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The IGME-CSIC as the Spanish reference centre for critical and strategic minerals (CEMCE)

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Abstract: Ensuring a secure and sustainable supply of critical minerals is essential for Europe's energy transition and industrial competitiveness. This article presents the proposal to establish the **Centre for Critical and Strategic Minerals (CEMCE)** as a new department within **IGME-CSIC**, acting as Spain's national reference body for exploration, processing, recycling and policy integration. CEMCE will implement the **National Mineral Exploration Programme (PNEM 2025–2029)** and coordinate national capabilities in line with the **EU Critical Raw Materials Act (CRMA)**. A comparative assessment with France, Germany and Italy illustrates best-practice models. The article outlines how CEMCE could contribute to reducing Spain's mineral import dependency in line with the quantitative benchmarks established under the Critical Raw Materials Act (European Commission, 2024), while strengthening domestic value chains and enhancing strategic autonomy.

Keywords: Critical minerals, supply security, energy transition, strategic autonomy, circular economy

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1. Introduction

The secure and sustainable supply of critical and strategic raw materials has become a central concern for the European Union, closely linked to industrial competitiveness, climate neutrality, technological sovereignty and security of supply. The accelerated deployment of renewable energy systems, electric mobility, digital infrastructures and defence-related technologies has significantly increased demand for a wide range of minerals, including lithium, cobalt, nickel, rare earth elements, copper and graphite. Global projections indicate that demand for several of these materials could multiply over the coming decades, driven by the combined effects of the energy transition, digitalisation and strategic re-industrialisation (OECD, 2019).

These trends have exposed Europe's structural dependence on external suppliers and the vulnerabilities associated with highly concentrated global supply chains. In response, the European Union has progressively elevated raw materials to the level of strategic policy priority. This evolution culminated in the adoption of the Critical Raw Materials Act (CRMA), which establishes binding targets for domestic extraction, processing and recycling of strategic raw materials, and explicitly recognises geological knowledge, exploration and permitting efficiency as enabling conditions for achieving these objectives (European Commission, 2024).

Spain occupies a relevant position within this European context. The country hosts a diverse geological endowment and remains one of Europe's leading producers of several industrial and metallic minerals. At the same time, Spain faces persistent challenges related to the ageing of geological data, limited systematic exploration in recent decades, administrative complexity and the need to integrate environmental protection, social acceptance and circular economy principles into mineral development strategies.

In response to these challenges, Spain has developed a comprehensive national policy framework centred on the Hoja de Ruta para la Gestión Sostenible de las Materias Primas Minerales, the I Plan de Acción 2025–2029 and the Programa Nacional de Exploración Minera (PNEM 2025–2029). Together, these instruments aim to update geological knowledge, promote responsible exploration, re-evaluate secondary resources and align national actions with European strategic objectives. The integrated vision of raw materials policy, linking primary and secondary resources, environmental considerations and governance mechanisms, is illustrated in Figure 1.

This article presents and develops the proposal to establish the Spanish Centre for Critical and Strategic Minerals (CEMCE) within the Instituto Geológico y Minero de España (IGME-CSIC). The proposed centre is conceived as a national coordination hub to support the implementation of the PNEM, strengthen data integration and contribute to European geological cooperation. Particular attention is given to the alignment between CEMCE and emerging European initiatives, notably the European International Centre of Excellence on Sustainable Resource Management (ICE-SRM EU), developed under the Geological Service for Europe (GSEU) project and the umbrella of EuroGeoSurveys.

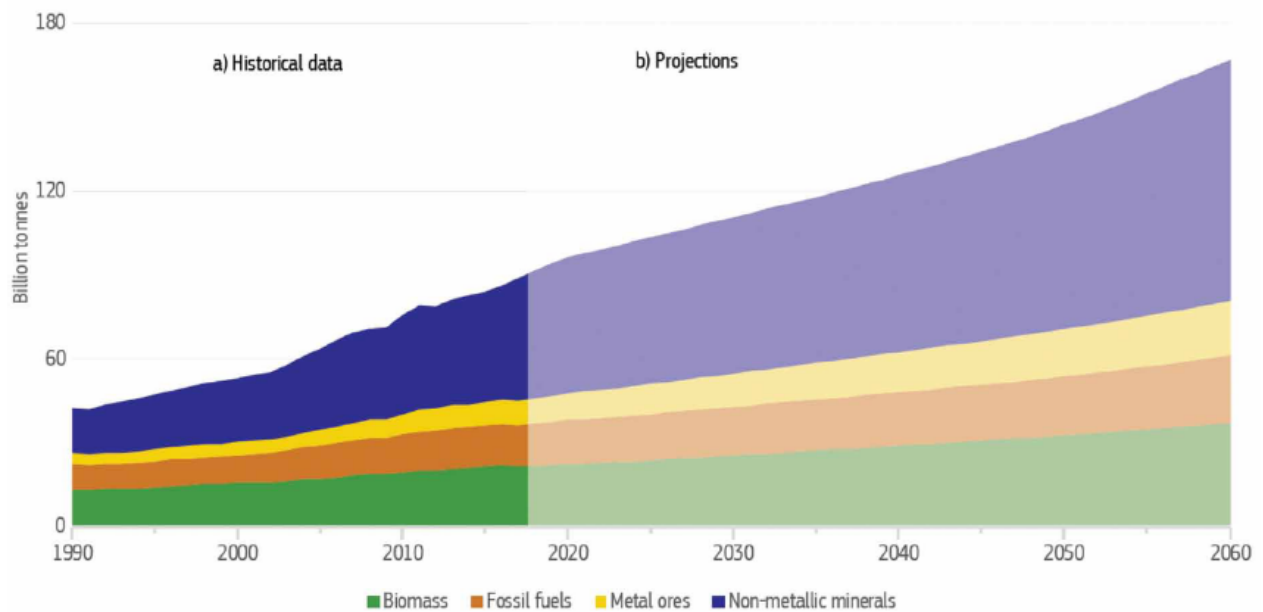


Figure 1: Global demand for raw materials. Source: Hoja de Ruta para la Gestión Sostenible de las Materias Primas Minerales (MITECO, 2022), p. 12.

2. European and national policy framework for critical and strategic minerals

Over the last decade, the European Union has progressively consolidated a strategic policy framework addressing raw materials as a cross-cutting issue spanning industrial policy, climate action, innovation and security. Early initiatives focused on identifying supply risks and promoting research and innovation, as reflected in instruments such as the *Raw Materials Scoreboard*, which provides comparative indicators on supply risk, economic importance and substitution potential (European Commission, 2020).

Recent analyses also underline the growing geopolitical and defence-related dimensions of critical mineral demand, reinforcing the strategic character of raw materials governance in Europe (Johnstone & Marín, 2026).

This policy evolution culminated in the adoption of the *Critical Raw Materials Act*, which introduces a legally binding framework to reduce external dependencies and strengthen domestic capacities across the entire value chain. The CRMA establishes quantitative benchmarks for domestic extraction (10%), processing (40%) and recycling (25%) of strategic raw materials by 2030, while also emphasising the importance of exploration, geological data availability and streamlined permitting procedures (European Commission, 2024).

At national level, Spain has translated these European priorities into a structured policy framework. The *Hoja de Ruta para la Gestión Sostenible de las Materias Primas Minerales* defines the strategic vision, identifying priority materials, governance challenges and sustainability objectives (MITECO, 2022). This vision is operationalised through the *I Plan de Acción 2025–2029*, which specifies concrete measures related to exploration, mining, recycling, institutional coordination and public engagement (MITECO, 2025).

A central element of this framework is the alignment between national and European classifications of critical and strategic raw materials. The list of materials considered under the PNEM 2025–2029, presented in Table 1, reflects this alignment and ensures coherence between national exploration priorities and EU-level policy objectives.

Table 1: List of critical and strategic raw materials. Source: PNEM 2025–2029 (IGME-CSIC, 2025).

Mineral or Group	Category	Strategic Applications	European Value Chains	Justification for Priority in Spain
Lithium	Primary	Batteries for electric vehicles, stationary storage systems	Energy storage, e-mobility	Occurrence in granitic pegmatites in western Iberia, strategic EU demand growth
Cobalt	Primary	Lithium-ion batteries, aerospace alloys	E-mobility, aerospace	Scarcity in Europe, strong reliance on imports, potential in polymetallic deposits
Nickel	Primary	Battery cathodes, stainless steel	Energy storage, industrial metals	Presence in ultramafic complexes; key metal for high-capacity batteries
Copper	Primary	Power transmission, motors, renewable technologies	Renewable energy, grid infrastructure	Widespread occurrence in Spanish ore belts including the Iberian Pyrite Belt
Rare Earth Elements (REE)	Primary	Permanent magnets, wind turbines, electronics	Wind energy, digital technologies	High EU dependency; potential in carbonatites and alkaline complexes
Tin	Primary	Solder, electronics, energy technologies	Digital technologies	Demand growth for electronics; occurrences associated with granitic systems
Tungsten	Primary	Hard metals, drilling and cutting tools	Industrial equipment	Spain historically significant tungsten producer; resources in western Iberia
Molybdenum	Primary	Steel alloys, catalysts	Industrial metals	Occurrences in porphyry systems; strategic importance for high-temperature alloys
Manganese	Primary	Batteries, steelmaking	Energy storage, industrial metals	Essential for emerging battery chemistries; presence in several Spanish regions
Graphite	Primary	Battery anodes, refractory materials	Energy storage	Considered strategic for battery production; mix of natural and synthetic resources
Phosphate minerals	Primary	Fertilizers, industrial applications	Agriculture, chemicals	Key agricultural input; potential in sedimentary basins
Potash salts	Primary	Fertilizers	Agriculture	Strategic for food security; long mining tradition in northeastern Spain
Aluminium (bauxite substitutes)	Primary and secondary	Lightweight alloys, transportation	Industrial metals	Domestic primary deposits limited; recycling potential significant
Magnesium	Primary and secondary	Lightweight alloys, automotive components	Industrial metals	EU considers magnesium supply highly vulnerable; recovery from residues possible
Industrial silica and high-purity quartz	Primary	Photovoltaics, optics, semiconductors	Solar energy, digital technologies	Essential for PV manufacturing; Spain has significant high-quality resources
Secondary raw materials from mining waste	Secondary	Recovery of critical metals and industrial minerals	Circular economy	Large tonnages available in legacy mining areas with potential for CRM extraction
Secondary raw materials from industrial residues	Secondary	Recovery of metals from slags, ashes and industrial by-products	Circular economy	Supports EU recycling targets; significant volumes in metallurgical and energy sectors

From a governance perspective, Spain's policy framework adopts an integrated value-chain approach, linking exploration, extraction, processing, recycling and secondary resources. This systemic vision, illustrated in Figure 2, represents a shift away from narrowly extractive models towards a more holistic approach that incorporates sustainability, circular economy principles and social acceptance.

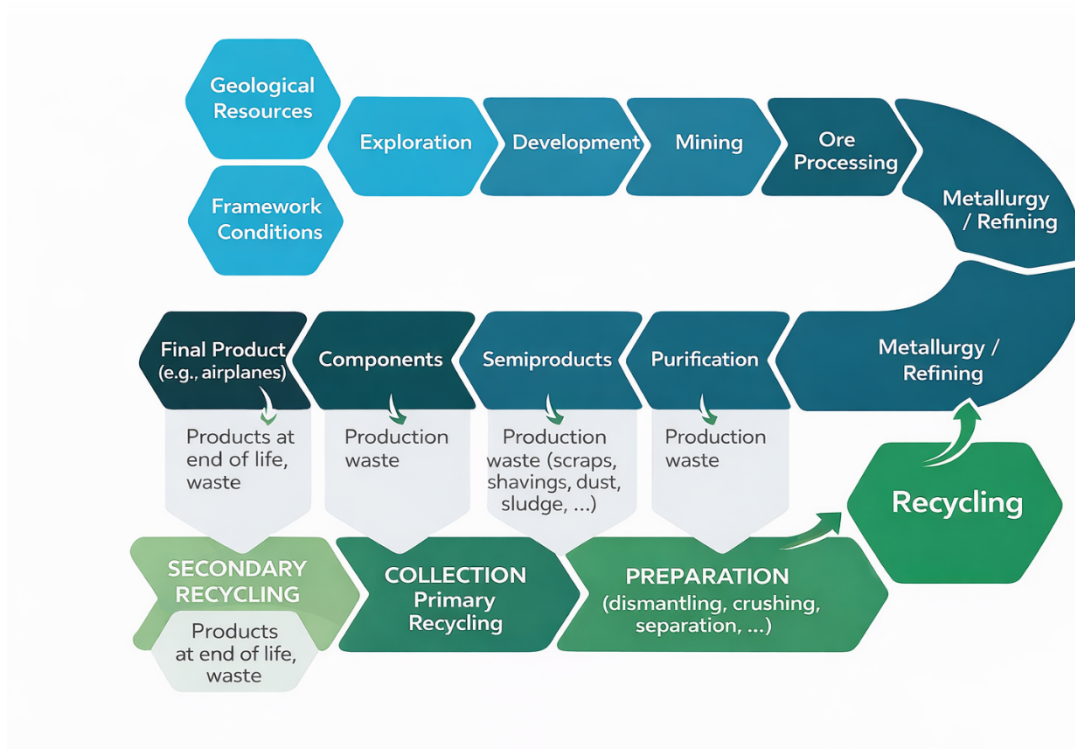


Figure 2: Integrated view of raw materials. Source: International Resource Panel (IRP, 2019).

3. Spain's national mining exploration programme (PNEM 2025–2029)

The *Programa Nacional de Exploración Minera 2025–2029* constitutes the operational backbone of Spain's renewed mineral policy. Its primary objective is to update and expand geological knowledge on critical and strategic raw materials through targeted exploration activities, re-evaluation of historical mining districts and systematic assessment of secondary resources (IGME-CSIC, 2025).

The programme addresses a long-standing gap in Spain's mineral governance, namely the limited level of systematic exploration in recent decades. By prioritising data acquisition, geological modelling and resource reassessment, the PNEM strengthens the scientific basis required for informed policy decisions, land-use planning and investment prioritisation.

A distinctive feature of the PNEM is its explicit integration of secondary resources, particularly mining waste, within the exploration framework. Figure 3 illustrates the types of elements potentially present in mining residues, highlighting that several elements traditionally considered as pollutants are simultaneously classified as critical or strategic raw materials. This dual character underscores the relevance of circular economy approaches and the potential to reduce environmental liabilities while enhancing resource efficiency.

By addressing both primary and secondary resources, the PNEM contributes to reducing supply risks while minimising the environmental footprint associated with greenfield exploration. Moreover, the data generated under the programme are designed to be compatible with European standards, facilitating integration into EU-level initiatives and comparative analyses across Member States.



Figure 3: Value chain of critical raw materials and the measures involved in the National Mining Exploration Program.

Beyond the identification of potentially recoverable elements, the PNEM 2025–2029 explicitly highlights the strategic relevance of mining waste from both an environmental and a resource-security perspective. As shown in Figure 4, several elements traditionally classified as potentially toxic are simultaneously recognised as critical or strategic raw materials under current European and national frameworks. This overlap reinforces the need for integrated assessment approaches that jointly address environmental risk mitigation, secondary resource recovery and circular economy objectives within mining governance.

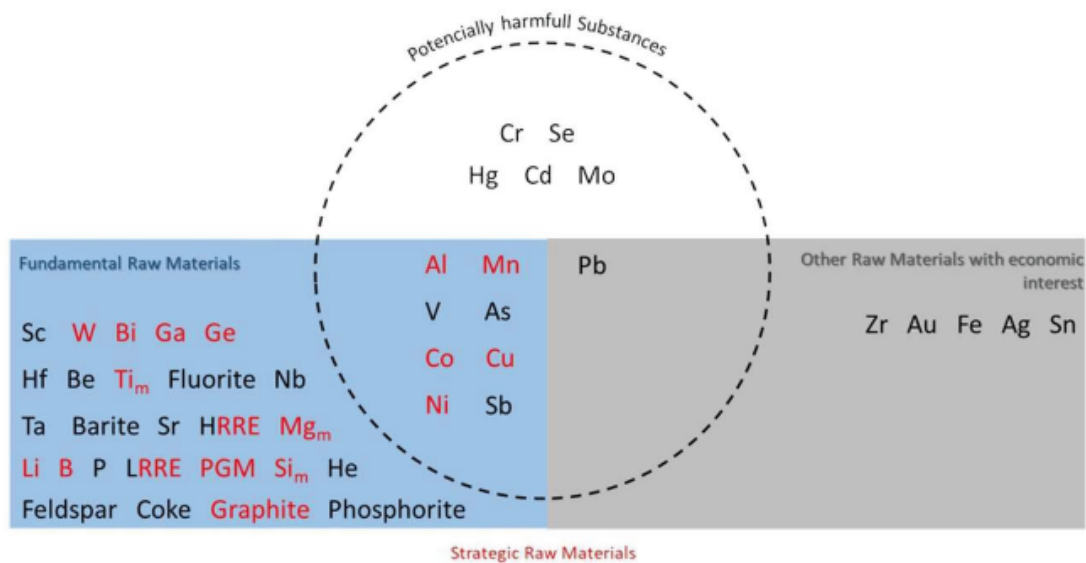


Figure 4: Types of elements potentially present in mining waste. Some potentially toxic elements (shown within the dashed circle) are also classified as critical or strategic raw materials. Source: PNEM 2025–2029 (IGME-CSIC, 2025).

4. Proposal for the Spanish centre for critical and strategic minerals (CEMCE)

The effective implementation of the PNEM and the broader national raw materials strategy requires a stable institutional structure capable of coordinating geological data, technical expertise and policy interaction. To address this need, the creation of the Spanish Centre for Critical and Strategic Minerals (CEMCE) is proposed as a dedicated department within IGME-CSIC.

The CEMCE is conceived as a national reference centre for critical and strategic minerals, integrating exploration data, mineral inventories, research activities and policy support functions. Its core missions would include coordination of PNEM activities, support for public administrations, interaction with industry and contribution to European geological cooperation mechanisms.

Organisationally, the CEMCE would leverage IGME-CSIC's existing infrastructure, laboratories and human capital, ensuring cost-effective implementation while enhancing institutional visibility at European level. By acting as a centralised coordination hub, the centre would help reduce fragmentation, improve data consistency and strengthen the link between geological knowledge and policy decision-making.

In comparative perspective, France operates through BRGM with a strong state-driven exploration mandate and an integrated mineral intelligence system. Germany's BGR emphasises federal coordination and international raw materials diplomacy, while Italy's Geological Survey focuses on regional data harmonisation and EU project integration. These institutional approaches highlight the importance of stable funding, centralised data platforms and clear policy interfaces, elements that the proposed CEMCE seeks to incorporate within the Spanish governance framework.

5. European coordination and the role of ICE-SRM EU

The implementation of the European Union's critical raw materials strategy requires not only regulatory instruments but also robust institutional mechanisms capable of translating policy objectives into operational actions. In this context, geological knowledge, harmonised data standards and coordinated resource assessment methodologies are increasingly recognised as essential enablers of strategic autonomy and supply security (European Commission, 2024; European Commission, 2020).

The European International Centre of Excellence on Sustainable Resource Management (ICE-SRM EU) represents a significant institutional innovation within the European geological framework. Officially launched in May 2025 in Nova Gorica (Slovenia), ICE-SRM EU has been established under the Geological Service for Europe (GSEU) project, operating under the umbrella of EuroGeoSurveys and hosted by the Geological Survey of Slovenia.

ICE-SRM EU is conceived as a permanent European hub for capacity building, methodological harmonisation and knowledge exchange in sustainable resource management. A core mission of the centre is to promote the application of internationally recognised frameworks for resource classification and management, particularly the United Nations Framework Classification for Resources (UNFC) and the United Nations Resource Management System (UNRMS). These frameworks provide a common language to integrate geological, environmental, social and economic dimensions of resource development, thereby supporting transparent decision-making and policy coherence across Member States.

The relevance of ICE-SRM EU is directly linked to the objectives of the CRMA, which sets ambitious targets for domestic extraction, processing and recycling of strategic raw materials by 2030. Achieving these targets requires reliable, comparable and up-to-date geological information, as well as a clear understanding of resource maturity, technical feasibility and sustainability constraints. By fostering harmonised classification and reporting practices, ICE-SRM EU contributes to improving the quality and policy relevance of mineral resource data at the European scale.

Within this European framework, the proposed CEMCE is designed to act as Spain's national interface with ICE-SRM EU. By aligning its activities with European methodologies and participating actively in ICE-SRM EU training and coordination initiatives, CEMCE would facilitate the integration of Spanish geological data into European platforms and contribute to joint analytical and capacity-building efforts. This alignment would strengthen Spain's contribution to European mineral intelligence, risk monitoring and strategic planning, reinforcing the role of geological surveys as trusted scientific institutions supporting evidence-based mineral policy.

The adoption of UNFC- and UNRMS-aligned methodologies at national level would directly support resource prioritisation, permitting streamlining and strategic project identification under the PNEM framework. This alignment would ensure consistency between geological classification, environmental evaluation and long-term strategic planning.

6. Conclusions and outlook for European mineral governance

The accelerating demand for critical and strategic raw materials poses both a challenge and an opportunity for Europe. While global competition for mineral resources is intensifying, the European Union has responded with a coherent policy framework aimed at strengthening supply security, reducing external dependencies and embedding sustainability across the raw materials value chain (OECD, 2019; European Commission, 2024).

Spain's national strategy, articulated through the *Hoja de Ruta*, the *I Plan de Acción 2025–2029* and the *Programa Nacional de Exploración Minera 2025–2029*, represents a structured response to these challenges. By prioritising geological knowledge, responsible exploration and the re-evaluation of secondary resources, this framework provides a solid scientific and institutional basis for informed decision-making (MITECO, 2022; MITECO, 2025; IGME-CSIC, 2025).

The proposed establishment of the *Spanish Centre for Critical and Strategic Minerals (CEMCE)* within IGME-CSIC addresses a key governance gap by creating a dedicated institutional structure to coordinate exploration activities, integrate

data and support public administrations. At the European level, the emergence of ICE-SRM EU under the GSEU project marks an important step towards a more integrated and knowledge-based approach to resource governance.

By aligning national initiatives such as CEMCE with European coordination mechanisms like ICE-SRM EU, Spain can reinforce its contribution to a shared European vision of sustainable resource management, strategic autonomy and long-term economic resilience. This approach confirms the central role of geological surveys in shaping Europe's mineral future and supporting evidence-based, socially acceptable raw materials policies.

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