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RESEARCH ARTICLE

Rare Earth Elements and Critical Minerals in Global Power Competition*

(*Küresel Güç Rekabetinde Nadir Toprak Elementleri ve Kritik Mineraller*)

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ÖZ

Küresel enerji dönüşümü, dijitalleşme ve ileri teknoloji üretiminin hızlanmasıyla birlikte nadir toprak elementleri ve kritik mineraller, ekonomik ve jeopolitik açıdan stratejik kaynaklar haline gelmiştir. Elektrikli araçlar, yenilenebilir enerji sistemleri ve savunma sanayiinde vazgeçilmez olan bu mineraller, enerji güvenliğinin yeni belirleyicileri arasında yer almaktadır. Ancak üretim ve rafinaj faaliyetlerinin belirli ülkelerde yoğunlaşması, küresel tedarik zincirlerinde bağımlılık ve kırılganlık yaratmaktadır. Bu çalışma, nadir toprak elementleri ve kritik minerallerin küresel güç rekabeti üzerindeki etkilerini analiz etmeyi amaçlamaktadır. Araştırmanın temel sorusu, bu kaynakların küresel güç dengelerini ve jeopolitik rekabeti nasıl şekillendirdiğidir. Nitel araştırma yöntemi kapsamında literatür taraması ve devletlerin nadir toprak elementlerindeki hakimiyeti ve ülkelerin tedarik zinciri çeşitlendirme stratejileri incelenmiştir. Bulgular, nadir toprak elementlerinin yeni bir kaynak bağımlılığı ilişkisi yarattığını, büyük güçler arasındaki ekonomik rekabeti jeopolitik gerilimlere dönüştürdüğünü ve askeri kapasite ile teknolojik üstünlük açısından stratejik önem kazandığını göstermektedir. Sonuç olarak, kritik mineraller uluslararası sistemde yeni bir jeoekonomik rekabet alanı oluşturmakta ve geleceğin güvenlik mimarisinin enerji, teknoloji ve kaynak kontrolü ekseninde yeniden şekilleneceğine işaret etmektedir.

Anahtar Kelimeler: *Dış Politika, Güç, Nadir Toprak Elementleri, Kritik Mineraller, Jeopolitik.*

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ABSTRACT

With the acceleration of the global energy transition, digitalization, and advanced technology production, rare earth elements and critical minerals have become strategically important resources in economic and geopolitical terms. These minerals, indispensable in electric vehicles, renewable energy systems, and the defense industry, are among the new determinants of energy security. However, the concentration of production and refining activities in certain countries creates dependency and fragility in global supply chains. This study aims to analyze the impact of rare earth elements and critical minerals on global power competition. The fundamental question of the research is how these resources shape global power balances and geopolitical competition. A qualitative research methodology was employed, including a literature review; the dominance of states in rare earth elements and countries' supply chain diversification strategies were examined. The findings show that rare earth elements create a new resource dependency relationship, transform economic competition between major powers into geopolitical tensions, and gain strategic importance in terms of military capacity and technological superiority. In conclusion, critical minerals are creating a new geo-economic arena of competition in the international system and indicate that the future security architecture will be reshaped around the axes of energy, technology, and resource control.

Keywords: *Foreign Policy, Power, Rare Earth Elements, Critical Minerals, Geopolitics*

1. INTRODUCTION

Minerals have played a decisive role in the economic development and welfare of societies throughout history. In this context, rare earth elements (REEs) and critical minerals, which are among the strategically important raw materials, are used in different forms after enrichment and purification processes. REEs, possessing unique physical and chemical properties, are important components in many high-tech fields such as magnets, catalysts, electronic devices, lasers, glass, ceramics, batteries, medical imaging, wind turbines, solar panels, electric vehicle batteries and energy storage systems, telecommunications, and semiconductor technologies (Akın, 2026: 19). Elements such as neodymium, dysprosium, samarium, and praseodymium, especially hold a critical place in the defense industry and renewable energy technologies. Global demand for these elements is expected to increase further in the future, in parallel with technological advancements (Aslan and Say, 2022: 148).

The melting of glaciers due to global climate change is facilitating access to critical mineral and fossil energy resources, while also increasing the use of new maritime transportation routes. Especially due to their rare earth elements and renewable energy potential, some regions are becoming strategic supply centers in the global green energy transition. This geographical shift offers significant opportunities in terms of energy, transportation, and scientific research, while minerals critical to the green transition are increasing the interest of actors such as China, the US, and the EU in these regions (Kalkışım, 2025: 1171). This situation is gradually transforming into a new arena of geopolitical competition on a global scale.

China's export restrictions and sanctions on rare earth elements have increased the strategic interest of developed countries, primarily the United States, but also Japan and Australia, in this field. China's desire to maintain its global dominance over these resources has made rare earth elements one of the important geopolitical elements of the 21st century. These elements, which are critically important in advanced technology production, are used as a strategic tool in international relations (Günsan, 2024: 152).

In this context, rare earth elements and critical minerals have become not only essential inputs for industrial production but also strategic resources shaping global power balances. Advances in green energy transition, digitalization, and defense technologies are increasingly reinforcing dependence on these elements, while control of these resources is considered a tool for economic and political dominance by states. The increasing accessibility of new resource areas due to climate change has made competition, especially among major powers, more visible. Within this framework, rare earth elements will continue to be central to energy security, technological independence, and geopolitical struggles in the future; and access to and security of supply will be a decisive factor in the strategic policies of states.

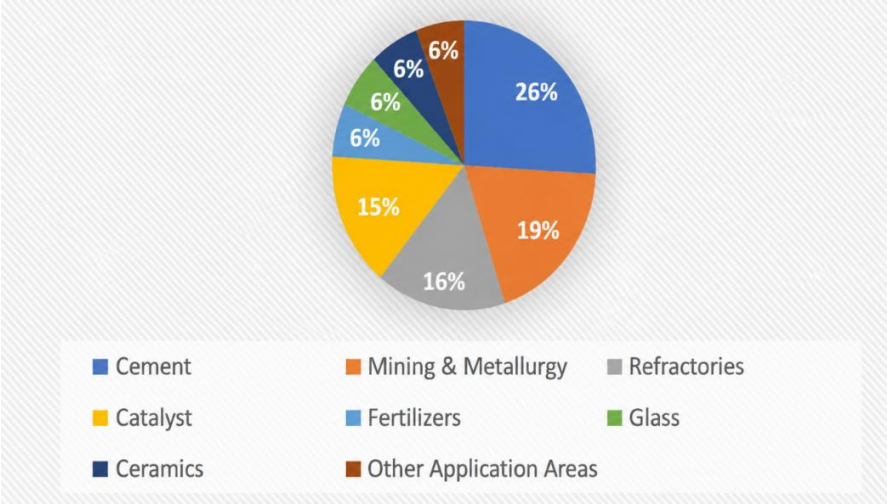
2. APPLICATIONS OF RARE EARTH ELEMENTS AND CRITICAL MINERALS

Rare earth elements and critical minerals hold an indispensable position in today’s advanced technology applications thanks to their unique physical and chemical properties. Due to their superior performance in electrical, optical, electro-optical, and magnetic systems, they are widely used in strategic sectors such as the defense industry, automotive technologies, satellite and communication systems, renewable energy applications, and medical technologies. These valuable and critical elements are also utilized in frequently used everyday products such as mobile phones, computers, LCD screens, fiber optic cables, laser systems, camera lenses, and sunglasses, as well as in high value-added products such as wind turbines, generators,

hybrid vehicle batteries, solar energy technologies, and medical imaging devices (Aslan and Say, 2022: 172).

One of the remarkable characteristics of these elements is that they are used not as the basic raw materials of products, but mostly as additives in small proportions. However, these small quantities enable the development of more efficient, durable, and functional technologies by providing significant improvements in product performance. This makes it possible to produce high-tech products with limited quantities of critical raw materials and elevates RTEs to the ranks of strategic resources (Massari and Ruberti, 2013: 40).

Figure 1. Applications of Rare Earth Elements



Reference: (Ministry of Energy and Natural Resources, 2023).

Rare earth elements (REEs) are among the strategic raw materials that play critical roles in both traditional industrial processes and low-carbon energy technologies. These elements are used extensively in catalyst and permanent magnet production, while also playing a significant role in the development of special metal alloys, optical glasses, and high-performance electronic components. The superior magnetic, optical, and electronic properties of REEs enhance the performance of advanced technology products and are therefore considered essential inputs for modern industry (Lepan, 2021).

Especially, alloys formed by neodymium (Nd) and samarium (Sm) with various metals enable the production of strong magnets that can maintain their magnetic properties even under high-temperature conditions. This is one of the main reasons why these elements are preferred in the defense industry, aerospace, electronic systems, and precision engineering applications. Used in technologies requiring high strength and performance, these magnets contribute to higher efficiency in products even when designed in smaller sizes (Günsan, 2024: 153).

Given the strong relationship between technological innovation capacity and economic growth, the future importance of RTEs becomes even more apparent. Digitalization, energy transition, and the widespread adoption of advanced manufacturing technologies are causing a continuous increase in demand for these elements. Indeed, permanent magnets produced from alloys containing elements such as neodymium, samarium, gadolinium (Gd), dysprosium (Dy), and praseodymium (Pr) are among the essential components of many strategic products such as computers, audio and video systems, electric vehicles, communication infrastructures, and military equipment. Thanks to these magnets, it is possible to develop more compact,

lightweight, and energy-efficient devices. Rare earth elements have become more than just inputs for specific industrial applications; they are a fundamental element of high-tech production and global competitiveness. Therefore, access to RTE resources, processing capacity, and supply security are of strategic importance for the technological independence and sustainable economic development of countries (Gündoğdu, 2022: 112).

The procurement and processing of raw materials (RWMs), considered critical and strategically important on a global scale, are becoming increasingly crucial for countries' technological independence and competitiveness. In this context, when Türkiye's sustainable development goals are evaluated in terms of high-tech production and industrial transformation, establishing a domestic and integrated supply chain for RWMs is of paramount importance. Furthermore, transforming these resources into high value-added products will both reduce external dependence and provide long-term contributions to the national economy. Therefore, RWMs should be considered not only as a raw material group but also as a fundamental element of technological development and economic competitiveness.

3. THE STRATEGIC IMPORTANCE OF RARE EARTH ELEMENTS AND CRITICAL MINERALS

Underground resources are of fundamental importance for the sustainability of countries' agricultural, industrial, and technology-oriented economic activities. Therefore, the diversity and capacity of a country's mineral reserves are directly related to its level of economic development. In particular, the limited supply, concentration in certain countries, widespread use in strategic sectors, and low substitution possibilities make some minerals more critical. These resources, which play an indispensable role in energy transformation, advanced technology production, and the defense industry, are defined as "strategic minerals" and are of great importance not only for their economic value but also from a political and geopolitical perspective. This situation shows that strategic minerals are not only an economic element today but also one of the fundamental factors determining the global competitiveness of states (Burat, 2025: 6).

With the energy transition and digitalization process, critical raw materials have ceased to be resources evaluated solely within the scope of economic supply and demand balance, and have become a fundamental element of technological independence, national security, and industrial policies. In this context, rare earth elements have gained strategic importance due to their indispensable role as components of clean energy technologies and digital infrastructures. The concentration of refining and separation capacity, rather than mining, in certain countries increases global supply dependency and geopolitical vulnerabilities. However, this situation also creates a significant economic and technological opportunity for resource-owning countries. From Turkey's perspective, rare earth elements hold a strategic position within the framework of energy transition goals, the need for domestic production in the defense industry, and circular economy applications. The utilization of secondary resources especially has the potential to provide significant advantages to Türkiye in terms of both environmental sustainability and economic added value.

Rare earth elements and critical minerals are at the heart of global competition today due to their crucial roles in energy transformation and high-tech production. These resources, heavily used in green energy applications such as electric vehicles, renewable energy systems, communication technologies, space exploration, nuclear technology, solar panels, wind turbines, and LED technologies, have the potential for even greater demand in the future. China’s dominant position in rare earth metal and mineral production creates significant concerns for the US and Western countries regarding supply security and economic

independence (Atabey, 2025: 14). Therefore, strategic minerals have become a fundamental element not only of economic development but also of national security policies. It is predicted that in the future, international competition will focus on controlling mineral resources on land, sea, and oceans. In this process, countries with technological and economic superiority gain a more advantageous position in the exploration and exploitation of underground resources. For Turkey, processing strategic minerals into high value-added products instead of exporting them as raw materials is considered a crucial necessity, both for economic gain and for achieving a stronger position in global competition.

Rare earth elements are gaining strategic importance, particularly in the defense industry, making their sustainable and sufficient production critical for countries. Samarium-cobalt (Sm-Co) and neodymium-iron-boron (NdFeB) magnets especially are widely used in radar and electronic warfare systems due to their superior thermal and magnetic properties. The need for periodic replacement of samarium-based magnetic components used in Aegis Spy-1 radar systems demonstrates that the need for rare earth elements in defense technologies will continue in the long term (Aslan and Say, 2022: 169). This situation reveals that developing the production capacity of rare earth elements is a crucial requirement for reducing external dependence in the defense industry and strengthening strategic security.

The increasing strategic importance of rare earth elements has led states and multinational corporations to develop long-term policies regarding raw material security. While some countries aim to reduce external dependence by increasing domestic production capacity, others are establishing economic and diplomatic collaborations with resource-rich countries. The dependence of fields such as high technology, defense industry, artificial intelligence, and space technologies on rare earth elements places these resources at the center of global power competition. Rare earth elements play an indispensable role, particularly in critical defense applications such as laser systems, missile technologies, and satellite communication infrastructures. China’s export restrictions on rare earth elements to Japan in 2010 and similar steps taken recently in trade tensions with the US clearly demonstrate that these resources can be used as a geopolitical tool. Considering that energy and natural resources have historically played a decisive role in international crises, it is assessed that rare earth elements will continue to be one of the fundamental elements of economic, political, and strategic competition in the future (National Intelligence Academy, 2025: 9).

Rare earth elements (REEs) are indispensable strategic raw materials in today's high-tech production processes. Used in many critical areas, especially in the defense industry, these elements play a significant role in the production of components resistant to high temperatures, wear, and corrosion. The shift away from fossil fuels towards low-carbon energy systems is rapidly increasing global demand for REEs. According to the International Energy Agency's predictions, the need for these elements will grow exponentially in the coming years as part of the clean energy transition. However, the fact that global production, processing, and refining capacity is largely controlled by China creates a serious supply security problem for developed economies such as the US, the European Union, and Japan. Therefore, these countries are trying to reduce their dependence on foreign sources through new mining investments, recycling technologies, and the search for alternative resources (Türkmen and Üncü, 2024). Especially China’s restrictions on technology transfer and its dominant position in the global supply chain make rare earth elements not only an economic but also a geopolitical and strategic power element.

Rare earth elements are no longer just economically valuable natural resources; they have become strategic components that have a decisive impact on energy transition,

technological independence, defense capabilities, and geopolitical power balances. Global digitalization, green energy policies, and high-technology-focused production processes are increasing dependence on these elements every day. The concentration of production and refining capacity in certain countries creates fragility in global supply chains, leading states to seek new strategic solutions. In this context, possessing not only the resources but also the capacity to extract, process, refine, and develop high value-added products is of critical importance. From Turkey's perspective, the effective utilization of rare earth elements stands out as a long-term strategic necessity for economic development, industrial localization, energy security, and increased international competitiveness.

4. INTERNATIONAL POLITICAL AND ECONOMIC IMPACTS OF RARE EARTH ELEMENTS

Rare earth elements have gained importance in both energy and broader economic security discussions due to their wide range of applications and highly concentrated supply chains. Despite being relatively abundant in the Earth's crust, this group of 17 elements is called rare because economically viable concentrations are rare and they are rarely found in pure form. Their chemical similarities make separation difficult during the extraction process, while their distinct physical and magnetic properties give each rare earth element a different value for various technological applications.

Today, assessments of critical and strategic raw materials are no longer considered solely within the framework of economic criteria; they are examined from a holistic perspective, considering geopolitical balances, technological developments, and sustainability goals. Comparing the critical raw material inventories published by international actors such as the USA, the European Union, Japan, and NATO reveal a significant overlap in minerals essential for energy transition, digital technologies, and the defense industry. In this context, rare earth elements have transcended being mere basic inputs used in industrial production, achieving a crucial position in terms of strategic autonomy, economic resilience, and supply chain security. Global developments demonstrate that competitive advantage in the field of critical minerals can be achieved not only by possessing natural resource reserves but also by processing, refining, and integrating these resources with advanced technologies (Yüce et al., 2025).

In evaluating the rare earth elements market, reserve quantities or production volumes alone are not sufficient indicators; the dynamics in this field need to be addressed with a holistic approach encompassing all stages of the value chain. While the rapid increase in global demand encourages new mining investments, environmental regulations, high investment costs, technical expertise requirements, and social acceptance processes make it difficult to increase supply capacity in a short time. In the rare earth elements sector, where processing and refining activities are concentrated in certain countries, these constraints lead to more pronounced supply-demand imbalances and increased market vulnerabilities (Burat, 2025:10).

Rare earth elements (REEs), which have become the cornerstone of modern industry, play an irreplaceable role in the production of high-tech products such as wind turbines, electric vehicle batteries, smartphones, and advanced medical devices (Akın, 2026; Günsan, 2024). With the global economic system shifting from a fossil fuel-dependent to a mineral-intensive structure, these elements have begun to be identified as strategic assets of the 21st century (Günsan, 2024; Uğur and Abbasigil, 2024). Despite their widespread presence in the Earth's crust, the technical difficulty and high environmental costs of their extraction and refining processes have led to an overconcentration of production capacity in certain regions, such as China (Akın, 2026; Günsan, 2024). China's monopoly control over approximately 90% of global RTE production, and especially refining capacity, creates a structural market problem in

global supply chains and poses a serious supply security risk for Western industrialized economies (Günsan, 2024; Uğur and Abbasigil, 2024).

On the political level, rare earth elements have become central to international relations as they have begun to be used as a "technological weapon" or a strategic pressure tool in interstate diplomatic crises (Günsan, 2024; Uğur and Abbasigil, 2024). Particularly in the global competition known as the "trade wars" between the US and China, the vital importance of these elements in the defense industry and semiconductor technologies has made the struggle more intense and multifaceted (Akın, 2026; Uğur and Abbasigil, 2024). In response to export restrictions imposed by China, actors such as the US, the European Union, and Japan have developed critical raw material strategies to protect their national security and technological sovereignty, forging new strategic alliances with countries like Australia and Canada (Akın, 2026; Günsan, 2024). This process, within the framework of the "clean energy paradox" clearly reflects the tension between the goal of achieving a low-carbon future and the geopolitical struggle for dominance over the strategic resources required for this goal (Akın, 2026).

5. GLOBAL POWER STRUGGLE AND GEOPOLITICAL COMPETITION AROUND RARE EARTH ELEMENTS

China has become a decisive global player in the field of rare earth elements and critical minerals. This is not only due to its reserve capacity but also to the planned, state-supported, and strategic industrial policies it has systematically implemented for many years. The production and export-oriented approach adopted, particularly since the 1980s, has enabled China to achieve a central position in the global RTE supply chain (Humphries, 2015). China has developed an integrated production model encompassing all processes, from mining to separation, refining, and the production of final technology products. Through this vertical integration, the country has significantly reduced production costs, gained a competitive advantage in the international market, and made it difficult for many competing producers to achieve economic sustainability (Kumar and Vishwanathan, 2025). Furthermore, China's dominance in the RTE field not only provides economic gains but also serves as a significant geopolitical tool, increasing its global influence in strategic sectors such as high technology, green energy, and the defense industry.

China's global dominance over rare earth elements and critical minerals is not limited to mining activities; it is based on control over a broad supply chain encompassing processing, refining, and advanced manufacturing processes. Currently, China, which accounts for most of the global rare earth production, has become a decisive player in the global market, particularly due to its dominant position in refining and separation capacity. This situation has created a dependency structure on China for many countries, primarily the US and the European Union, in their energy transition, digitalization, and high-tech goals. China's occasional export restrictions demonstrate that rare earth elements are considered not only for their economic value but also as a geopolitical tool. Export restrictions imposed during the diplomatic crisis with Japan, and limitations on certain minerals critical to semiconductor production, clearly show that China can use these resources as a strategic leverage tool (Hammond and Brady, 2022: 638). These developments have caused serious concerns in Western countries regarding supply security, technological independence, and national defense capabilities. Therefore, the US, the European Union, and allied countries have begun to develop comprehensive policies to create alternative supply networks, increase domestic production capacity, and diversify critical mineral supply chains in order to reduce their dependence on China (Akın, 2026: 24).

The United States views critical minerals and rare earth elements not only as economic resources but also as vital elements for national security and strategic independence.

Accordingly, the US has begun to pursue more comprehensive and interventionist policies aimed at reducing its dependence on foreign sources in these areas. Especially, under the Defense Production Act (DPA) enacted in 2022, significant financial support has been provided to increase domestic rare earth element and critical mineral production capacity (Hammond and Brady, 2022: 634). This approach is considered a reflection of the US's efforts to protect supply security in the energy transition, defense industry, and advanced technology sectors, and to increase its strategic competitiveness against China.

The European Union is developing more systematic and strategic policies to reduce its increasing external dependence on critical raw materials and rare earth elements. In this context, the Critical Raw Materials Act (CRMA), which came into force in 2023, contains important regulations aimed at strengthening the Union's supply security. With this regulation, the EU aims to prevent excessive dependence on a single country for any critical raw material and to keep this dependency below a certain level (Righetti and Rizos, 2023: 70). This approach is seen as an indication of the effort to increase economic resilience, strengthen strategic autonomy, and pursue green transformation goals with a more secure sourcing structure, particularly against China-centric supply chains.

Australia and Canada stand out as reliable strategic partners for Western countries thanks to their rich mineral reserves, advanced mining infrastructure, and stable political structures. Australia, in particular, is a leader in global lithium production and possesses significant resources of many critical minerals, especially rare earth elements (Britt and Czarnota, 2024: 1019). Canada, on the other hand, has vast reserve potential in nickel, cobalt, lithium, and rare earth elements, and is increasing its investments in these areas as part of its critical mineral strategies. Both countries play a significant role in the US and European Union's policies to reduce dependence on China-centric supply chains (Akın, 2026: 25). This situation demonstrates that Australia and Canada are not only suppliers of natural resources but also geopolitically influential actors in terms of global energy transformation and strategic mineral security.

Despite possessing extremely rich reserves of critical minerals and strategic raw materials, the African continent occupies a paradoxical position in global competition. The Democratic Republic of Congo especially plays a central role in critical supply chains, accounting for a large portion of global cobalt production, while South Africa stands out as one of the most important sources of platinum group metals. However, this abundance of natural resources does not always translate into sufficient economic development and social welfare. This situation gives rise to the approach described in the literature as the "resource curse" which states that abundance of natural resources can be accompanied by economic vulnerabilities, governance problems, and development imbalances (Boafo et al., 2024: 9). Therefore, while Africa is an indispensable part of global supply chains, it also faces structural challenges in terms of resource management and development processes.

From the perspective of global power struggles and geopolitical competition, China's dominant position in manufacturing and processing capacity is driving Western countries to develop alternative supply sources and strengthen their strategic autonomy. In this context, while the US, the European Union, and other developed countries are trying to reduce their dependence through policies supporting domestic production and international collaborations, resource-rich countries like Australia and Canada are emerging as critical partners. However, as seen in the case of Africa, resource wealth is not always synonymous with development, and governance and integration into the value chain are becoming decisive factors.

6. DISCUSSION AND CONCLUSION

The study revealed that rare earth elements and critical minerals have evolved from being merely economically valuable natural resources to becoming strategic elements influencing global power balances in today's international system. Rapid advancements in energy transition, digitalization, the defense industry, and advanced technology production have increased global demand for these resources; however, the concentration of production, extraction, and refining processes in certain countries has highlighted supply security issues and geopolitical vulnerabilities. China's dominant position in the rare earth element supply chain, especially demonstrates that these resources can be used not only as economic tools but also as elements of diplomatic pressure and strategic competition.

The research findings show that the determining factor in global competition is not simply possessing rich reserves, but rather the capacity to create an integrated value chain encompassing the extraction, processing, refining, and transformation of these resources into high-value technological products. Therefore, competition in the critical minerals sector has taken on a multi-dimensional character, differing from the classic struggle for resource sharing, requiring a combined assessment of technology, industrial policies, innovation capacity, and strategic governance mechanisms. Policies by actors such as the US, the European Union, and Japan to create alternative supply networks, invest in recycling technologies, and encourage domestic production are also concrete indicators of this transformation.

On the other hand, as seen in the example of Africa, natural resource wealth alone does not guarantee economic development. Effective resource management, transparent governance, institutional capacity, and the ability to integrate into global value chains in a high value-added manner play a decisive role in transforming these resources into social welfare. This situation shows that in the age of critical minerals, "resource management" is as strategically important as "resource ownership." From Turkey's perspective, rare earth elements and critical minerals offer significant opportunities in terms of energy security, localization in the defense industry, high-tech production, and industrial transformation. However, identifying and extracting mineral reserves alone is not enough to effectively utilize these opportunities. Developing domestic separation and refining capacity, supporting research and development activities, strengthening university-industry-public sector collaborations, and expanding recycling and circular economy practices are necessary to create a long-term and holistic critical mineral strategy. In this way, Turkey can move away from a structure based on raw material exports and reach a position that produces high added value, strengthens its technological independence, and increases its global competitiveness.

In the 21st century, one of the important dimensions of geopolitical competition is shaped around critical minerals and rare earth elements that make this energy possible, rather than energy resources themselves. In this process, where the relationship between green transformation goals and strategic resource security is increasingly strengthening, economic resilience, technological sovereignty, and national security of states will largely depend on the success of critical mineral policies. Therefore, it is considered that rare earth elements and critical minerals will continue to be at the center of international politics, global economic competition, and strategic power struggles in the future.

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