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Inventory of Geological Samples Collected from the Rio Grande Rise: Caeté Lithotheque (Minas Gerais State), Geological Survey of Brazil

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Abstract

The Rio Grande Rise Project (PROERG), developed by the Geological Survey of Brazil since 2009, has collected hundreds of cobalt-rich ferromanganese crusts, sediment samples, and biological material. After 14 years of storage, a systematic inventory was carried out between October 2024 and August 2025 at the Caeté Lithotheque, in the state of Minas Gerais. The work included classification, reorganization, and documentation of lithotypes, thin sections, and geochemical aliquots. A total of 132 stations were inventoried, corresponding to 13.6 t of samples, including 355 geochemical aliquots, 114 new aliquots, 57 thin sections, 4 piston cores (129 m), and 1659 photographs. The results highlight the scientific and strategic importance of the collection for cobalt- and phosphate-rich crusts, paleoceanographic reconstruction, and fossil occurrences. Recommendations include more detailed studies of ferromanganese crusts, thin section production, generation of geochemical data, research on stromatolites, and fossil specimens, including a probable *Otodus megalodon*. The revitalized PROERG collection represents a significant contribution to marine geology, sovereignty over marine resources, and the dissemination of geoscientific knowledge.

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1. Introduction

Geoscientific lithotheques are fundamental for the preservation and availability of samples, being useful for education, research, and technological development. They provide organization and cataloging of various types of samples, such as sediments, drill cores, fossils, and rocks, ensuring that data and information are preserved. Additionally, they allow both physical and virtual access to the collection, enabling researchers from different parts of the world to conduct studies and analyses remotely. The literature includes numerous studies highlighting the benefits of conducting inventories and/or systematically organizing geological samples in lithotheques (Bost et al. 2011; Sánchez et al. 2014; Driscoll et al. 2016; Pereira et al. 2016; Fioretti et al. 2023; Ramírez-Amador 2025).

In this regard, lithotheques contribute to strengthening the management of geoscientific knowledge, as well as to strategic planning. In the Brazilian context, lithotheques such as the Caeté Lithotheque help preserve geological memory and national sovereignty, exemplified by the sample collection from the Rio Grande Rise Project.

The Rio Grande Rise Project (PROERG) is an initiative of the Geological Survey of Brazil aimed at mapping Cobalt-Rich Ferromanganese Crusts (CRFC) on the Rio Grande Rise (RGR) (Figure1). In parallel, other activities have been conducted, such as geophysical, biological, and oceanographic surveys, with the objective of studying the geological and paleoceanographic evolution of the area and supporting Brazil's submissions for the extension of the Legal Continental Shelf (LCS) to the United Nations Commission on the Limits of the Continental Shelf (CLCS).

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Currently, the project is aligned with the 2024–2027 Multi-year Plan, under the program *Ocean, Coastal Zone and Antarctica, which aims to expand scientific and technological knowledge, biodiversity conservation, and the sustainable use of natural resources, through the effective management of coastal and marine spaces, in order to promote Brazil's interests in the ocean, coastal zone, and Antarctica* (SGB, 2023). In addition, the project focuses on supporting marine geology studies for the extension of the outer limit of the Brazilian continental shelf beyond 200 nautical miles, in accordance with the United Nations Convention on the Law of the Sea.

The project has been under development since 2009, and during 2011 and 2012 hundreds of ferromanganese crust samples were collected, sometimes enriched in Co and P, as well as specimens of local fauna and flora. The crust samples were initially stored in a warehouse located in the Penha neighborhood of Rio de Janeiro and later transferred to the Caeté Lithotheque. After 14 years of storage, the Marine Geology Division requested a preliminary assessment of the collection's conditions and the preparation of an inventory of the project's samples. This assessment, conducted between July and September 2024, identified both positive aspects and several critical weaknesses.

Among the positive aspects, the preliminary organization of the collection carried out in 2021 stands out, resulting in the creation of several digital files. In addition, several historical files produced by the project team, derived from studies and publications, were identified and proved to be fundamental for the execution of this work.

2. Justification and objectives

Despite the reorganization activities carried out and the publication of several works over the years (Cavalcanti et al. 2013; Cavalcanti et al. 2015; Cavalcanti et al. 2016; Harlamov et al. 2015; Pessoa 2015; Lacasse et al. 2017; Lisniowski 2018; Graça 2018; Graça et al. 2019; Oliveira 2019; Sousa 2019; Lisniowski 2020; Lisniowski et al. 2020a; Lisniowski et al. 2020b; Sousa et al. 2021; Cavalcanti and Santos 2022; Del Rey et al. 2024), various needs for improvement were observed, focusing on the revitalization of the collection and the promotion of geological knowledge dissemination. Furthermore, the aim is to comply with international best practices in project management and compliance (PMI 2021; PRINCE2 2023; ISO 2021). Among these, the aspects that contributed to justifying the execution of the inventory stand out: a) Absence of standardized data (petrography, geochemistry, etc.), lack of an interactive dashboard, and difficulties in accessing and consulting spreadsheets; b) Need for reorganization of sample boxes by lithotype, cores, and geochemical aliquots, as well as the replacement of old pallets in poor condition with new pallets in good condition; c) Need for updating and standardizing sample names; d) Need for adjusting the weight of sample boxes to 25 kg each (Caeté Lithotheque standard); e) Cleaning and reorganization of the sample storage area to facilitate handling and increase efficiency in space utilization; f) Need for reassessment of the collection with a focus on fostering new scientific publications; g) Need to expand the dissemination of geological knowledge essential for Brazil's sustainable development.

The inventory of the Rio Grande Rise therefore represents a strategic resource for both internal and external users, as it allows quick and remote access to data and images of the samples. In addition, it enables data comparisons, as well as the planning and execution of new research, development, and innovation projects. Therefore, this short communication aims to present the results of the inventory of the Rio Grande Rise Project (PROERG) samples stored at the Caeté Lithotheque. It comprises the results of the activities carried out between October 2024 and August 2025.

3. Expected benefits and value delivery

The execution of the inventory sought to generate benefits related to the organization and broad, unrestricted knowledge of the collection. It is expected to increase operational

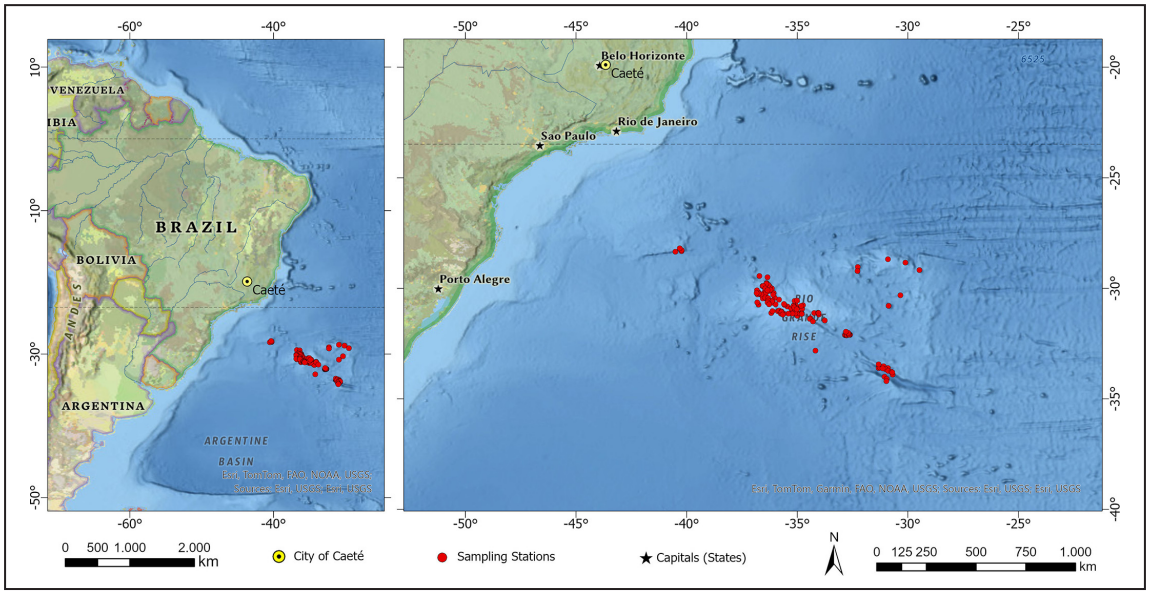

Figure 1. Location map of sampling stations (Rio Grande Rise).

efficiency in searching and identifying samples, enabling faster and more assertive results in storage, data access, and the promotion of geosciences.

In addition, the results are expected to contribute to stakeholder satisfaction, creating a more collaborative and productive environment. Among the expected benefits, the following stand out: a) Integration of data (petrography, geochemistry, etc.) and creation of an interactive inventory dashboard; b) Reorganization of samples, geochemical aliquots, cores, and pallets; c) Standardization of sample nomenclature; d) Reorganization of the storage space and increased efficiency in space utilization; e) Support for qualified and strategic decision-making; f) Interactivity, visualization, and efficient data analysis; g) Valorization of geological heritage and geoscientific knowledge; h) Promotion of scientific research and new publications; i) Reinforcement of national sovereignty; j) Compliance with the principles of **LIMPE** (Legality, Impersonality, Morality, Publicity, and Efficiency), especially Publicity and Efficiency; k) Contribution to the development of activities in the mineral sector (strategic objectives of the institution).

4. Products and results

To carry out the inventory, a set of activities was conducted aimed at standardizing, organizing, and documenting the collection. Initially, the samples stored in boxes and pallets were organized and described, classified according to rock type (substrate) and by survey legs (I, II, III, and IV). In parallel, all samples were photographed, followed by digital image processing to ensure standardized scales and the creation of a systematic image database. During this process, samples with uncertain or missing numbering were recovered, properly reviewed, and incorporated into the collection with standardized nomenclature.

The laboratory aliquots were reorganized into standardized boxes and containers, following the protocols adopted by the Caeté Lithotheque. New aliquots intended for future laboratory analyses were also regrouped and stored in appropriate standardized containers. The existing petrographic thin sections were organized and stored in standardized boxes, ensuring better preservation and accessibility. In addition, the Piston Corer, Box Core, and dredge sediment samples, as well as the separated aliquots from the Piston Corer, were reorganized, documented, and properly stored. A selection of historical samples was also separated for donation to university researchers, promoting the dissemination of geological knowledge and enhancing the value of the collection.

Table 1 presents a summary of the main results achieved in this inventory. Figure 2 shows an example of a collected sample. The final products generated by the inventory were: i) Dashboard; ii) Dashboard Explanatory Note; and iii) Internal Report.

Internal and external users can request access to the collection by contacting the Marine Geology Division and/or the lithotheque team through the official SGB website (www.sgb.gov.br) or by e-mail at seus@sgb.gov.br. Visits for sample consultation and research are scheduled in advance to ensure that handling occurs under controlled conditions and in accordance with SGB institutional standards.

In addition, it is possible to access the dashboard, which provides remote access to essential information about each sample, including photographs, geographic location, collection context, simplified lithological description, and other details (https://rigeo.sgb.gov.br/handle/doc/25710). The dashboard was developed to support scientific research, education, and institutional planning, facilitating data sharing between SGB internal teams and external researchers from universities, research institutions, and partner organizations.

5. Final considerations and recommendations

Regarding the activities and results achieved, the following considerations and recommendations are presented:

a) The issue of sample fragmentation and other weathering effects is mentioned in scientific works and is one of the most critical factors observed in the inventoried collection. Some samples simply disintegrate at a light touch, while others fragment during box handling, often resulting in the separation of the substrate from its crust. In this regard, it is recommended that short- and medium-term scientific studies be encouraged and conducted before further deterioration occurs.

b) The unidentified samples (approximately 120 kg) should be prioritized for demands related to technical-scientific exhibitions that do not require data such as location, sample name, or any other collection details.

c) Aliquots originating from the commercial laboratories (e.g., Geosol, ACME), as well as the new aliquots generated for future analytical studies (XRD, XRF), should be carefully evaluated in any future research. Geosol results were based on whole rock, whereas ACME analyses focused on crusts. Any comparison and/or future analysis must take these facts into account.

d) Regarding the volume of samples in the collection, few thin sections (57) have been prepared, mostly from

Table 1 – Summary of the main results obtained in the inventory.

Item	Stations	Quantity	Remarks
Inventoried stations		132	2 with only chemical aliquots, 1 with only sediment, and 1 with no sample
Inventoried mass (kg)		13,565	
Identified thin sections	31	57	2 broken but still usable
Geochemical aliquots	88	355	Distinct aliquots (Geosol)
New aliquots	69	114	Distinct aliquots
Piston corer (Holes)	4	129	Approximate recovery in meters
Box core (Stations)	2	7	Samples
Sediment samples	22	22	Distinct aliquots (dredge sediment samples and two Piston Corer stations)
Photographs	129	1659	Standardized and digitally processed

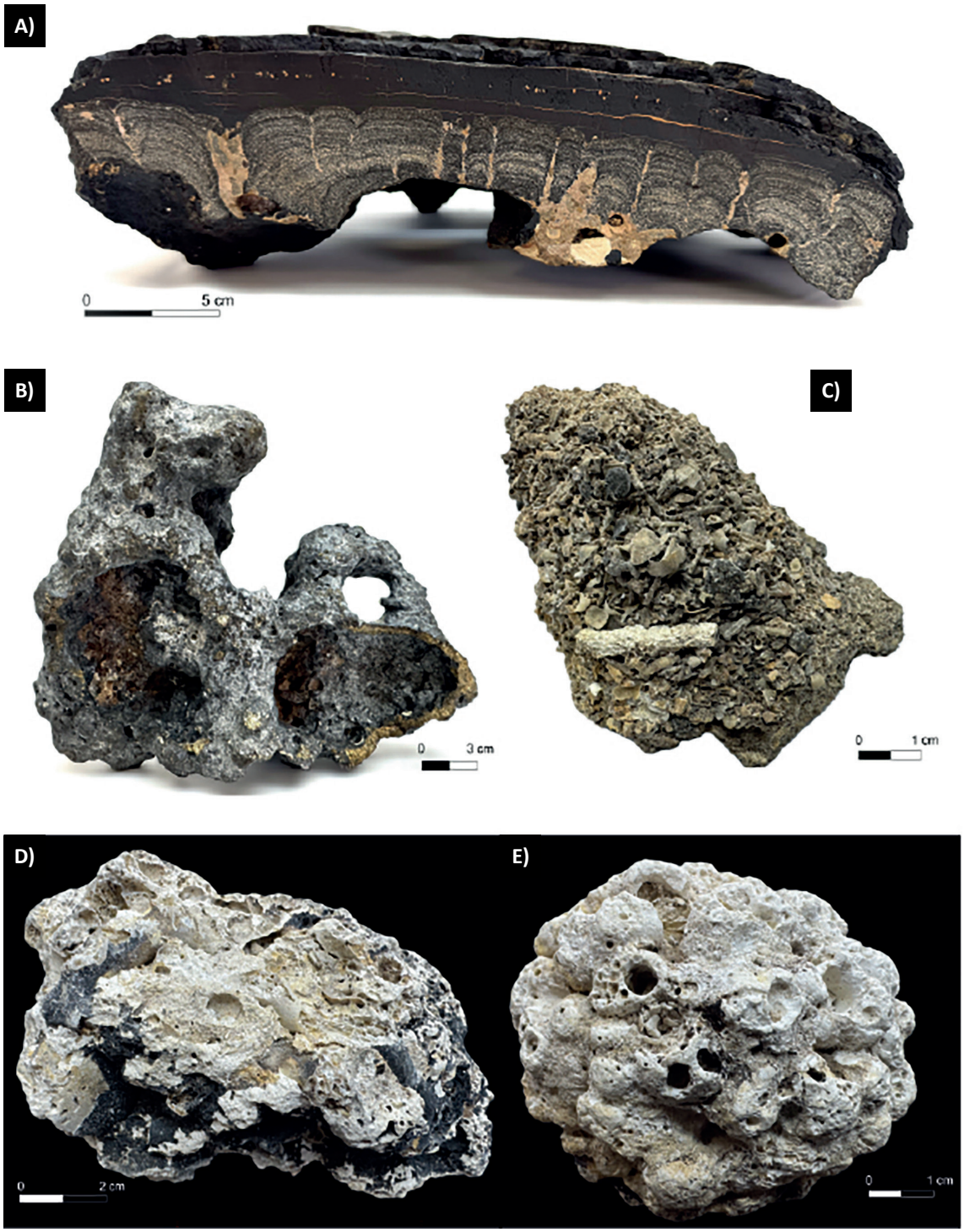

Figure 2 – A) Crust with stromatolite, station 4340-I-011-MLS. B) Crust with carbonate substrate, station 4340-II-013-JAD. C) Calcarenite with bioclasts, station 4340-I-021-MLS. D) Coquine, 4340-I-051-MLS e E) Coquine, 4340-I-063-MLS.

ferromanganese crusts, and secondarily from stromatolites and volcanic rocks. It is strongly suggested that thin sections be prepared from representative samples of all stations and lithotypes, along with their respective chemical analyses. These actions may encourage new publications and the dissemination of geoscientific knowledge.

e) The inventoried collection, due to its strategic importance and large volume of samples, represents an excellent potential for scientific research. In addition to cobalt- and phosphate-rich crusts, there is great opportunity for studies on fossils of different species, stromatolites, volcanism, carbonate rocks (limestones, coquines, etc.), and clastic rocks (conglomerates, sandstones), among others.

f) The piston corer cores deserve special attention due to the need for refrigeration. In this regard, before any approach, consultation with DIGEOM is required regarding the feasibility of stratigraphic studies, organic matter analysis, isotopic and geochronological research.

g) Station 4340-IV-150-R contains, among other rocks, a fossil specimen likely of *Otodus megalodon*, which should be studied and dated in the short term, as it is probably one of the first records of this fossil in the South Atlantic, adjacent to Brazil.

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C - Data Interpretation/ Validation **D** - Writing
E - Review/Editing **F** - Supervision/Project administration

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