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Geoscience for Public Policy: The role of the Geological Survey of Brazil in supporting national development strategies

Ana Claudia de Aguiar Accioly[1*]; Sandra Fernandes da Silva[2]; Luiz Gustavo Rodrigues Pinto[3]; Carlos Eduardo de Oliveira Dantas[4]

[1]Geological Survey of Brazil - CPRM, Av. Sul, 2291, Afogados, Recife-PE, Brazil, CEP: 50770-011
[2]Geological Survey of Brazil - CPRM, Avenida Brasil, 1731, Funcionários Belo Horizonte- MG, Brazil, CEP: 30140-002
[3]Geological Survey of Brazil - CPRM, Rua Costa, 55 - Cerqueira César - São Paulo-SP, Brazil, CEP: 01304-010
[4]Geological Survey of Brazil - CPRM, Setor Bancário Norte - SBN Quadra 02, Bloco H - Asa Norte, Brasília-DF - Brazil, CEP: 70040-904

Abstract

This article explores the critical role of the Geological Survey of Brazil (SGB-CPRM) in advancing national development strategies through the provision of geoscientific data and expertise. It examines how the institution's activities align with and support key public policies in Brazil, including those focused on safe and sustainable mining, mapping and studies of ocean and coastal zones, water security ("water in quantity and quality, forever"), disaster risk reduction, and other crosscutting agendas. Through a comparative analysis of strategic plans from leading global geological surveys, the article underscores Brazil's technical strengths and strong data production capabilities, while also drawing attention to the lack of a formally established national mineral policy integrated into broader development frameworks. It argues that SGB-CPRM plays a vital role in bridging this policy gap and positioning Brazil to participate effectively in the global transition to a low-carbon economy. The article also describes the Brazil Geological Survey's contributions under the Multi-Year Plan (PPA), particularly in geological mapping and critic minerals, marine geology, water resources and geohazards. Despite facing budgetary and operational constraints, the institution has continued to make progress through institutional collaboration and technical resilience. SGB-CPRM acts as a strategic partner in the formulation and implementation of public policies, integrating geoscientific information into policy frameworks to enhance the effectiveness and sustainability of government actions across various sectors. One of the SGB-CPRM's most tangible contributions lies in its long-standing geological mapping program, which has produced an extensive and systematically updated set of geological maps covering the vast Brazilian territory. These maps—developed over decades and continually updated—are accessible through the institutional repository and constitute a fundamental resource for academic research. While not formally responsible for policy formulation, SGB-CPRM acts as a key articulator, providing critical scenarios and technical insights to both the executive and legislative branches. In addition to the national geological mapping program, a core function of SGB-CPRM is to serve as the central hub for generating Brazil's basic geoscientific data. This foundational information, made available through its public platforms, is indispensable for the creation of evidence-based policies. By ensuring access to reliable and standardized national data, SGB-CPRM empowers government bodies, the private sector, and civil society to make informed decisions. To enhance the effectiveness of these policies, there is a clear need for more participatory committees focused on Brazil's diverse development strategies. Continued investment in its technical capabilities and expanded data dissemination efforts will further solidify SGB-CPRM's pivotal role in supporting Brazil's national development strategies and contributing to a more resilient and sustainable future.

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*Corresponding author
Ana Claudia de Aguiar Accioly
E-mail address: ana.accioly@sgb.gov.br

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1. Introduction

In Brazil, mineral policy is shaped by a complex governmental framework spanning federal, state, and, at times, municipal levels. Its foundation rests on the 1988 Federal Constitution, the Mining Code (Decree-Law No. 227/1967, amended by Law No. 13.575/2017), and vital complementary regulations and other political instruments like the National Dam Safety Policy (Law No. 12.334/2010) and Growth Acceleration Program (PAC) Decrees (No. 6,025/2007; No. 11.632/2023). The Ministry of Mines and Energy (MME), through its National Secretariat for Geology, Mining and Mineral Processing (SNGM), leads the formulation, implementation, and coordination of policies for the mineral sector (BRASIL, 2025a) and Mineral Code (BRASIL, 1967). It defines strategic guidelines, goals, and long-term plans, including the National Mining Plan 2030 (BRASIL, 2011), which guides the production of essential geoscientific data to support the sustainable development of the mineral sector. The National Mining Agency - ANM, an autonomous body under the MME, is responsible for regulating, supervising, and managing mining activities in the country. It operates the Geographic Information System for Mining – SIGMINE (ANM, 2025), which contains comprehensive data on mining rights, exploration permits, and available areas. The National Congress plays a meaningful role in establishing and updating the legal framework for mining, including the approval of key legislation such as the Mining Code and the regulation of royalties and financial compensations, particularly the Financial Compensation for the Exploitation of Mineral Resources (CFEM- Law 70990/1989). Strategic decisions regarding national mineral policy are overseen by the Presidency of the Republic and the Civil House (BRASIL, 2024a), which are responsible for authorizing bidding processes, approving tax incentives, and implementing high-level policies, like industrial development acceleration programs. State governments also play a significant role, especially regarding construction materials (e.g., sand, gravel, crushed stone) by handling environmental licensing and local land-use regulations.

The Geological Survey of Brazil (SGB-CPRM) operates within an institutional framework focused on the systematic production, organization, and dissemination of geoscientific data to support public policies aligned with national and international development agendas. This framework encompasses the collection of field data, laboratory analysis, integration of geophysical and geochemical datasets, and the transformation of raw data into accessible outputs such as geological maps, digital databases, risk alerts, and technical reports (SGB-CPRM, 2024). Recent analyses of the economic impacts of geological mapping indicate that the benefits can be seven to ten times greater than the initial costs, and in some cases may reach up to thirty-five times the investment (American Geosciences Institute, 2023). Table 1 presents the key institutions and their respective functions within the framework of Brazil's mineral policy. Within this framework, the Geological Survey of Brazil plays a prominent role through its mission to produce, organize, and disseminate geoscientific data. This information serves as a core technical and scientific foundation for supporting public policies. Other stakeholders include academic institutions, geological institutes, the Brazilian Mining Institute, professional associations, development agencies, the Center for Mineral Technology, universities, as well as professional and civil society organizations — all of which act as collaborators and supporters in this field. The National Mineral Policy Council, established by Decree No. 11,108/2022 and amended by Decree No. 11,419/2023, serves as a governance mechanism intended to align mineral policy actions with the National Mining Policy. In addition, comparative analyses of the evolving role of geological surveys worldwide, such as **those presented by Hill** et al. (2020), help contextualize the institutional arrangements that underpin the functioning of Brazil's geoscientific and mineral policy system.

Table 1. Key Stakeholders in Brazil's Mineral Policy

2. Mineral policy in the international context: Reflections for Brazil

Globally national geological surveys carry out public policy functions that transcend the specific political and economic regimes in which they operate. Despite variations in state policy and economic contexts, these institutions consistently position themselves as integral agents of the State. To understand how this role is articulated in practice, this study conducted an analysis of the official strategic plans from a diverse set of leading geological surveys. The review includes documents published online by Geoscience Australia (2020), the Geological Survey of Canada (2023), the United States Geological Survey (USGS, 2021a), the Servicio Geológico Minero Argentino (SEGEMAR, 2022), the Bureau de Recherches Géologiques et Minières (BRGM, 2021), the British Geological Survey (BGS, 2023), the Geological Survey of Norway (NGU, 2020) and others. Furthermore, the analysis was expanded to include specialized reports on critical minerals and geohazard strategies from other key nations. This supplementary review aimed to identify and describe the core geoscientific services provided by these institutions, examining documents from Morocco (2021), India (2020, 2030), Japan (2018), China ([ca. 2013], 2025), Denmark (2024), South Africa (2020) and Chile (2018).

The strategic plans reviewed reveal a broad and diversified portfolio of geoscientific services, including geological mapping, mineral resource assessments, hydrogeological studies, geohazard monitoring, and environmental analyses. These services reflect the expanding mandate of geological surveys to address contemporary societal challenges and promote sustainable development, consistent with global assessments of the evolving role and responsibilities of national geological surveys (Hill et al. 2020; Smelror 2020). Rather than operating in isolation, these institutions align their technical expertise with national priorities, thereby reinforcing their strategic relevance in shaping public policies related to resource governance, environmental protection, and social well-being, as evidenced by the institutional documents analyzed. In addition to their technical mandates, geological surveys operate as instruments of the State, playing a fundamental role in national planning and public policy execution. Their budgets are within broader governmental frameworks and reflect political priorities such as critical mineral supply, disaster risk reduction, environmental monitoring, and energy transition. This financial dependency underscores their accountability to public institutions and reinforces their position as agents of the State. Strategic planning documents frequently emphasize their role in producing public goods—such as geoscientific data, risk maps, and mineral inventories—that support decision-making across multiple sectors and levels of government.

Geological surveys worldwide are redefining their strategic roles in response to evolving societal demands and the growing need for evidence-based public policies. Strategic planning documents—such as those of Geoscience Australia (2020–2030), USGS (2021–2030), SEGEMAR (2021–2030), CGS (2021), and SGM (2010–2030)—demonstrate a shared institutional emphasis on modernizing geoscientific infrastructure, advancing digital transformation, and aligning georesource and risk assessments with national development goals. These plans also reveal how public funding structures are closely tied to governmental priorities, positioning geological surveys not merely as technical entities, but as state agencies with mandates to support policy across sectors such as mineral and water management, disaster risk reduction, energy transition, and territorial planning. In this context, budget allocations are not neutral but reflect strategic decisions that reaffirm the role of geological surveys as embedded components of the State apparatus. Over the past two decades, many countries have restructured their mineral policies to respond to emerging challenges, particularly those related to the energy transition, climate change, technological shifts, and the growing demand for critical minerals (Figure 1). As highlighted in recent syntheses, particularly in the contributions compiled in “The Green Stone Age” (Smelror et al. 2023), these global transformations have intensified the strategic relevance of mineral supply chains and underscored the need for more coherent and forward-looking policy frameworks. These developments reinforce the understanding that mineral policies are essential components of broader public policy strategies aimed at ensuring economic resilience, technological sovereignty, and sustainable development (Russo, 2024).

Figure 1 - Strategic responses by countries to global pressures

Internationally, countries like Australia, Canada, the United States, and members of the European Union have recently updated their mineral strategies to address supply chain vulnerabilities, particularly for critical minerals essential for clean energy technologies and digital transformation (IEA, 2025; Gadd et al. 2023; Jørgensen et al. 2023). This pivot reflects the evolving mission of geological surveys, as detailed in the special issue "The Changing Role of Geological Surveys," positioning them as key players in the dawning "Green Stone Age" of mineral-dependent green technologies. In Europe, for example, mineral and land-use policies integrated to prevent conflicts and promote sustainable resource management. This approach is highlighted by Endl et al. (2023), who state that “the protection of mineral deposits is now embedded in spatial planning frameworks to balance economic development with environmental conservation.” This integration has been a key driver for improving governance and societal acceptance of mining activities. Likewise, Australia adopts a model aimed at attracting investment by aligning mineral policy with national development goals and offering public geoscientific data to reduce exploration risks (Australia, 2020).

The United States has adopted a strategic approach centered on the secure supply of critical minerals, combining geological knowledge, investment in domestic production, recycling, and international cooperation. This multifaceted model reflects a growing trend in which geoscientific data recognized not only as a technical asset but also as a strategic resource for national security and technological competitiveness (USGS, 2021b). When compared to these international models, Brazil shows significant strengths, particularly in its technical capacity for geological surveying and its experience in producing comprehensive geoscientific datasets through the SGB-CPRM. However, there are notable gaps, including the absence of a formally articulated national mineral policy that is integrated with broader industrial, environmental, and technological policies. Brazil’s mineral policy framework remains predominantly reactive rather than proactive, often focusing on regulatory compliance rather than on strategic resource planning. Furthermore, issues related to illegal mining, the slow pace of environmental licensing, and conflicts over land use—especially in protected and Indigenous territories—continue to hinder the development of a more sustainable and resilient mining sector. The absence of an integrated mineral policy is particularly relevant in the context of the energy transition and the increasing demand for critical minerals. Countries worldwide are prioritizing the mapping, valuation, and development of critical mineral resources as part of their climate and industrial policies (Cartier, 2022; Smelror et al. 2023). In contrast, Brazil has not yet fully incorporated this perspective into its national strategies, despite having substantial geological potential to contribute to global supply chains for energy-transition materials.

This scenario underscores the strategic role of the Geological Survey of Brazil (SGB-CPRM, 2024) in bridging this gap. By producing high-quality geoscientific data and supporting evidence-based policymaking, the SGB-CPRM can contribute not only to national mineral governance but also to positioning Brazil as a key player in the global transition toward a low-carbon economy.

3. Results and Discussion

3.1. The role of the Geological Survey of Brazil in supporting public policies

Despite this well-established governance structure, Brazil faces major challenges in balancing economic growth, environmental protection, and social responsibilities. As the fifth largest country in the world by land area, and with a large urban population exposed to landslide risk zones and increasing concerns over river flooding, requiring extensive monitoring, Brazil also faces vulnerabilities related to natural disasters (Dos Santos and Ushida, 2025). Moreover, as an agriculture-driven country, it is highly dependent on critical minerals for the agribusiness sector (Martins et al. 2020) over 85% of Brazil’s potassium is imported, creating risks for food security. Rock-based soil remineralizers offer a local, sustainable alternative (Theodoro et al. 2022; Manning and Theodoro, 2018; Hemachandra et al. 2021), adding another layer of complexity to its mineral policy and environmental governance. In this context, the Geological Survey of Brazil plays a critical scientific and technical role by providing fundamental geoscientific data that support regulatory decisions, strategic planning, and policy development. SGB-CPRM's work is vital for fostering a safer and more sustainable mining sector that aligns with global priorities such as the energy transition and the low-carbon economy.

Although mineral policy is not formally recognized as a thematic area in Brazil’s official Catálogo de Políticas Públicas (IPEA, 2025), it functions as a key cross-cutting domain that supports national development. It intersects with energy policy, industrial policy, science and technology, environmental governance, and territorial planning. In addition

to the agencies directly responsible for policy formulation and regulation, several other institutions are essential for supporting the implementation, technological development, and sustainability of Brazil's mineral sector and the influence of the extractives production in the commercial balance (Brasil, 2025b). These activities are aligned with the priorities established in Brazil's Plano Plurianual (PPA – Multi-Year Plan), defined by the Federal Constitution (Brasil, 1988). The PPA sets the government's medium-term strategic direction by outlining programs, goals, and public policies over a four-year period, in alignment with the presidential term cycle (Brasil, 2024b). SGB-CPRM's work contributes directly to the government's strategic goals for sustainable development, mining and marine geology development, environmental protection, water resources and disaster risk reduction.

The Geological Survey of Brazil plays an essential role in executing and supporting a wide range of public policies that contribute directly to Brazil's national development strategies. Through its technical-scientific mission, SGB-CPRM transforms geoscientific knowledge into actionable information that guides decision-making for critical sectors. These contributions are closely aligned with the current Pluriannual Plan (PPA) 2024–2027 of the Brazilian federal government, notably through the implementation of strategic programs such as Safe and Sustainable Mining, Ocean, Coastal Zone and Antarctica, Disaster Risk and Management, and Water Resources in Quantity and Quality Forever (Figure 2). In the marine and coastal domain, SGB-CPRM carries out projects on marine aggregates, seabed studies, and integrated geological, geophysical, and oceanographic surveys, activities that support territorial planning, sustainable resource management, and advances in Brazil's understanding of marine environments. Moreover, they reinforce cross-cutting national policies in key areas such as environmental protection, education, energy transition, and sustainable development.

Figure 2 - Core government programs supported by the Geological Survey of Brazil in the Pluriannual Plan (PPA) 2024–2027, including mining, marine geology, geoharzards, and water resources. Each program adheres to national legislation and sets annual outcomes for public policies.

3.2. Public Policies of Core Government Programs (PPA 2024–2027) supported by the Geological Survey of Brazil

3.2.1. Program 3102 – Safe and Sustainable Mining

The Geological Survey of Brazil supports the expansion of the mineral sector based on increase in geological and mining knowledge, sustainability, governance, legal security, and innovation. This program is directly linked to the National Mineral Policy and infrastructure programs such as Growth Acceleration Program (PAC). SGB-CPRM provides geological data, mapping, and mineral assessments that reduce exploratory risks and guide sustainable mineral development. The Growth Acceleration Program, relaunched in 2023, encompasses a wide range of national infrastructure and development initiatives. It includes a specific axis on Energy Transition and Energy Security, which directly supports mineral research for the energy transition. Within this scope, SGB-CPRM has delivered key technical deliverables, such as assessments of critical and strategic minerals, marine mineral resources data, and regional geological maps. These outputs are largely in line with the National Mineral Policy, and the National Energy Transition Policy. Furthermore, in 2025, approximately about 60% of SGB's discretionary budget is dedicated for PAC priorities (Brasil, 2024a).

3.2.2. Program 6113 – Oceans, Coastal Zone, and Antarctica

The Oceans, Coastal Zone, and Antarctica Program aims to expand scientific and technological knowledge about marine environments, supporting the sustainable use of marine mineral resources and strengthening Brazil's jurisdiction over onshore and offshore (PCJB) in PPA program. SGB-CPRM's marine geology research supports the Blue Economy strategy and the National Marine Resources Policy. Integrated into the XI Sectoral Plan for Marine Resources (Decree 12.363/2025) – PSRM (Brasil, 2025b), the program mobilizes scientific and technological initiatives in marine geology, such as geological, geophysical and oceanographic surveys, to map and assess mineral resources within Brazil's and in international seabed areas. The Geological Survey of Brazil work supports contracts with the International Seabed Authority, contributes to interoperable GIS-based data systems, informs the formulation of public policies, and reinforces national sovereignty through science, conservation, and the sustainable use of marine resources.

3.2.3. Program 2321 – Water Resources: Water in Quantity and Quality Forever

The Water Resources: Water in Quantity and Quality Forever focuses on improving water security in municipalities facing limited water availability. The Geological Survey of Brazil contributes through groundwater studies, hydrogeological mapping, and the operation of key information systems such as SIAGAS (Groundwater Information System) (SGB-CPRM, 2025b). It also manages two national monitoring networks: The National Hydrological Network (RHN) and the Integrated Groundwater Monitoring Network –RIMAS (SGB-CPRM, 2025c), which provide critical data for sustainable water use planning and support public policies for integrated water resource management across Brazil. The Geological Survey of Brazil coordinates key hydrological monitoring networks and information systems to support sustainable water resource management. The National Reference Hydrometeorological Network (RHNR) monitors surface water conditions, including interstate and international water transfers, critical hydrological events, water availability, long-term trends, water quality, and regulatory flows. This system enhances decision-making in water security and supports evidence-based policy formulation. Together, these initiatives reflect SGB-CPRM's commitment to advancing hydrogeological knowledge and fostering integrated water resource governance across Brazil.

3.2.4. Program 2318 – Disaster Risk and Management

The Disaster Risk and Management Program supports risk reduction strategies in line with the National Policy on Civil Protection and Defense (Law 12.608/2012, Brasil, 2012). The Geological Survey of Brazil provides landslide risk maps, flood zoning, hydrological monitoring, and early warning systems,

helping municipalities improve preparedness and response to natural disasters. Through its technical expertise, the Geological Survey of Brazil plays a fundamental role in supporting the Ministry of Regional Development and the National Center for Monitoring and Early Warning of Natural Disasters (CEMADEN). The Geological Survey of Brazil develops detailed geological and geotechnical hazard assessments, notably through the Risk and Disaster Management Geoportal (SGB-CPRM, 2025d,e), which consolidates spatial data and thematic maps used by civil defense agencies across Brazil. These products guide territorial planning, emergency protocols, and investment in protective infrastructure. SGB-CPRM also contributes with training and standardized methodologies, as exemplified by the Technical Manual for Hazard and Risk Mapping of Mass Movements (SGB-MDR, 2014), developed in cooperation with the MDR. This document sets out the procedures for identifying risk-prone areas and prioritizing intervention, aligning local actions with federal strategies. Moreover, by maintaining a permanent network of hydrological and geological monitoring stations, SGB feeds real-time data to CEMADEN's early warning systems, reinforcing a coordinated response capacity to rainfall-induced landslides and floods (SGB-CPRM, 2025f). Such integration of institutional efforts—data collection by SGB, modeling by CEMADEN, and public policy leadership by MDR—ensures that the National Civil Protection and Defense System is grounded in robust geoscientific evidence.

3.3 Other Thematic Public Policies Supported by Geological Survey of Brazil

The Geological Survey of Brazil also supports cross-cutting public policies listed in the official catalogs of the Ministry of Mines and Energy (Brasil, 2025a) and the Institute for Applied Economic Research (IPEA, 2025) which compile information on public policies implemented in Brazil over the past decades.

3.3.1. National Mineral Policy – PlanGeo

The Geological Survey of Brazil is leading the implementation of PlanGeo (Brasil, 2024c), a ten-year initiative established by Normative Ordinance No. 72/GM/MME of March 13, 2024. The plan focuses on geological mapping at 1:100,000 and 1:250,000 scales and is formally as the Decennial Geological Mapping Plan (SGB-CPRM, 2025g). This initiative is closely aligned with the Ministry of Mines and Energy's renewed commitment to sustainable mining and the energy transition, as reaffirmed during the World Economic Forum, where Brazil's leadership in the production of critical minerals was highlighted. By providing updated geological datasets, thematic maps, and strategic resource intelligence, SGB enables more effective investment planning and supports national efforts to increase domestic value addition, while promoting environmental stewardship in mineral-rich regions.

3.3.2. National Policy on Mineral Waters

The Laboratory of Mineral Analysis - LAMIN, based in Rio de Janeiro, is the official laboratory of the Geological Survey of Brazil. In addition to analyzing geological samples, the Laboratory of Mineral Analysis was designed by ministerial ordinances to assess imported mineral waters and evaluate hydromineral sources authorized by the National Mining Agency (ANM, 2025). These technical assessments certify quality and composition, ensuring consumer safety and supporting the sustainable use of this public resource.

3.3.3. Circular Economy and Sustainable Extraction

The Geological Survey of Brazil promotes circular economy principles in the mining sector through "zero waste mining" initiatives, such as cobalt recovery and the reuse of mineral residues. These actions aim to reduce environmental impacts and transform mining waste into secondary raw materials, fostering more sustainable and resource-efficient practices (Takehara et al. 2023).

3.3.4. National Fertilizer Plan (2022–2050)

The Geological Survey of Brazil contributes to the National Fertilizer Plan (Brasil, 2022), established by Decree 10.991/2022, through geological studies and mapping of key agrominerals—such as phosphate, potassium, and silicate rock dust. These activities aim to reduce Brazil's dependence on imported fertilizers and reinforce national strategies for food security and sustainable agriculture. This multisectoral engagement reflects the integration of geoscientific knowledge into public policy and supports the development of domestic supply chains for essential agricultural inputs several times integrates geological and agronomic data (Magalhães et al. 2024).

3.3.5. National Energy Transition Policy

The Geological Survey of Brazil (SGB-CPRM) provides critical data on strategic minerals essential for clean energy technologies, such as lithium, nickel, cobalt, graphite, and rare earth elements, directly supporting Brazil's energy transition and climate commitments. Inspired by global benchmarks like Australia's Critical Minerals Strategy 2023–2030, which emphasizes developing sovereign capabilities, securing international partnerships, and enabling downstream processing through a strategic list of 26 critical minerals (Australia, 2023). Brazil has made significant progress in this domain. The policy and economic conditions underpinning these advances, as well as the broader international debate on critical minerals, have been examined in recent studies (Castro et al. 2022, IBRAM, 2025). Following this broader strategic overview, he Geological Survey of Brazil has actively contributed through the development of technical evaluations, articles, and the "Catalogue of Mineral Resources for the Energy Transition" (Silva et al. 2023; Silva et al. 2025; Cunha et al. 2025), mapping and assessing areas with critical mineral potential. These efforts are central for supporting Brazil's clean energy transition and achieving its long-term sustainability goals. The aforementioned catalogue serves as a guide for public policies, facilitating the prioritization of investments aligned with Brazil's energy transition strategy and industrial resilience.

The following policies discussed in this article were compiled based on information provided by the Carta Anual de Políticas Públicas e Governança Corporativa 2025 (SGB-CPRM, 2025a).

3.3.6. Investment Partnerships Program (PPI)

The Geological Survey of Brazil reassesses mineral assets and supports public tenders to attract private investments in

mining projects, thereby strengthening regional development. In collaboration with the Ministry of Mines and Energy (MME) and other institutions coordinating the Investment Partnership Program (PPI), SGB-CPRM provides updated geological and mineral data essential for structuring concession projects. These technical contributions reduce geological uncertainty, enhance transparency in public offerings, and promote sustainable private investment in Brazil's mineral sector.

3.3.7. National Marine Resources Policy

The SGB-CPRM's marine geological research underpins Brazil's claims over extended maritime territories and supports the sustainable use of marine mineral resources. A notable achievement includes the successful extension of the Rio Grande Rise claim, a crucial program that guarantees sovereignty over Brazil's legal maritime platform and the sustainable utilization of mineral resources, including offshore oil and gas.

3.3.8. National Territorial Planning Policy and Urban Development Programs

The Geological Survey of Brazil supports urban and rural planning through geological and geotechnical mapping that informs land-use policies, disaster risk reduction, and infrastructure development.

3.3.9. National Solid Waste Policy and Basic Sanitation Policy

SGB-CPRM conducts site selection studies for landfills and waste disposal sites, ensuring geological suitability and minimizing environmental impacts. This contributes to the National Solid Waste Policy and the Basic Sanitation Policy.

3.3.10. National Environmental Policy

Since 2013, SGB-CPRM has actively engaged in the recovery and monitoring of areas in Santa Catarina impacted by coal mining, aligning with the National Environmental Policy. Their efforts involve physical interventions to mitigate environmental damage and restore micro-basins, utilizing varied techniques based on mining type. Continuous monitoring ensures the effectiveness of these measures, focusing on water quality, soil assessment, vegetation and fauna tracking, and environmental education.

3.3.11. National Innovation Policy

Submitted as a Scientific, Technological, and Innovation Institution (ICT) in 2018, SGB-CPRM has since structured its Technological Innovation Nucleus—revised in 2022—and established its RD&I Management Committee to foster new research initiatives. In 2024, the institution expanded its partnerships and projects in alternative energy, water resources, energy transition, and mineral exploration, in alignment with national decarbonization goals and the National Hydrogen Program. SGB-CPRM also promotes innovation in the mineral sector through platforms such as GeoSGB, P3M, and BaseGEO, integrating geoscientific data and transforming technical knowledge into innovation via programs like PLANGEO, PRONASOLOS, and REATE.

3.3.12. National Education Policy

SGB-CPRM contributes to the National Education Policy by popularizing geosciences and strengthening educational training through "SGBeduca Program" and the Earth Sciences Museum (MCTer). Activities, aligned with the PROEC program, include educational workshops, exhibitions, the "Museum in Motion" initiative, and geosciences courses for teachers, emphasizing sustainability and the 2030 Agenda. These efforts also support the Education for Sustainable Consumption Policy and the More Teachers for Brazil program, while the SGB-CPRM Residency Program offers technical training for recent Earth Sciences graduates, adhering to the National Education Plan 2024–2034 guidelines.

3.2.13. Executive Branch Management and Maintenance

The Executive Branch Management and Maintenance ncompasses activities like the recovery of degraded areas (e.g., the Carboniferous Basin of Santa Catarina), public employee training, compliance with international commitments, and public dissemination of technical information.

4. Strategic alignment and future outlook

The role of SGB-CPRM extends beyond data provision; it functions as a strategic partner in the formulation and implementation of public policies. By integrating geoscientific information into policy frameworks, the SGB-CPRM enhances the effectiveness and sustainability of government actions across various sectors. The institution's work is particularly important in addressing complex challenges such as climate change adaptation, resource scarcity, and rapid urbanization. One of the SGB-CPRM's most tangible contributions lies in its long-standing geological mapping program, which has produced an extensive and systematically updated set of geological maps covering the vast Brazilian territory. These maps—meticulously developed over decades and continually updated—are accessible through the institutional repository and constitute a fundamental resource for academic research. They have supported numerous publications in both national and international journals, including the Journal of the Geological Survey of Brazil, which offers not only a historical perspective on geological surveys carried out in Brazil but also insights into the current state of the art (Rosa-Costa et al. 2022). Furthermore, this geoscientific knowledge is made fully accessible and interoperable via Geographic Information Systems (GIS) on the institutional platform. This digital transformation is not merely a technical upgrade; it is a strategic implementation of Brazil's public policy for geological information, PLANGEO 2025–2034 (Brasil, 2024c). The policy framework is designed to unlock the economic value of geoscientific data by ensuring its modernization and accessibility, thereby reducing investment risks and enabling innovation (Häggquist & Söderholm, 2015). This approach reaffirms the SGB-CPRM's commitment to public service by transforming raw data into a valuable public good.

Based on the analyses presented, the unquestionable relevance of the data produced by geological surveys for the formulation and execution of effective public policies becomes evident. The detailed information, made available on platforms

such as GEOSGB, RIGeo, BaseGEO, SIAGAS, RIMAS, and SACE, along with specific pages like Geological Risk Mapping (https://www.sgb.gov.br/produtos-por-estado-cartografia-de-riscos-geologicos), Disaster Prevention (https://www.sgb.gov.br/prevencao-de-desastres), and Auctions (https://www.sgb.gov.br/leilao) on the official SGB website, are very important to society.

4. 1 Strategic contributions to national development

The SGB-CPRM's geoscientific data and expertise are foundational for addressing critical national priorities and supporting Brazil's development strategies. These multifaceted contributions directly advance key areas aligned with the Sustainable Development Goals (SDGs), such as risk reduction (SDG 11, 13), sustainable resource management (SDG 7, 12), economic growth (SDG 8), and environmental protection (SDG 14, 15). As highlighted by Gray and Crofts (2022), the potential of geosciences to contribute to the SDGs is vast. By providing this comprehensive geological information, the SGB-CPRM enables evidence-based policymaking that not only strengthens national resilience but also actively contributes to this global sustainability agenda.

An important and often overlooked discussion concerns the sustainability of institutional expertise in the face of shrinking budgets. Over the past eight years, there has been a declining trend in the discretionary budget of the Geological Survey of Brazil, as evidenced by the institution's annual reports. This scenario has significantly limited the pace and visibility of public policies associated with SGB's mission. Nevertheless, the high level of technical expertise accumulated over decades has enabled the continued execution of strategic State functions. However, the long-term sustainability of these efforts increasingly depends on the institution's ability to transfer this knowledge to new generations of professionals—an additional challenge in the face of budget constraints and the pressing need for workforce renewal. The budgetary allocation for the extractive sector, particularly mining, has been consistently reactive rather than strategic. This approach reflects an ambiguous policy framework that neglects the necessity of a proactive, data-informed strategy. The discourse on the extractive sector's trade balance focuses on the mineral industry, but overlooks that the economic sectors responsible for producing the data and public policies for its development are not properly classified in the main political-economic models (IPEA, 2025; Brasil, 2025b).

4.2 Important roles played by the Geological Survey of Brazil

Reducing Risks: Its data on geological hazards, such as landslides and floods, is vital for informing disaster risk, reduction strategies and guiding urban planning, thereby protecting lives and infrastructure.

Promoting Sustainable Resource Management: Through the identification and assessment of mineral and water resources, the SGB-CPRM ensures their responsible and efficient use, contributing to long-term sustainability.

Supporting Economic Development: The availability of high-quality geological information attracts investments in the mineral sector by significantly reducing exploration uncertainties, fostering a more robust and competitive economy.

Fostering Environmental Protection: The SGB-CPRM's detailed geological and hydrogeological studies are fundamental for environmental licensing processes and the recovery of degraded areas, ensuring responsible stewardship of natural resources.

Future Outlook and Policy Integration: The SGB-CPRM is poised to further enhance its strategic role in Brazil's national development. As the country navigates complex global challenges, the demand for geoscientific information will only intensify. The institution's commitment to transparency, innovation, and public service, exemplified by its digital transformation initiatives and adherence to policies like PLANGEO 2025–2034 (SGB-CPRM, 2025g), positions it as an indispensable actor in shaping a resilient and sustainable future for Brazil.

Beyond these direct applications, the SGB-CPRM continuously advances its capabilities in geochemical, geophysical, marine geology, and geodiversity data collection. These advancements, detailed in *Caderno* 1 of the studies for the upcoming National Mining Plan 2050 (Brasil, 2025d), strengthen the geological survey's capacity to provide increasingly sophisticated support for strategic decision-making, in line with the long-term development goals. Although the National Mining Plan 2030 (Brasil, 2011) remains the current policy framework referenced by the MME in the 2024–2027 PPA, the new plan builds upon and expands its strategic guidelines.

5. Conclusions

The SGB-CPRM, as the Geological Survey of Brazil, is a fundamental institution for supporting geoscientific public policy in the country. Its technical contributions are essential for promoting sustainable development, ensuring resource security, and mitigating geological risks. By acting as a key articulator, the SGB-CPRM provides critical scenarios and technical insights to both the executive and legislative branches, serving as the central hub for generating and disseminating the nation's basic geoscientific data. This foundational information is indispensable for evidence-based policymaking, empowering government bodies, the private sector, and civil society to make informed decisions that drive progress and ensure national security. To enhance the effectiveness of these policies, there is a clear need for more participatory committees that integrate key institutions like the Institute for Applied Economic Research (IPEA) and the National Mining Agency (ANM). Such collaborative structures would provide strong support for the national mineral policy, which is vital for the country's trade balance and for addressing the complex demands of a modern society, especially those related to the energy transition and critical minerals.

Ultimately, sustained investment in technical capacity and the expansion of data dissemination efforts will not only consolidate the SGB-CPRM's fundamental role in supporting Brazil's development strategies but also enable the institution to address the complex demands of a modern society. Therefore, the effective activation of the National Mineral Policy Council (CNPM) is imperative to translate these strategies into coordinated and impactful actions.

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Authorship credits

Author	A	B	C	D	E	F
ACAA						
SFS						
LGRP						
CEOD						

A - Study design/ Conceptualization **B** - Investigation/ Data acquisition
C - Data Interpretation/ Validation **D** - Writing
E - Review/Editing **F** - Supervision/Project administration

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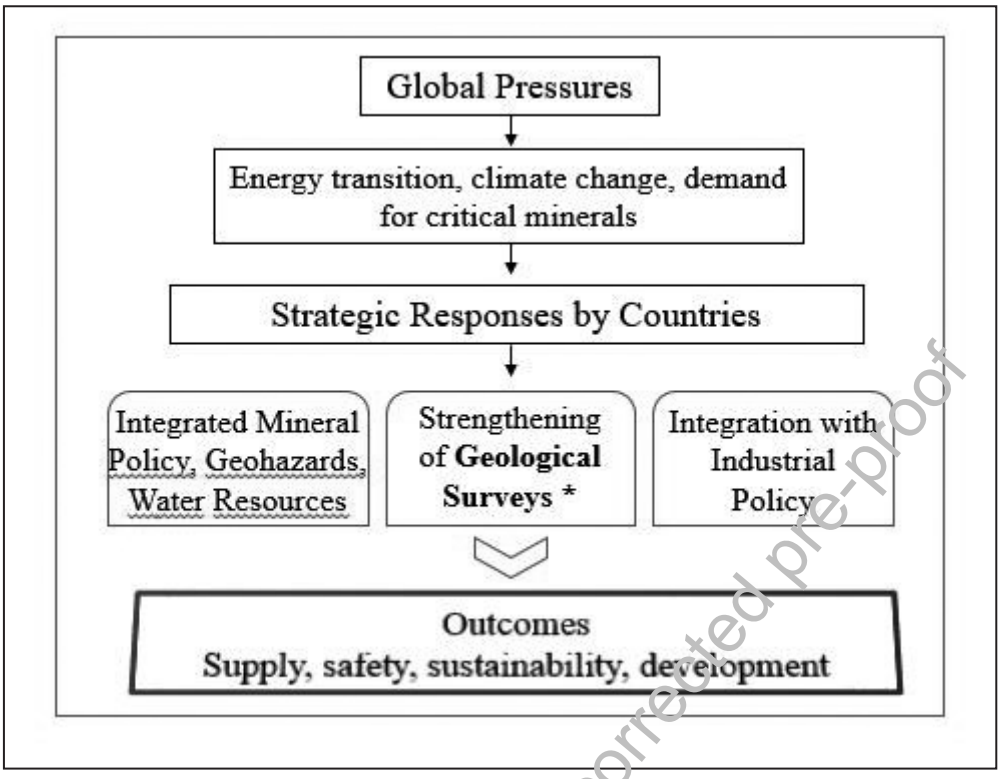

FIGURE 1. Strategic responses by countries to global pressures.

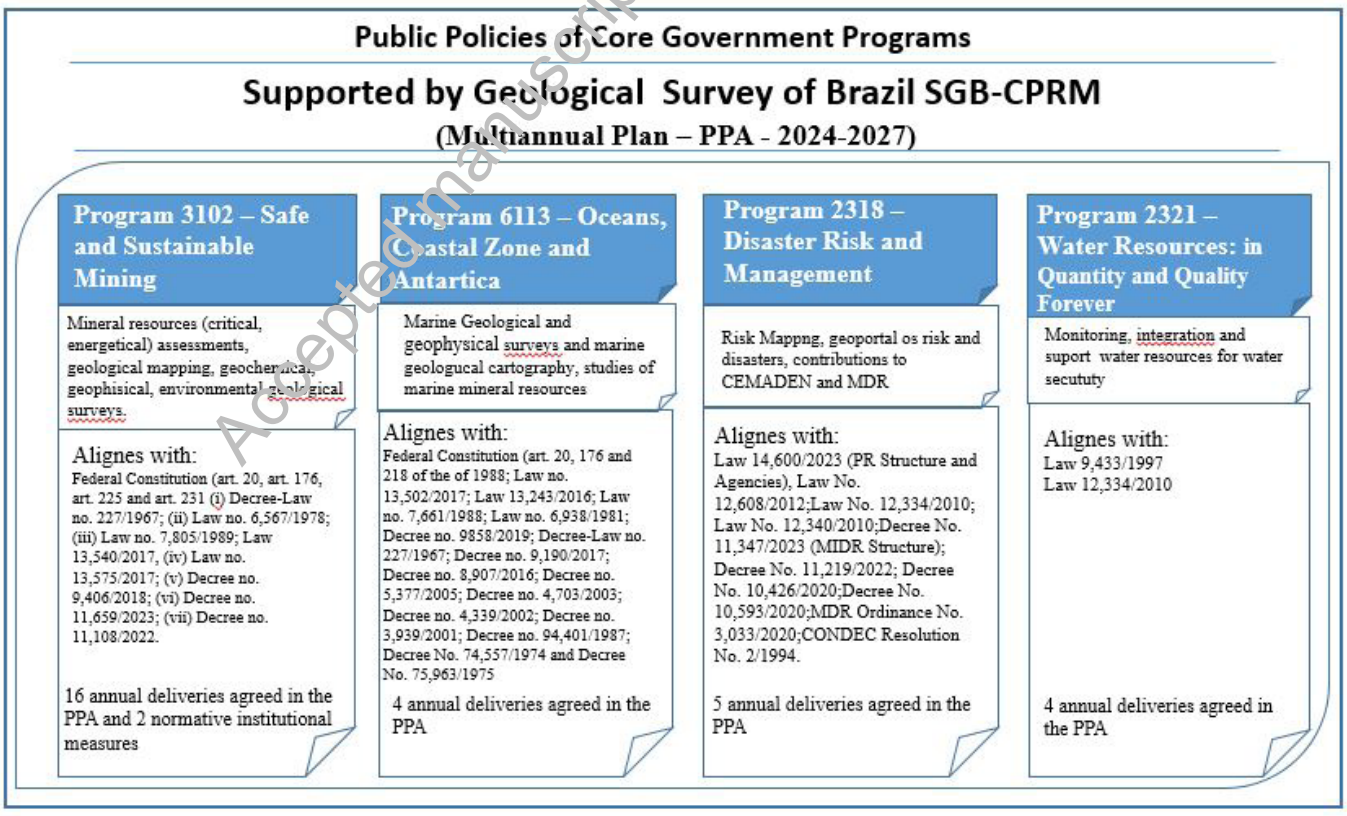

FIGURE 2. Core government programs supported by the Geological Survey of Brazil in the Pluriannual Plan (PPA) 2024–2027, including mining, marine geology, geoharzards, and water resources. Each program adheres to national legislation and sets annual outcomes for public policies.

TABLE 1. Key Stakeholders in Brazil's Mineral Policy

Function	Institution
Policy Formulation	Ministry of Mines and Energy (MME) / National Secretariat for Geology, Mining and Mineral Processing (SNGM)
Regulation and Supervision	National Mining Agency (ANM)
Legal Framework and Legislation	National Congress
Strategic Decision-Making	Civil House and Presidency of the Republic and National Council of Mineral Policy.
Public Geoscientific Data and Support	Geological Survey of Brazil (SGB-CPRM)
Licensing for Construction Minerals	State Governments (local minerals)