



Development of Rare Earth Elements for Indonesia's Geostrategy and National Resilience

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Article Info:	Abstract
Keywords: Critical Minerals; Downstreaming Policy; Geostrategy; National Resilience; Rare Earth Elements.	Purpose: Indonesia's prospects for developing rare earth elements (REEs) as strategic resources are examined amid geopolitical competition, concentrated supply chains, and geoeconomic fragmentation, with implications for national resilience. Design/methodology/approach: A qualitative descriptive synthesis of selected academic literature, institutional reports, policy documents, and relevant online sources applies geostrategy and the triple bottom line. <i>Asta Gatra</i> provides an interpretative framework for assessing national resilience. Findings: Indonesia's REE-bearing mineral potential contrasts with limited processing capacity, technological dependence, and fragmented regulation. Concentrated global refining increases exposure to supply disruptions. Domestic technological development, coordinated mineral governance, and strategic partnerships could strengthen industrial capacity and resource security. These opportunities relate to the natural resources dimension of <i>Tri Gatra</i> and the economic, political, and defence and security dimensions of <i>Panca Gatra</i> , subject to environmental safeguards and equitable social benefits. Implications: Policy priorities include processing technology, workforce development, regulatory coherence, responsible investment, and international cooperation. Further research should evaluate technical and commercial feasibility, institutional readiness, and measurable resilience outcomes. Originality/value: Integrating geostrategy, sustainability, energy security, and <i>Asta Gatra</i> links mineral governance and domestic value creation to interconnected dimensions of Indonesia's national resilience.
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INTRODUCTION

Over the past two decades, rare earth elements (REEs) have evolved into increasingly vital strategic resources for modern technology industries. Their physical and chemical properties facilitate their use in a wide range of high-value technologies, including solid-state drives, flat-panel displays, rechargeable batteries, radar and missile systems, high-strength permanent magnets, and electric generators (Scerri, 2025; Voncken, 2016). Industrial reliance on these minerals has solidified the role of REEs in global economic, technological, energy, and security competition. Consequently, the advancement of modern technology has heightened the imperative for nations to secure REE supplies as a component of their industrial capacity and national resilience.

China holds a dominant position in the international supply of REEs, making these minerals a key element of its geopolitical rivalry with the United States. This competition encompasses access to resources, control over supply chains and processing technologies, and the ability to sustain strategic industries. China's restrictions on REE exports have exacerbated bilateral trade tensions. In response, the United States threatened to impose tariffs of up to 100 percent on Chinese imports and postponed planned bilateral talks between President Donald Trump and President Xi Jinping (Leba, 2025). China's Ministry of Commerce subsequently asserted that the government implemented these restrictions to regulate the use of strategic materials in high-tech military industries, rather than as a retaliatory measure in a trade war.

REEs are widely distributed throughout the Earth's crust, yet concentrations suitable for economic extraction are relatively limited. Generally, REEs are categorised as light rare earth elements and heavy rare earth elements. Industry utilises light rare earth elements in water purification, hydrogen storage and absorption, and various catalytic reactions. Heavy rare earth elements support the production of energy-efficient phosphors and a range of technological devices, spanning from computer and mobile phone screens to optical system components, fibre-optic cables, and communication network repeaters (International Energy Agency, 2024). These diverse applications extend the strategic role of REEs across the energy, civil technology, and defence sectors. The renewable energy industry also relies on REEs to support the development of wind power plants and the manufacturing of electric vehicles.

The accelerating transition from fossil fuels to renewable energy continues to drive the need for REEs. The growth of electric vehicles and the development of renewable energy power plants are fuelling demand for minerals essential to batteries, electric motors, generators, and various energy technology components. The International Energy Agency (IEA) projects that global demand for rare earth elements will increase three- to seven-fold by 2040 (Fatunde, 2024). These demand projections highlight the strengthening link between the security of strategic mineral supplies and the sustainability of the energy transition. Consequently, energy security hinges on a nation's ability to ensure the availability of energy sources, strategic minerals, processing technologies, and supply chains that underpin the national energy system.

Rising global demand has reinforced China's position, as the country accounted for approximately 60 per cent of global production in 2021. China subsequently expanded export restriction policies covering gallium, germanium, and graphite in 2023. These policies underscored the shift in US-China competition toward resource geopolitics. Rare Earth Elements (REEs) now serve as strategic instruments influencing technology, energy, and security policies. The United States responded to these developments by considering export restrictions on Boeing aircraft components to China (Rare Earth

Exchanges, 2025b). The responses from both nations highlight the direct link between resource control, technology, and supply chain security within the context of global power competition. Nations that control strategic minerals and their processing capacities gain stronger leverage in safeguarding their economic, technological, energy, and defence interests.

The concentration of REE production and processing in a limited number of countries creates vulnerabilities for nations reliant on external supplies. Supply disruptions can hinder sectors such as technology, electric transportation, digital systems, renewable energy development, and defence. Consequently, energy security is closely tied to a nation's ability to secure the strategic minerals that underpin modern energy technologies. Capacities regarding exploration, processing, refining, technological mastery, and supply chain diversification determine a nation's ability to respond to external pressures. From a national resilience perspective, these capabilities strengthen a country's adaptability to shifts in global geopolitics and geoeconomics.

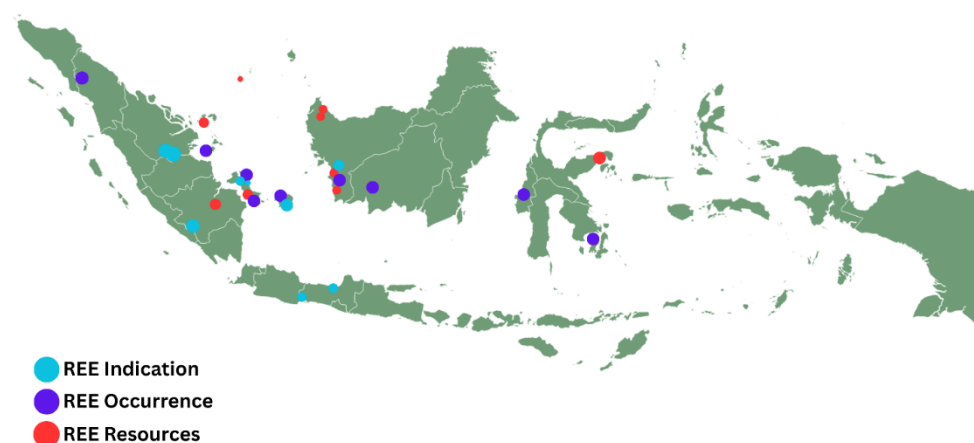


Figure 1. REE Investigation Map in Indonesia
Source: Adapted from Badan Geologi (2019)

Global dynamics place Indonesia in a strategic position due to its Rare Earth Element (REE) potential derived from minerals such as tin, bauxite, and nickel. These resources are distributed across Bangka Belitung, Kalimantan, and Sulawesi (Permadi, 2021). The availability of REE resources presents an opportunity for Indonesia to strengthen its position in the global strategic mineral supply chain. However, Indonesia currently lacks the adequate domestic capacity to fully realise its REE potential. REE development in the country remains focused on the initial exploration stage, while limitations in metallurgical and refining technologies, a lack of comprehensive geological data, and unintegrated downstreaming policies constrain the growth of the national REE industry.

The gap between resource potential and domestic processing capacity limits Indonesia's ability to generate value-added products from REEs. Growing global demand presents an opportunity for Indonesia to transition from a raw material supplier to a producer of high-value materials and components. Achieving this status requires mastering the value chain, spanning from upstream extraction to downstream processing. A comprehensive roadmap could guide the integrated development of industrial capacity,

technology, human resources, regulations, and investment. Strengthening this value chain could lay the foundation for Indonesia to evolve into a producer of high-quality technology components (Ika, 2025).

The development of Rare Earth Elements (REEs) is directly linked to national energy security, as the transition toward electric vehicles and renewable energy drives up demand for the strategic minerals that underpin modern energy technologies. This rising demand compels Indonesia to strengthen its domestic capabilities in processing mineral resources and mastering processing technologies. Reliance on foreign mineral supplies and technologies can heighten national vulnerability, particularly when supply chain disruptions or policy shifts by supplier nations restrict the availability of raw materials and technology. Consequently, Indonesia must bolster its domestic processing capacity, technological mastery, and REE value chain development to meet national industrial needs. Strengthening domestic capacity can foster energy independence, reduce external reliance, and enhance the nation's ability to respond to shifts in the strategic landscape.

The link between REE development and energy security is increasingly critical, as Indonesia's vast mineral potential has not yet been fully matched by its capacity to generate value-added products. Limitations in processing technology, refining capacity, geological data availability, and policy coordination continue to hinder the establishment of a competitive REE industry. Therefore, Indonesia requires an REE development strategy that integrates resource management, industrial downstreaming, technological mastery, and energy security strengthening into the national resilience agenda. Cross-sectoral integration can reinforce national self-reliance, boost domestic industrial capacity, and expand Indonesia's position within the global strategic mineral supply chain.

Given the interplay between resource potential, limited domestic capacity, energy security, and shifting global supply chain structures, this study examines Indonesia's strategy for developing REEs as a geostrategic resource to strengthen national resilience. The study analyzes Indonesia's position within the global REE supply chain, currently dominated by China, and identifies the opportunities and challenges affecting its development at the national level. The analysis encompasses exploration, mining, processing and refining technologies, investment, cross-sectoral regulations, radioactive material oversight, and workforce competency development. Furthermore, this study assesses the contribution of REE development to energy security as a component of Indonesia's national resilience. Ultimately, the analysis aims to explain how Indonesia can develop REEs as a geostrategic instrument to strengthen self-reliance, reduce vulnerability to global supply chain disruptions, and enhance national resilience.

LITERATURE REVIEW

Theoretical Studies

This study is grounded in geostrategy, which has evolved from a predominantly military concept into an approach encompassing political, economic, diplomatic, and technological dimensions of international relation (Cebotari & Budurina-goreacii, 2021). Drawing on Mahan, Mackinder, and Spykman, geostrategy links geographic position with political power and explains how states use space and instruments of power to pursue national objectives amid global competition. It therefore informs foreign policy, capacity building, and national security strategies. However, its application to natural resources and modern technology remains underdeveloped. This study addresses that gap by

examining control over strategic minerals as a geostrategic instrument for strengthening Indonesia's national resilience.

Grygiel (2006) defines geostrategy as a state's capacity to leverage geographic location, natural resources, and the strategic environment to protect and advance national interests, with control over high-value resources supporting autonomy and global competitiveness. Högselius (2019) extends this perspective by showing that resource geopolitics also depends on integrating resources into industrial infrastructure, transport networks, and technological systems. States that connect resource potential to global supply chains can thereby strengthen their international bargaining power.

Traditional geostrategy links geography, strategic resources, and the distribution of power. Wani (2022) shows how territorial position and security rivalry shape regional dynamics, while Cannon et al. (2025) demonstrate the continuing relevance of Heartland and Rimland perspectives in explaining how strategic territories, critical resources, and connectivity influence regional and global power. Contemporary geostrategy therefore extends beyond territorial control to encompass strategic resources and their integration with industrial and technological systems. Manana (2021) links geostrategic positioning to competition over energy resources and regional alliances, while (Yu, 2024) shows that China's rare earth dominance reflects deliberate integration of resource control, industrial capability, and global influence, despite environmental costs. However, limited research explains how resource-rich developing countries outside major power blocs can use strategic minerals to strengthen national resilience. This study addresses that gap by examining how Indonesia can leverage REE development to reduce external dependence, strengthen industrial sovereignty, and enhance bargaining power amid US-China competition.

This approach assesses whether Indonesia's rare earth element (REE) development strategy aligns with geostrategic interests and sustainability principles. Sustainability is evaluated through the conventional Triple Bottom Line (TBL) dimensions of economic value, social benefits, and environmental protection, with innovation capability and regulatory quality treated as enabling factors rather than additional dimensions. For national resilience, the analysis applies the *Asta Gatra* framework, focusing on the natural resources, economic, political, and defence and security dimensions most directly related to REE development. Energy resilience is positioned as a cross-sectoral capability linking and reinforcing these dimensions.

Empirical Studies

Empirical research on critical minerals has increasingly examined the relationship between supply security, economic resilience, geopolitical competition, and environmental sustainability. Shiquan and Deyi, (2022) examine the changing security structure of critical mineral supply chains and show that technological development and geopolitical competition have reshaped patterns of resource dependence. Political intervention, market concentration, and disruptions arising from the COVID-19 pandemic increase the vulnerability of global supply chains. Shiquan and Deyi (2022) also evaluate net import dependency and multidimensional indicator systems as approaches to supply risk assessment and advocate a broader model of mineral security governance covering the full resource lifecycle from exploration to recycling. However, the analysis stops short of integrating security considerations across the entire supply chain. The limitation has

relevance for Indonesia because limited domestic processing capacity and weak downstream integration continue to constrain the development of mineral value chains.

Hensel (2023) extends the discussion by examining how political tensions, export restrictions, limited refining capacity, and uneven geographical distribution affect strategic mineral supply chains. The analysis identifies cooperation between government and industry, investment in technology, and diversification of supply sources as essential components of supply resilience. Hensel (2023), however, gives limited attention to the capacity of resource-rich developing economies to transform domestic mineral resources into higher-value products. The omission is important because mineral ownership alone does not guarantee stronger economic or strategic capacity. Domestic processing, technological capability, and value creation determine whether producer countries can move beyond dependence on exports of raw materials and semi-finished products.

Vivoda et al. (2024) broaden the analysis from supply vulnerability to the restructuring of the global political economy. Rising dependence on critical minerals increasingly shapes geopolitical trade alignments and strengthens the relationship between supply security and national bargaining power. Vivoda et al. (2024) demonstrate that supply chain disruption, environmental risk, and export controls imposed by major producers contribute to deeper global economic fragmentation. The study nevertheless provides limited explanation of how resource-rich developing economies can convert mineral endowments into stronger bargaining positions. Indonesia therefore presents an important case for examining whether control over REE resources, stronger domestic processing capacity, and deeper value chain integration can improve national positioning within global mineral supply chains.

Environmental consequences introduce another dimension into the governance of REE development. Yu, (2024) traces the development of rare earth production in China since the late 1970s and links China's production dominance with growing environmental pressures. Mining and processing activities in Baotou and Ganzhou have contributed to water pollution, soil degradation, and higher health risks for communities surrounding production areas. Yu, (2024) further identifies a persistent gap between sustainable development objectives and extraction practices because environmental remediation has not matched the scale of accumulated damage. Evidence from China, therefore, demonstrates the importance of embedding environmental safeguards throughout REE development, beginning with exploration and continuing through processing and downstream industrialisation. For Indonesia, environmental governance becomes essential to prevent economic gains from REE development from weakening long-term development sustainability.

Vukovic et al. (2025) add a broader sustainability perspective by applying the *triple bottom line* concept across 74 Russian regions between 2013 and 2018. The results show positive and significant associations between regional economic growth and investment in research and development, business creation, poverty reduction, and lower emission intensity. Although the analysis does not directly examine strategic minerals, the empirical evidence demonstrates that durable development depends on the interaction between economic performance, social welfare, and environmental protection. The findings therefore provide an empirical basis for applying the *triple bottom line* perspective to REE development in Indonesia. Economic value creation can then be assessed together with social benefits and environmental sustainability rather than treated as an isolated development objective.

Taken together, previous studies establish supply security, processing capacity, geopolitical competition, environmental risk, and sustainability as major dimensions of critical mineral governance. Existing research, however, largely examines these dimensions through separate analytical perspectives. The literature has yet to explain comprehensively how a resource-rich developing economy can connect control of REE resources, downstream industrial development, environmental sustainability, energy security, and geostrategic bargaining power within a national resilience framework. The present study addresses this gap by examining REE development in Indonesia through geostrategic and *triple bottom line* perspectives and by assessing how resource development can support energy security and strengthen national resilience.

METHODS

This study adopts a qualitative descriptive design based on a literature review to examine the development of rare earth elements (REEs) as a geostrategic resource for strengthening Indonesia's national resilience amid strategic competition between the United States and China. The analysis focuses on Indonesia's position within the global REE supply chain, domestic downstreaming policies and regulatory developments, technological capability, sustainability, energy security, and their implications for national resilience (Siyoto & Sodik, 2015; Sukardi, 2021). Secondary data were obtained through a literature review (Danial & Wasriah, 2009) using academic publications, institutional and policy reports, and selected credible online sources. The literature search covered sources available up to August 2026 and was conducted through Google Scholar, Scopus, and relevant official institutional websites. Sources were included based on their relevance to REEs, geostrategy, sustainability, energy security, and national resilience, while sources lacking clear authorship, institutional credibility, or direct analytical relevance were excluded. The final evidence base comprised approximately 40 sources, with peer-reviewed publications and official reports prioritised for core analytical claims and news or online media used only as supplementary evidence for recent developments. The evidence was synthesised across resource availability, processing capacity, supply vulnerability, governance, energy security, and sustainability; the resulting themes were interpreted against the relevant *Asta Gatra* dimensions.

RESULT AND DISCUSSION

Rare Earth Elements as a Strategic Commodity

Rare earth elements (REEs) comprise elements with atomic numbers 21, 39, and 57 through 71, characterised by fluorescent, conductive, and magnetic properties. While REEs are relatively widely distributed in the Earth's crust, economically viable concentrations are more limited and often associated with uranium and thorium (Science History Institute, n.d.). Geochemical research also indicates that REEs can be found in unconventional sources. Bagdonas et al. (2026) identified concentrations of REEs and yttrium in coal-bearing strata within the Powder River Basin, United States; these concentrations varied based on stratigraphic position, depositional environment, groundwater interaction, hydrothermal activity, and volcanic ash deposition. These findings expand the potential for utilising coal-bearing sediments and mining waste as supplementary sources of critical minerals.

The strategic role of REEs has evolved alongside technological advancements. Demand began to rise with the advent of colour television and intensified during the Cold War, when samarium-cobalt magnets facilitated the development of high-capability radar systems (Sandria, 2021). China subsequently established a large-scale REE mining and refining industry starting in the 1970s, solidifying its dominance through competitive production costs, international investment, and export controls (Mitra Tambang Sentosa, 2025). These developments transformed REEs from mere industrial raw materials into strategic commodities that influence the structure of global supply chains.

The distribution of production and reserves reveals a high degree of concentration within the global rare earth element (REE) supply chain. China produced approximately 270,000 tonnes in 2024, while the U.S. Geological Survey reported an estimated 270,000 tonnes for 2025; global production increased from 380,000 tonnes in 2024 to an estimated 390,000 tonnes in 2025. China also holds the largest reserves at 44 million tonnes, followed by Brazil (11 million tonnes) and Australia (6.3 million tonnes). This structure indicates that resource ownership and production capabilities remain concentrated in a small number of nations; consequently, control over REEs carries significant economic and geostrategic implications. The USGS has also emphasised that economically mineable REE deposits are far more limited in concentration than their overall abundance in the Earth's crust suggests.

The strategic value of REEs is increasingly significant due to their applications in permanent magnets, electronic devices, renewable energy technologies, electric vehicles, and defence systems. Neodymium and praseodymium are utilised in permanent magnets, while NdFeB and SmCo magnets are essential for wind turbines and electric vehicles (Mitra Tambang Sentosa, 2025). The defence industry also relies on REE magnets for various high-tech systems (Rare Earth Exchanges, 2025a). This rising demand means that the security of REE supplies is directly linked to the sustainability of the technology, energy, and defence sectors.

China's dominance reinforces the geopolitical dimension of REEs. Export restrictions have prompted the United States to respond with tariff policies and limitations on specific transactions (Leba, 2025; Rare Earth Exchanges, 2025b). The IEA projects continued growth in REE demand through 2040 (Fatunde, 2024), intensifying competition regarding access, processing, and supply security. Control over these strategic minerals thus serves as a source of bargaining power, as producer nations can influence the industrial viability of countries that rely on external supplies.

Table 1. World Mine Production and Reserves

Country	Mine Production		Reserves
	2024	2025 (est.)	
China	270,000	270,000	44,000,000
United States	45,500	51,000	1,900,000
Australia	29,000	29,000	6,300,000
Burma	27,000	22,000	NA
India	2,900	2,900	NA
Russia	2,600	2,600	3,800,000
Thailand	2,100	4,800	NA

Country	Mine Production		Reserves
	2024	2025 (est.)	
Nigeria	1,500	1,500	NA
Madagascar	1,400	2,700	NA
Brazil	560	2,000	11,000,000
Vietnam	300	150	3,500,000
Malaysia	140	110	710,000
Greenland	-	-	1,500,000
Tanzania	-	-	890,000
South Africa	-	-	860,000
Canada	-	-	830,000
Other countries	1,000	550	NA
World Total (Rounded)	380,000	390,000	>75,000,000

Source: U.S. Geological Survey (2026)

Table 1 presents the concentration of global rare earth element (REE) mine production and reserves. For Indonesia, the principal strategic challenge lies in converting mineral resource potential into industrial capability through domestic processing, refining technologies, and integration into downstream markets. Limited industrial capacity increases dependence on foreign processing facilities and exposes mineral-producing countries to global supply chain disruptions, highlighting the importance of domestic value-chain development for industrial competitiveness and supply security (U.S. Geological Survey, 2026; International Energy Agency, 2025).

Figure 2 further illustrates the geographical concentration of global critical mineral refining capacity. China dominates the refining of copper, lithium, cobalt, graphite, and rare earth elements, while Indonesia holds a leading position in nickel refining (International Energy Agency, 2025). The pattern shows that mineral reserves alone do not determine geostrategic influence because processing capability, refining technology, and control over downstream value chains shape a country's ability to convert resources into economic value, technological capability, and bargaining power. Countries exposed to concentrated mineral supply have therefore adopted different strategies to reduce dependency. Germany pursued supply diversification after tighter Chinese export requirements affected major automotive manufacturers, including BMW and Volkswagen (Jackson & Eckert, 2025), by exploring alternative sources and strengthening strategic partnerships (Werkhäuser & Kinkartz, 2025). Japan adopted a broader strategy following China's 2010 REE embargo by expanding strategic stockpiles, investing in Lynas, supporting mining operations in Australia, and developing processing facilities in Malaysia (Meridith & Butts, 2025; Terazawa, 2023). The responses of Germany and Japan show that diversification, technological investment, strategic partnerships, and stronger processing capacity can reduce external dependence and improve resilience to supply disruptions. These lessons are transferable to Indonesia in the form of supplier diversification, targeted technology partnerships, and staged development of domestic processing capacity; however, direct replication is constrained by differences in industrial maturity, institutional capacity, financing, and established strategic stockpiling arrangements.

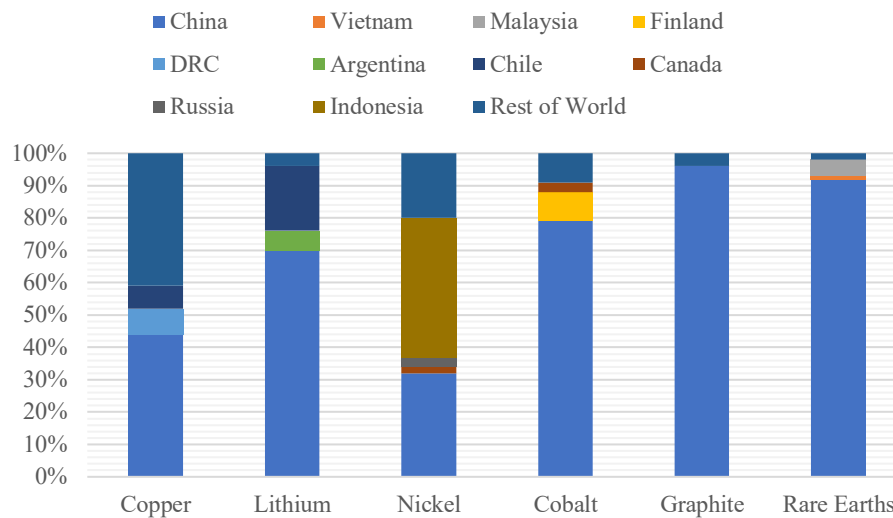


Figure 2. Share of Refined Material Production by Country 2024
Source: International Energy Agency (2025)

Geostrategic analysis provides a broader explanation for the transformation of REEs from industrial commodities into resources with strategic influence. Control over strategic resources can generate long-term economic and political advantages (Cebotari & Budurina-goreacii, 2021; Grygiel, 2006). Högselius (2019) argues that resource dependence acquires geopolitical significance when alternative supplies remain difficult to secure and access to the resource affects the continuity of major economic and technological systems. China's strong position in REE processing therefore extends beyond commercial advantage because control over refining capacity can influence the strategic choices available to dependent countries. Responses from the United States, Germany, and Japan further show how diversification, industrial capacity, and international partnerships can reduce supply vulnerability and strengthen national adaptive capacity. Hanita (2020) similarly identifies the transformation of vulnerability into resilience as an important component of national resilience.

Opportunities and Challenges for Indonesia

The experiences of other nations in mitigating REE supply vulnerabilities offer strategic lessons for Indonesia. Rising global demand presents an opportunity for Indonesia, as its domestic REE resources are associated with tin, bauxite, and nickel deposits found in Bangka Belitung, West Kalimantan, and Sulawesi (Permadi, 2021). However, the domestic industry's capabilities have not kept pace with the available geological potential. Indonesia continues to import lanthanum, cerium, neodymium, praseodymium, and samarium to meet the needs of industries such as pigments, oil refining, ceramics, electric vehicles, permanent magnets, and generators (Setiawan, 2025). This import dependency highlights the gap between REE resource availability and Indonesia's capacity to process these minerals into products of higher economic value.

Limited refining capacity and a lack of mastery over metallurgical technologies exacerbate this gap. Yu (2024) demonstrates that China has built a strategic advantage by controlling the value chain, spanning from mining operations to industrial processing.

Wire (2025) indicates that raw material producers reap more limited economic benefits when other nations control the higher-value processing stages. This comparison underscores that mere resource ownership is insufficient to establish strategic strength. Indonesia must transform its geological potential into processing capacity, technological mastery, industrial capability, and bargaining power within the global supply chain.

Table 2. Distribution of Rare Earth Bearing Minerals in Indonesia

Region	Rare Earth Bearing Minerals	Mining Association
Bangka Belitung	Monazite, Xenotime, Zircon	Tin Mining Tailings
West Kalimantan	Monazite, Xenotime	Heavy Mineral Sands
Riau Island	Monazite	Tin Deposits
West Sulawesi	Monazite	Lateritic Deposits

Source: *Badan Geologi* (2019)

Table 2 illustrates the relationship between Indonesia's REE potential and mining activities that have developed in several regions. Bangka Belitung possesses monazite, xenotime, and zircon associated with tin mining tailings. West Kalimantan holds monazite and xenotime associated with heavy mineral sands, while the Riau Islands have monazite linked to tin deposits. West Sulawesi also contains monazite associated with lateritic deposits. The distribution of these minerals offers Indonesia the opportunity to obtain REEs as by-products of existing mining operations. A strategy of utilising by-products could expand national supply sources and reduce the need to open new primary mines.

Indonesia faces several obstacles in transforming its geological potential into production capacity. The domestic industry still faces limitations regarding separation and purification technologies, while regulatory uncertainty and environmental risks hinder large-scale REE development. The radioactive content associated with monazite and xenotime also necessitates adequate environmental and safety oversight. REE development must also consider community health, social acceptance, and the equitable distribution of economic benefits, particularly in mining and processing areas exposed to environmental and safety risks. Furthermore, a lack of integrated downstream industrial infrastructure limits the ability of domestic companies to convert mineral concentrates into high-value REE oxides. Consequently, Indonesia needs to increase technology investment, strengthen regulatory certainty, establish institutional coordination, and implement consistent environmental management to ensure that REE resources yield economic and geostrategic benefits.

The government is addressing the need to strengthen the value chain through a downstreaming policy. This policy encourages companies to process and refine minerals domestically prior to export, thereby allowing Indonesia to enhance the economic value of its mineral resources (Budiono, 2025). The benefits of downstreaming should also extend to employment creation, local capability development, and broader economic benefits for communities in resource-producing regions. The construction of smelters and processing facilities expands the national industry's capacity to transform raw materials into products ready for subsequent stages of production. The government subsequently reinforced its policy direction through the fourth amendment to the Mineral and Coal Mining Law, approved by the House of Representatives on 18 February 2025 and enacted

as Law of the Republic of Indonesia No. 2 of 2025 on 19 March 2025. The amendment reinforces the national policy framework for mineral governance and value creation (Ministry of Energy and Mineral Resources, 2025; Republic of Indonesia, 2025). Strengthening regulations also grants the state the legitimacy to maintain strategic control over mineral-rich regions as part of a security-orientated approach to resource utilisation (Permadi, 2025b).

The success of REE downstream development depends on regulatory consistency, legal certainty, institutional coordination, and technological capability. Fiscal uncertainty and complex licensing can undermine investment and industrial development (Permadi, 2025c), while collaboration among government, industry, academia, and civil society can strengthen domestic capabilities (Permadi, 2025a). Growing demand for permanent magnets, electric motors, and renewable energy technologies reinforces the strategic importance of domestic REE processing in reducing external dependence and strengthening energy security. Within the *Asta Gatra* framework, these developments could reinforce the natural resources dimension of *Tri Gatra* and the economic, political, and defence and security dimensions of *Panca Gatra* through responsible resource utilisation, industrial competitiveness, regulatory coherence, and secure strategic supply chains. Environmental safeguards and equitable social benefits remain essential to sustainable national resilience.

Indonesia's REE opportunities arise from mineral-bearing deposits, established mining activities, downstreaming policy, and global demand; constraints include separation technology, refining capacity, regulatory uncertainty, environmental risks, and institutional coordination. Under *Asta Gatra*, responsible resource utilisation supports the natural resources dimension of *Trigatra*; domestic value addition and technological capability support the economic dimension of *Panca Gatra*; regulatory coherence and international bargaining affect its political dimension; and continuity of strategic material supplies concerns defence and security. Energy security links these dimensions, while social benefits and environmental safeguards determine whether downstream development strengthens resilience over time.

The analysis identifies Indonesia's main opportunities in REE resource availability, established mining activities, downstreaming policy, and rising global demand, while limitations in processing technology, refining capacity, regulation, environmental management, institutional coordination, and foreign technology remain major constraints. Converting REE resources into geostrategic capability therefore requires stronger technological capacity, investment, governance, environmental protection, and industrial development. Within the *Asta Gatra* analytical framework, REE development is most directly associated with the natural resources, economic, political, and defence and security dimensions, while energy security serves as a cross-sectoral capability that links these dimensions to Indonesia's broader national resilience.

CONCLUSION

The findings show that Indonesia can develop rare earth elements as a geostrategic resource for strengthening national resilience when the country converts its geological potential into domestic processing capacity, technological capability, and a secure mineral supply. Resource availability alone does not create strategic advantage. Limited refining capacity, dependence on imported REE products, regulatory inconsistency, and weak institutional coordination still constrain Indonesia's ability to capture greater value from its mineral resources. Downstreaming policy and the 2025 amendment to the

Mineral and Coal Mining Law provide an important foundation for strengthening domestic value creation, but their effectiveness depends on regulatory consistency, investment certainty, technological development, environmental governance, and coordination between central and regional governments. Stronger domestic REE capabilities could reinforce the natural resources, economic, political, and defence and security dimensions of *Asta Gatra* by improving value creation, supply continuity, regulatory coordination, and strategic autonomy. These capabilities can strengthen national resilience by increasing Indonesia's capacity to anticipate and respond to disruptions in critical mineral supply.

Implementation should follow a clear policy sequence reflecting the responsibilities of the principal actors. In the immediate term, the central government and regulators should prioritise geological data consolidation, licensing clarity, institutional coordination, and effective oversight of radioactive materials. Over the medium term, government, industry, and research institutions should expand processing and refining capacity, strengthen applied research, improve investment certainty, and facilitate technology transfer. In the longer term, collaboration among government, universities, and industry will be essential to develop specialised human capital, deepen technological capabilities, and build strategic international partnerships that strengthen Indonesia's position in global REE value chains. This study draws on secondary literature, institutional reports, policy documents, and media sources and therefore does not assess technical feasibility, commercial viability, or site-specific conditions at individual mining locations. Future research could extend the analysis by integrating geostrategy, resource dependence, supply chain resilience, energy security, and national resilience, while empirical studies using fieldwork, expert interviews, comparative approaches, mixed methods, and technical and economic assessments would help evaluate processing capabilities, institutional readiness, environmental risks, technology transfer, and the measurable contribution of REE development to Indonesia's energy security and national resilience.

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Declarations

All authors contributed to the conceptualisation, analysis, manuscript development, critical review, and approval of the final version. The study received no external funding, and the authors declare no conflict of interest. The authors completed and signed the JLRI Artificial Intelligence Declaration, and Generative AI was used solely to support language editing, clarity, and manuscript presentation. The authors independently verified and remain fully responsible for the scientific content, data, analysis, interpretation, and conclusions. Ethics approval and informed consent were not applicable to this study, while data supporting the findings are available from the corresponding author upon reasonable request.

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