Toliara

believed to have the second-largest rare earth potential in the world after China, but its reserves have not yet been proven. This would represent a thousand years of guaranteed exploitation.

## **2. CHINA'S MONOPOLY ON RARE EARTHS**

China has a virtual monopoly on the extraction of rare earths, as well as their refining, which involves separating them from other minerals. The International Energy Agency (IEA) estimates that China accounts for approximately 61% of rare earth production and 92% of their processing. Refined rare earth production in 2023 according to the International Energy Agency (IEA) This means that it currently dominates the rare earth supply chain and has the ability to decide which companies can and cannot obtain rare earth reserves. Extracting and processing these rare earths is expensive and polluting. All rare earth resources also contain radioactive elements, which is why many other countries, including those in the EU, are hesitant to produce them. "Radioactive waste from production requires safe, compliant and permanent storage. At present, all EU storage facilities are temporary," European rare earth experts point out. But China's dominance of the rare earth supply chain did not happen overnight. Rather, it is the result of decades of strategic government policies and investments. Getty Images The mining town of Bayan Obo in Inner Mongolia has one of the largest deposits of rare earth metals. During a visit to Inner Mongolia in 1992, the late Chinese leader Deng Xiaoping, who oversaw China's economic reform, said: "The Middle East has oil, and China has rare earth metals." "Since the late 20th century, China has prioritized developing its rare earth mining and processing capabilities, often with lower environmental standards and labor costs than other nations," says Gavin Harper, a critical materials researcher at the University of Birmingham. (X Ma, Z Meng, MV Bellonia, J Spangenberg, G Harper, E Gratz, (2025) The evolution of lithium-ion battery recycling, *Nature Reviews Clean Technology* 1 (1), 75-94) "This has allowed them to compete with their global competitors and build a near monopoly across the entire value chain, from mining and refining to manufacturing finished products such as magnets." How has China restricted exports of these minerals? In response to tariffs imposed by Washington in April, China has begun imposing export restrictions on seven rare earth minerals, most of which are known as "heavy" rare earths, which are essential for the defense sector. They are rarer and more difficult to process than the "light" rare earth metals, which makes them more valuable. Since then, all companies have had to obtain special export licenses to ship rare earth metals and magnets out of the country. This is because, as a signatory to the international nuclear non-proliferation treaty, China has the ability to control the trade in dual-use items. According to the Center for Strategic and International Studies (CSIS), this makes the United States particularly vulnerable because it does not have the capacity outside of China to process heavy rare earth metals. In October, China expanded its controls on rare earth exports.

## **3. US WEAKNESSES IN RELATION TO RARE EARTHS**

Foreign companies must now get approval from the Chinese government to export even small amounts of rare earth metals and must explain what the land is being used for. Rare earth mine in Nancheng County, Jiangxi Province What impact could this have on the United States? The US Geological Survey shows that between 2020 and 2023, the United States relied on China for 70% of all imports of rare earth metal compounds and metals. Beijing's export restrictions could therefore hit the United States hard. Washington has accused China of treason over its restrictions on rare earth metals exports. US Treasury Secretary Scott Besant called China's restrictions "economic coercion" and "stifling the global supply chain." However, he left the door open to negotiations. Heavy rare earth metals are used in many military applications, such as missiles, radar and permanent magnets. The CSIS report shows that defense technologies, including the F-35 fighter jet, Tomahawk missiles and Predator drones, rely on these minerals. It adds that this comes at a time when China is "expanding its munitions production and acquiring advanced weapons systems and equipment at a rate five to six times faster than the United States." "The impact on the US defense industry will be significant," military experts say. And it's not just in the defense sector. The US manufacturing industry, which Trump has said he hopes to revive with his tariffs, is likely to be severely hit. "Manufacturers, particularly in the defense and high-tech sectors, face potential shortages and production delays due to halted shipments and limited supplies," the US Department of Defense said. Rare earth metals are needed to make magnets, a key component of electric vehicle motors. "Prices for critical rare earth metals are expected to rise, driving up the upfront costs of components used in a wide range of products, from smartphones to military equipment," he said, adding that this could lead to a potential slowdown in production for affected American companies. (Laplane, M. 2021). If such a shortage from China continues in the long term, the United States could potentially begin to diversify its supply chains and increase domestic and processing capacity, although this would still require "significant and sustained investment, technological advancements, and potentially higher overall costs compared to previous reliance on China." And it is clear that this is already a concern for Trump. In April, he ordered an investigation into the national security risks posed by the United States' dependence on these critical

minerals. At an October 2025 meeting in Malaysia with Chinese President Xi Jinping, these topics were at the center of discussions between the Chinese and American delegations. “President Trump recognizes that overreliance on foreign critical minerals and their derivatives can jeopardize U.S. defense capabilities, infrastructure development, and technological innovation,” the executive order states. “Critical minerals, including rare earth elements, are essential to national security and economic resilience.”

#### **4. DEPENDENCE ON ENVIRONMENTAL POLLUTION**

As declarations to achieve a sustainable ecological transition multiply, the activities established to achieve it have highlighted the central role played by rare earths. The global ecological transition requires increased use of these metals, which are essential for the production of new technologies categorized as "green". Due to their importance, many fear the spread of disputes over these strategic metals. This issue is even more acute given that China occupies a key position in their exploitation. This strategic position provides an advantage that allows it to present itself as a leading world power in the so-called green technologies, a coveted position - also synonymous with uncertainty - for the rest of the international community. Unequal distribution and exploitation of rare earths in favor of China Rare Earths are a group of sixteen chemical elements. The peculiarity of these elements lies in their chemical composition: their outer electron shells are identical, but for each of them, an additional electron is present in the deep shell, which makes them unique and very difficult to replace. This category of metals is also divided into two subdivisions: light rare earth metals, the most numerous, and heavy rare earth metals. These metals are not rare in terms of deposits, they exist all over the world, but their extraction is complex. This name comes from their very low concentration in deposits during extraction (Fontanel J. 2021). Global reserves of rare earth metals are estimated at around 88 million tons, with China holding 36%, followed by Russia and the United States. These minerals, essential for new technologies and the digital industry, are used in various sectors for a large number of high-tech production processes: mobile phones, screens, and even electric car engines. Their strategic nature is reinforced by their importance for the oil and defense industries, which raises major geopolitical issues. China developed a significant policy for rare earth metals very early on, through the 4R strategy (Reduce, Reuse, Recycle, Recover), combined with competitive prices and quotas that favor a local oligopoly. Its goal is also to establish itself in the production of the countries that own these resources in order to prevent them from becoming competitors. Thanks to technology transfer and a price war, China is now the leading producer of rare earth metals. The possession of these metals is a concern for the international community... but also for the environment. Although China has already demonstrated its dominance through the quantity of its resources and their management, it is consolidating this position through various actions. For example, Japan paid the price when Beijing suspended the export of rare earth metals following maritime tensions, demonstrating the geopolitical consequences that this situation generates. The United States, for its part, reopened one of its largest rare earth mines, while planning to create a strategic reserve of these metals in the future. Despite a series of initiatives aimed at developing its own production and improving refining controls, the European Union currently remains dependent on China for 95% of its rare earth metals. Although other countries such as Russia and Brazil are seeking to expand their production, China's dominance continues. The consequences of this extraction are also environmental, and once again place China at the centre of attention. The exploitation of these metals has led to the abandonment of many villages and the contamination of soil and groundwater with toxic residues. Miners are exposed to dangerous conditions, often without adequate protection. The recycling of rare earth metals remains underdeveloped, and electronic waste, much of which comes from the United States and Europe, is often shipped to China. The increase in the production of rare earth metals therefore has disastrous consequences for the environment, in contrast to their use in so-called green or low-carbon technologies.

#### **5. THE EUROPEAN UNION AND RARE EARTHS**

Sometimes it is necessary to crush a thousand times more rocks to obtain a few grams of these metals. The European Commission has identified the main producers of rare earth metals needed for future economic development. As with oil, rare earths are likely to become increasingly difficult to extract in new mines that are currently unprofitable, significantly reducing their energy advantage. The easiest deposits are exhausted. Metal production consumes 7 to 8% of global energy. Ricardo's theory of rent applies. The limits of mining are not quantitative, but energy-related.<sup>7</sup> A genuine rare earth diplomacy is being established, with Germany exploring in Mongolia and France in Kazakhstan; Faced with growing mining nationalism, especially in Latin America (Chile, Peru, Bolivia for their lithium and copper reserves; Brazil for bauxite and iron, or New Caledonia for nickel), consumer countries are seeking to obtain guarantees of supply. China itself is hunting for rare earths all over the world, in Canada and Peru, but especially in Africa. It is waging a price war that makes competing mines less exploitable in the short term, often driving foreign mining companies into bankruptcy. It then buys them at low prices, often through difficult-to-

disclose financing arrangements. Finally, it invests in the capital of competing companies, especially in Greenland, Kyrgyzstan, and even the United States. This is a strategy of entry, dumping, and control of rare earths that is not in line with the rules of the World Trade Organization, the results of which in the control of “rare earths” will only be seen in a decade if other countries do not react in time. Green development, hostage to rare metals The growth prospects of green technologies are considerable. Thanks to these materials, it is possible to imagine that all the energy needs of a country like France could be met from renewable sources. But there is a catch. These technologies crucially require rare earth metals, which makes this hypothesis increasingly difficult to support given current geological knowledge. However, not all their effects have been demonstrated. The impact of 6 Today, 35 barrels of oil in production require one barrel to produce (compared to 100 for one barrel a century ago). (Bardi, U. 2015) photovoltaic panels (which emit 70 kilograms of CO<sub>2</sub> per unit) and solar thermal energy (3,500 liters of water per megawatt-hour) have not always been taken into account. The same is true for electric cars, the production of which requires more energy than a conventional car (especially for the lithium battery). According to UCLA researchers (2012), the production of an electric car with a range of 120 km or 360 km, respectively, consumes three times or 7 to 8 times more energy than a conventional vehicle. However, when in use, it releases half as much CO<sub>2</sub> over its life cycle. For ADEME, over its entire life cycle, an electric vehicle has an energy consumption close to that of a diesel vehicle, with a similar environmental impact, and even worse if the electricity is produced by coal-fired power plants, as is still the case in many countries (China, India or Australia). The cost of replacing batteries, the environmental costs of the onboard electronics and the potential for recycling must also be taken into account. The battery is a key element of the electric car, the most expensive, manufactured in China, which allows for strategic partnerships (Volkswagen and CATL, the Chinese specialist). This dependence is due to rare metals such as lithium, cobalt, nickel and manganese. Mining is highly polluting, with significant health consequences for the surrounding population. The dependence on cobalt, primarily produced in the DRC (Congo), also does not guarantee energy independence. Pollution is simply deterritorialized. These analyses of monetary costs and pollution costs are lacking.

## **6. WASTE HAS BECOME A GOLD MINE**

The stock of discarded materials is increasing every year. Every German, Spaniard or Frenchman produces between 23 and 28 kilograms of electronic waste every year. Manufacturers sometimes try to recycle large metals (gold, silver, aluminum or copper), but rarely small metals. Japan is striving to do so, considering that there are probably 300,000 tons of rare metals in the 200 million smartphones used. A circular economy is being considered and developed. The search for substitutes is also underway, as is the optimal use of metals. Used weapons also have many components that could be recycled. By definition, an electric car does not emit anything locally. However, its production is significantly more energy-intensive, and therefore more greenhouse gas-intensive, than a car with an internal combustion engine. The battery accounts for half of the energy needs associated with the production of an electric car. However, it takes approximately 70,000 MJ to produce a petrol or diesel car, and 120,000 MJ to build an electric one. (Fontanel, J. 2020) Fine particle pollution is also not reduced by using electricity, given the global circular economy, which poses a challenge to traditional supply chains. The problem is that rare metals are not used in their pure form in the composition of green technologies, by producing these well-known composite materials that improve the qualities of the component compared to that made from simple metals. We must be able to “separate”, which is often long and expensive, involves chemicals and significant energy consumption. Manufacturers still prefer the direct market; recycling does not exceed 10% of production on average (18 metals are recycled at over 50%, 3 at over 25%; 3 at over 10%, all others well below that). Waste must be accumulated to take advantage of economies of scale. According to the Basel Convention, electronic waste must be recycled in the countries where it is collected. The United States has not signed this convention and sends 80% of its waste to Asia, as does Japan. De facto, under the label “Second-hand”, Europe does the same. China is the buyer. The ecological transition is uneven, favorable to the wealthy classes in urban centers, unfavorable to mining areas. The radioactivity of certain thorium or uranium zones is at least as high as that of Chernobyl. The idea that digital technology can help us reduce energy costs is a postulate. Of course, the digital economy allows us to design smart electricity grids capable of optimizing costs, based on the permanence and intermittency of energy sources. It also reduces the carbon impact of human activities, with the third industrial revolution proposed by Rifkin. (Corniou, M (2022) Dematerialization leads to remote work, remote procedures and data storage, which reduces energy costs. However, this picture remains incomplete. This thinking works “*ceteris paribus*”, all other things being equal. Upstream, new rarities are emerging, which are likely to create “bottlenecks”, which will inevitably lead to an increase in raw material prices and a slowdown, or even a halt, at least partially, in the widespread application of new technologies. “Rare earths” are the first reserves to be affected. The digital industry uses metals (22% mercury, but also silver, gold, lead, etc.). Computers and mobile phones use one fifth of the production of rare metals. (Gacon, J./Pitron, G./Danino-Perraud, R./ et Audrey Sérandour, 2023).

## **7. CHINA – A VISION TOWARDS GLOBAL LEADERSHIP**

The rare earth industrial strategy has been launched with great success. In China's plan, several types of businesses were considered priorities: biotechnology, efficiency and new energy sources, information technology, new materials, clean vehicles and high-tech industrial equipment. It benefits from cheap labor, low cost of capital (devaluation of the yuan) and a large domestic market. It has successfully used joint ventures, benefiting from foreign knowledge, which has enabled the internalization of foreign technologies and their subsequent use in China. This is a form of technology theft through good-faith cooperation between nations. Today, China is going on the offensive, with co-innovation becoming Chinese innovation, with foreign companies increasingly being invited to operate on Chinese soil. (Perruche, C. 2025) China is ahead in several industrial sectors, such as biology, energy, materials, automation, oceanography and information technology. However, it does not have absolute power due to insufficient training, a limited number of researchers in relation to its population, the inertia of state-owned enterprises in the energy, telecommunications and financial sectors, and political authoritarianism that can hinder economic and social innovation. The survival of the Communist Party undoubtedly represents another constraint. On the other hand, technological progress is significant in many prestigious areas such as space, computers, photovoltaics, hydropower and wind power. China is taking away green jobs because environmental issues are very strongly expressed by the population. Citizens have organized NIMBY (not in my backyard) protests, pushing Beijing to become a leader in the energy transition. By attracting foreign companies and setting them up on its soil, China has seized some of the wealth previously developed by Western countries. In a way, this is a self-proclaimed policy of "beggar-thy-neighbor" ("every man for himself, even to the direct detriment of his neighbor"). Most American magnet manufacturers have disappeared within 30 years. A policy of dumping is in effect, and competitors are gradually forced to cooperate before they surrender. "The capitalist will sell the rope that hangs him," said Lenin. The Chinese Communist Party has learned this lesson well. (Goetz, E. 2025) Rare earth metals will transform international relations, leading to a loss of confidence in globalization and a shift in military strategies, which will focus less on Gulf issues and more on countries with access to rare earth metals. Militarily, the production of most of the most sophisticated weapons depends on the purchase of rare earth metals from China. This dependence is undoubtedly a potential for military conflict, since all modern technology relies on these rare earth materials, which puts security and economic equilibrium at great risk. China is establishing itself as a great power of the future, thanks to metals that replace polluting energy sources and a monopoly on many essential rare metals (in some cases irreplaceable), low-carbon energy sources and digital technology. The environmental impact of these mines is significant, and mineral shortages could quickly become a reality, ecologically, geologically and, above all, politically. (Vasselier, A. 2021)

## **8. INSTEAD OF CONCLUSION: GEOECONOMIC AND GEOPOLITICAL WAR BETWEEN EAST AND WEST OVER RARE METALS**

The importance of rare earth elements has also been highlighted by the war in Ukraine. It is precisely because of their importance that the United States has shown a keen interest in offsetting its financial support to Ukraine. This is why the long-term agreement between President Trump and Governor Zelensky was signed in 2025. Furthermore, it is known that Russia controls 20% of the areas rich in strategic minerals, which are of interest to the United States, the United Kingdom, and France. (Grasland,E. 2025) In this context, thanks to Ukraine possessing approximately 5% of the world's reserves of critical raw materials, including rare earth elements, Kyiv has acquired strategic importance in the competition between these three actors. Iron, lithium, titanium, and graphite are just some of these precious minerals, as discussed during the meeting between Ukrainian President Volodymyr Zelensky and Donald Trump at the White House. The two leaders negotiated continued US military and financial support for Ukraine in the context of peace negotiations with Russia. In exchange for US assistance in guaranteeing the security of its territory, in the event of a ceasefire, Ukraine was preparing to agree to grant the Americans privileged access to the critical minerals located in its subsoil. These resources are essential for manufacturing low-carbon technologies (wind turbines, electric batteries), digital technologies (touchscreens), and defense (drones). While the Trump administration seems reluctant to renew its military and financial support for Ukraine after three years of war, it remains interested in the country's mineral wealth. The American president sees this as a way for Ukraine to "repay" the United States for the financial aid it has received so far. But that's not all, explains Emmanuel Hache, scientific advisor at IFP Energies Nouvelles and research director at the Institute for International and Strategic Relations (IRIS), to Vert magazine: "In addition to the economic argument, there is a major geostrategic argument," he explains, "based on the view that if we—the United States—don't do it, another power will develop the metals in Ukraine: China." "America first," the Ukrainians... later. While the agreement provides for the creation of a joint investment fund dedicated to the reconstruction of the war-torn country, the United States is also securing significant control in exchange for a vague promise of "new assistance, for example, air defense systems for Ukraine,"

according to Yulia Svyrydenko. This joint fund will be responsible for investing “in mining, oil and gas projects, as well as in infrastructure or related processes,” the Ukrainian minister further explained. For the first ten years, profits will be directed toward “reconstruction” and “new projects.” At the end of the war, Ukraine could thus become one of the most competitive defense industrial bases in Europe, aligned with NATO standards. With the rapid increase in demand for rare earth metals, there is a global quest to secure access to and control over them. China’s market dominance (70% of extraction and 85% of processing) has raised concerns in the United States and the European Union. In the context of increasing tensions between China and the West, this “cold war for minerals” has transformed the geopolitics of critical raw materials, including rare earth metals. In recent years, for example, the United States has sought to “secure supply chains” by diversifying its sources of rare earth metals. This has resulted in intensified domestic mining (reopening the Mountain Pass site in California and processing the ore locally, rather than shipping it to China), as well as exploration for new deposits at locations such as Bear Lodge in Wyoming. The European Union is also encouraging the development of rare earth mining projects in its region, such as Sweden, Finland, Spain and Serbia. China is also securing its supply of rare earth metals by developing mining projects in Asia, Africa and Latin America. Among other policies, the US Anti-Inflation Act requires electric vehicle manufacturers to source at least 40% of the mineral content of their batteries from the US or from allies (i.e. not from China). This percentage is set to increase to 80% by 2027. Washington is not only doing everything it can to secure its own essential minerals, but is also forcing its allies to reduce trade with China and compete for minerals elsewhere in the world. Similarly, the European Commission has presented legislation on critical raw materials (2023), which sets ambitious targets for 2030: to achieve 10% extraction of critical minerals, 40% of processing by European countries and a maximum of 65% of strategic raw materials consumed in the EU at any stage of processing to come from a third country. In this context, in the summer of 2023, Beijing introduced export controls on gallium and germanium, which are essential components of solar cells, optical fibers, and microchips used in electric vehicles, quantum computing, and telecommunications. In August, Chinese exports of these minerals fell sharply from nearly 9 metric tons to zero.

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