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INTEGRATION OF HISTORICAL-CULTURAL AND GEOLOGICAL HERITAGE: GEOTRAIL IN THE HISTORIC CENTER OF PORTO ALEGRE, RS

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Abstract: *Geotourism is a form of tourism that uses geology as its main attraction, promoting the preservation of geodiversity and the appreciation of geological and cultural heritage. In urban settings, it connects the history of city development to the materials used in monuments and buildings. Porto Alegre, the capital of Rio Grande do Sul, stands as a true open-air architectural museum, with local rocks incorporated into its Historic Center. This study proposes the creation of a geotrail to highlight the use of rocks in urban development through the analysis of historical buildings and monuments such as the Palácio Piratini, Júlio de Castilhos Museum, Catedral Metropolitana de Porto Alegre, Praça Matriz, Praça da Alfândega, and Farol Santander. The main regional materials identified include Ponta Grossa and Viamão granites, rhyolites, diabases, and sandstones from the Botucatu Formation. Jurassic limestones from France and marbles from Espírito Santo were also used. The macroscopic description of the rocks, combined with historical and architectural context, seeks to promote the integration of geology, culture, and society, reinforcing the importance of preserving Porto Alegre's historical and geological heritage.*

Keywords: Geotourism; Historical Heritage; Petrology; Conservation; Geology Education.

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1. INTRODUCTION

Although often overlooked, geodiversity is present in elements such as landforms, soils, and climate, and plays a fundamental role in the development of societies and urban growth (Jorge et al. 2016). It represents the interaction between the Earth's physical aspects and the necessary support for life.

Geotourism is a form of tourism based on the geology of a region as its main attraction. It values the environment, culture, and the well-being of the local community (Brilha et al. 2005), promoting education and the conservation of geologically significant sites through recreational and educational experiences (Hose et al. 2000).

Geological heritage encompasses elements of geodiversity that hold scientific, educational, cultural, touristic, or aesthetic value, and should be preserved as a legacy of humanity (Nascimento et al. 2015). This preservation involves not only physical sites but also the knowledge associated with them.

However, many residents remain unaware of the natural and cultural heritage found in their own surroundings. Urban geotourism brings people closer to the history of the city by highlighting geology embedded in its architecture. The creation of a geotrail in the Historic Center of Porto Alegre aims to present to the community the use of rocks in urban development through the study of buildings and monuments with geological features, as well as to highlight the historical context associated with these locations. This initiative seeks to foster a deeper understanding of the region's geological and cultural richness, encouraging appreciation, awareness, and the preservation of local heritage.

2. METHODOLOGY

The study was conducted in the Historic Center of Porto Alegre (Rio Grande do Sul), focusing on the identification and preservation of geological materials present in monuments, buildings, and public squares. The research was divided into two stages: a bibliographic review, which involved examining works on geodiversity, geotourism, geological heritage, and the history of the city; and fieldwork, which consisted of the identification and macroscopic description of the rocks used in the selected locations.

During the fieldwork, site visits, photographic documentation, and completion of data sheets with information on the materials and their locations were carried out. The selection of points was based on criteria such as geological relevance, historical-cultural value, and accessibility. The collected data were organized into categories based on proximity and historical period in order to optimize the flow of the geotrail.

As a result, an illustrated geotrail was created, including a map and points of interest, with the aim of promoting geoscientific education, valuing heritage, and raising community awareness about the importance of its preservation.

3. RESULTS AND DISCUSSION

This section presents the analysis of selected points of interest in the Historic Center of Porto Alegre, addressing geological, historical, and cultural aspects, as well as the development of a geotrail.

3.1 Points of Interest and Historical-Cultural Contextualization

The Centro Histórico of Porto Alegre displays a variety of architectural styles that reflect different periods in the city's urban history, especially the transition from the Second Empire to the Republic, including the Old Republic (1889–1930) and the Vargas Era (1930–1945). Constructions from this period predominantly used local materials, such as granites from the quarries in the Vila Nova and Hípica neighborhoods, and sandstones from the regions of Taquara, Sapucaia do Sul, and São Leopoldo (Philpp et al. 2009).

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This study analyzed six significant landmarks in the urban evolution of the city: Palácio Piratini, Catedral Metropolitana De Porto Alegre, Júlio de Castilhos Museum, Praça da Matriz, Praça Alfândega, and Farol Santander. These sites highlight the historical-cultural value and geological potential of the buildings, focusing on construction aspects, materials used, and their heritage significance.

3.1.1. Piratini Palace

The seat of the state executive branch, Palácio Piratini is also the official residence of the governor of Rio Grande do Sul. Its construction, which replaced the former Palácio de Barro, took place between 1909 and 1921, based on a project by the French architect Maurice Gras. The building was erected on foundations composed of Ponta Grossa granite blocks, extracted from Morro da Tapera. The base portion of the external façade is made up of white limestone blocks from the Jura region in France, dated to the Jurassic period (201–142 Ma), as evidenced by the presence of marine fossils such as corals, bryozoans, and mollusks (from the cephalopod, gastropod, and bivalve classes). The building features elements of French neoclassical architecture and includes thresholds, baseboards, and staircases also covered with Jura limestone (figure 1). Inside the building, green serpentinite plates from the state of Minas Gerais are used as decorative elements.

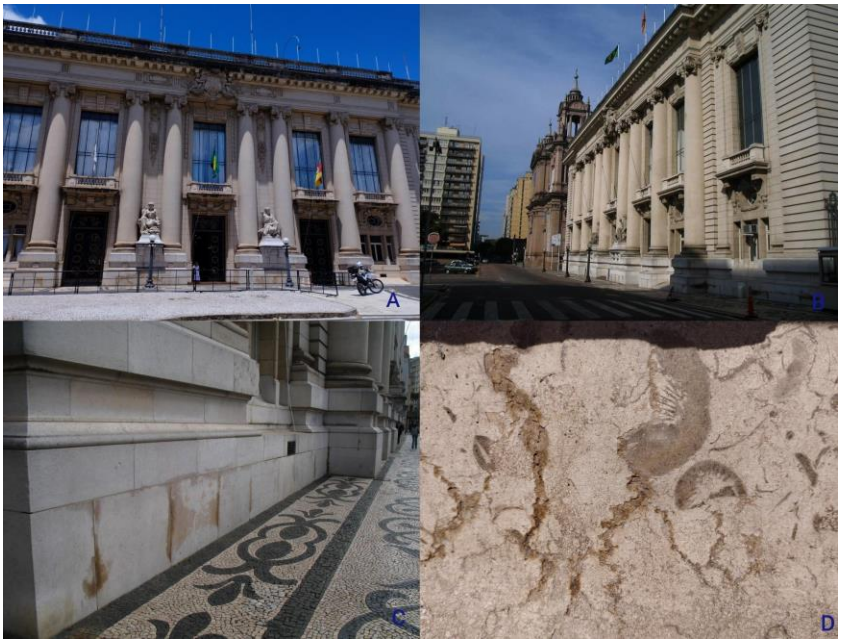

Figure 1. Details of Palácio Piratini. A) Entrance of Palácio Piratini; B) Side view detail; C) Sidewalk with quartz and diabase mosaic; D) Detail with marine fossils.

3.1.2. Catedral Metropolitana de Porto Alegre

The founding of the Paróquia Nossa Senhora Madre de Deus is directly linked to the origins of Porto Alegre. When the region was still merely the port of Viamão (then the capital of the Captaincy), the arrival of Azorean settlers and the passage of troops from São Paulo heading to the Missions required the establishment of a religious structure. Thus, in 1753, a chapel was built under the invocation of Saint Francis of the Stigmata, giving rise to the name São Francisco do Porto dos Casais.

The Catedral Metropolitana, an important landmark of Neo-Renaissance architecture in Porto Alegre, was initially designed by the architects Jesus Maria Corona, Theo Wiederspahn, and Johan Ole Baade, and later revised by Giovanni Battista Giovenale of the Roman Curia. Construction began in 1923 to replace the old Matriz church, and it was inaugurated only in 1986.

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The Catedral was built with Ponta Grossa granite blocks extracted from Morro da Tapera, and part of the interior flooring features Viamão granite, sourced from an old quarry in the Lomba do Pinheiro area. The reddish-toned interior columns are also made of Ponta Grossa granite (figure 2). The original dome covering was made of white marble from Espírito Santo, later replaced with copper plates in 2006 (Philpp et al. 2009).

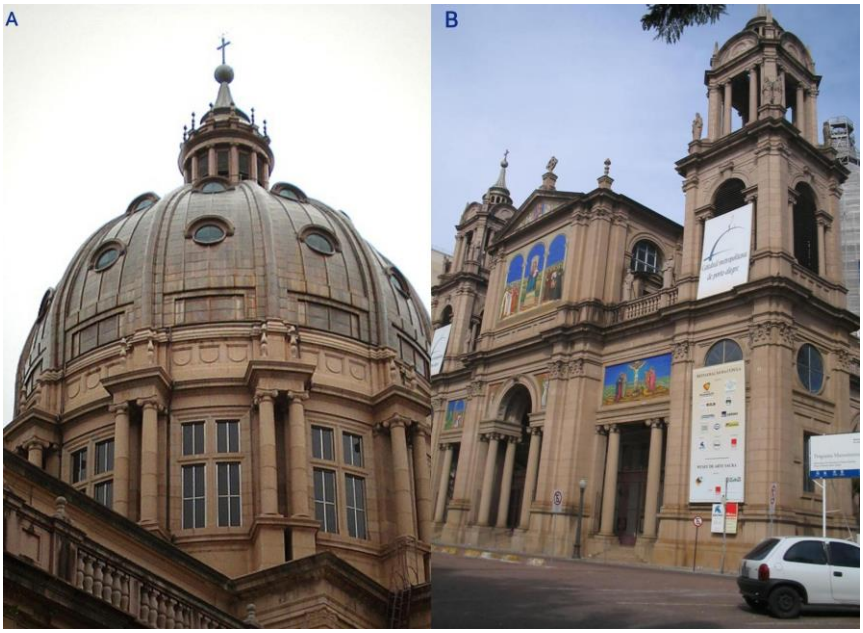

Figure 2. A) Detail of the dome; B) Façade of the Catedral Metropolitana.

3.1.3. Júlio de Castilhos Museum

The building that houses the Júlio de Castilhos Museum, located at 1231 Duque de Caxias Street, was originally an aristocratic residence built in 1887 by Colonel of Engineers Catão A.S. Roxo, a hero of the Paraguayan War. In 1897, the property was acquired by the Republican Party of Rio Grande do Sul (PRR) to serve as the residence of its president, Júlio de Castilhos, who governed the state between 1898 and 1903. In 1905, the State Government purchased the mansion and transferred the collection of the State Museum to it, preserving Castilhos' former bedroom and office as a memorial. The Júlio de Castilhos Museum is the oldest museum in Rio Grande do Sul and serves as a vital space for preserving the political, social, cultural, and economic memory of the state's history (Silveira et al. 2011; Quadrado et al. 2021).

The neoclassical-style building stands out in the Centro Histórico with a façade covered in eolian sandstones from the Botucatu Formation, extracted in Taquara (Morungava), and a foundation made of Ponta Grossa granite blocks—integrating cultural heritage with local geodiversity (Philipp et al. 2009).

3.1.4. Praça Matriz

Praça Marechal Deodoro, popularly known as Praça Matriz, is one of the most emblematic public spaces in Porto Alegre. Its origins date back to 1753, with the construction of a small cemetery and later the first Igreja Matriz (main church). It became the political and religious center of the city, especially after the transfer of the capital of the Hereditary Captaincy of São Pedro from Rio Grande to Porto Alegre in 1772. Throughout the 19th and early 20th centuries, the square was surrounded by important buildings such as the Government Palace, Theatro São Pedro, and the Palácio da Justiça.

In 1914, it became home to the Monument to Júlio de Castilhos. The square's promenade features mosaics made of rhyolite, while other areas are paved with syenogranite (figure 3) (Philipp et al. 2009).

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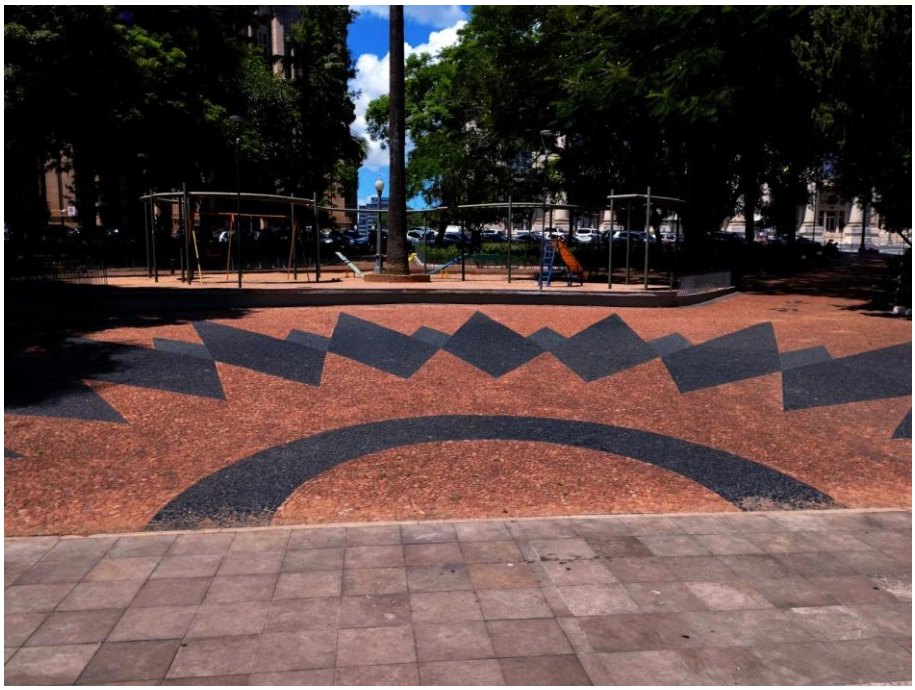

Figure 3. Detail of the mosaic on the promenade of Praça da Matriz

3.1.5. Praça Alfândega

Located on the banks of Lake Guaíba, in the Centro Histórico of Porto Alegre, Praça Alfândega (originally called Praça da Quitanda) emerged in the late 18th century in the area of the city's former river port, the Port of Viamão. In 1783, a stone pier was built to facilitate the disembarkation of people and goods, and in 1804, Governor Paulo da Gama ordered the expansion of the dock and the construction of a warehouse supported by 24 stone pillars. The square gained commercial importance for housing vendors and merchants, in association with the city's first customs house.

Its establishment as a public space took place between 1856 and 1858, with the constructionof a stone wall and stairways by the lake, in what is now known as Sete de Setembro Street.

Surrounded by landmarks such as the Museu de Arte Rio Grande do Sul(MARGS), the Rio Grande do Sul Memorial, Farol Santander, and the Clube do Comércio, the square has also been the site of the traditional Porto Alegre Book Fair since 1955. Its pavement stands out for the use of so-called "Portuguese stones"—mosaics composed of small fragments of rhyolite and diabase extracted from within the city itself (figure 4). In 2011, the artwork African Footprint (Pegada Africana) was installed along a new section of the Andradas Street promenade, maintaining the same rock composition as the original pavement (Philipp et al. 2009).

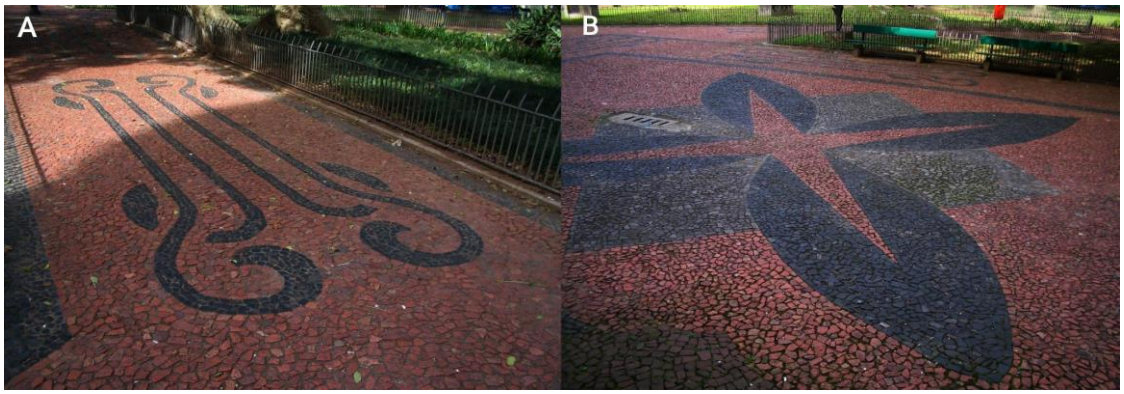

Figure 4. Detail of the mosaic on the promenade of Praça Alfândega.

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3.1.6. Farol Santander

The Farol Santander is an icon of eclectic architecture in Porto Alegre, with notable neoclassical elements and rich sculptural ornamentation. The façade was built using Ponta Grossa granite blocks extracted from Morro da Tapera, applied with various finishes: natural, sandblasted, bush-hammered, and polished. The decorative elements were also sculpted from the same type of rock (Philipp et al. 2009).

The building was constructed between 1927 and 1931, based on a project by engineer Hipólito Fabre, with contributions from architects Fernando Corona, Stephan Sobczak, Alfredo Staege, and Theo Wiederspahn. Originally home to major financial institutions such as Banco da Província, Banco Nacional do Comércio, Banco Sul-Brasileiro, and Banco Meridional, the building now houses a cultural center open to the public (figure 5).

Figure 5. A) Detail of different granite finishes; B) Façade of the Farol Santander

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3.2 Characterization of Rocks and Cladding Materials

The selection of rocks used in the construction and cladding of buildings in Porto Alegre's Centro Histórico reflects both the regional availability of materials and the aesthetic and technical preferences of different historical periods. The main lithologies identified at the analyzed sites are described below, including petrographic characteristics, origin, and architectural applications.

Sandstone from the Botucatu Formation

Extracted from quarries located between the municipalities of Gravataí and Taquara, the sandstone from the Botucatu Formation presents planar-parallel and large-scale trough cross-bedding structures. Its layers range from millimeters to centimeters thick, with alternating grain sizes and occasional opaque minerals. The sandstone varies in color from pink to light gray and has an arkosic composition rich in quartz, with 5 to 15% feldspars (plagioclase and microcline), as well as accessory minerals such as zircon, rutile, and volcanic fragments (Di Benedetti et al. 2007). The fine- to medium-grained sand particles are sub-rounded to rounded and exhibit high sorting.

This sandstone was used on the façade of the Júlio de Castilhos Museum, applied to both the flooring and the low-relief decorative elements. Light gray blocks form the base of the façade and balustrades, while light pink blocks are found on columns and ornamental frames (Philipp et al. 2009). After more than a century, the rock remains in fair condition, with localized deterioration caused by chemical and physical weathering. Observed effects include discoloration, granular disintegration (mainly of plagioclase), cracking, and the formation of surface deposits due to chemical decomposition by rainwater, wind action, temperature fluctuations, air pollution, biodeterioration, and construction-related factors (Di Benedetti et al. 2007).

3.2.1. Ponta Grossa Granite

Ponta Grossa Granite crops out as small slabs or blocks in urban road cuts. It is a leucocratic syenogranite of pinkish-red color, with a massive structure and medium to coarse-grained hypidiomorphic equigranular texture (5–10 mm), composed of K-feldspar, plagioclase, quartz, and rare biotite, with accessory minerals such as zircon, titanite, apatite, allanite, and opaque minerals (Philipp et al. 2009).

This granite was widely used as foundation and paving material. Quarries at Morro da Tapera supplied blocks for buildings such as Palácio Piratini, Júlio de Castilhos Museum, Catedral Metropolitana, and Farol Santander (Philipp et al. 2009).

3.2.2. Viamão Granite

Found mainly east of Porto Alegre and in the municipality of Viamão, Viamão Granite appears in low-relief areas with rounded boulder fields. It has a massive to foliated structure with oriented megacrysts of K-feldspar. Its porphyritic texture includes 15 to 35% orthoclase and microcline megacrysts (1 to 5 cm, sometimes up to 10 cm) embedded in a coarse- to medium-grained equigranular hypidiomorphic matrix. Its monzogranitic composition includes plagioclase, K-feldspar, quartz, biotite, and occasionally hornblende, along with accessory minerals such as zircon, titanite, allanite, and opaques (Philipp et al. 2009).

Widely used in civil construction as foundation stone, Viamão Granite was extracted in large blocks from the Lomba dos Pinheiros region, cut and polished into slabs used for the exterior cladding of the former Banco Santander and as interior flooring in the Catedral Metropolitana (Philipp et al. 2009).

3.2.3. Rhyolite

Rhyolites occur as dikes cutting through much of the granitic rocks in the Porto Alegre region, associated with Santana Granite. These dikes range from 2 to 10 meters thick and are predominantly oriented NW–SE. The rhyolite has a pink color and massive structure. Its

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porphyritic texture contains 2 to 7% euhedral phenocrysts of quartz and alkali feldspar (1–4 mm) in an aphanitic matrix. Aphyric varieties also occur. Small, regular rhyolite fragments were used as paving stones (Portuguese mosaic), forming geometric or free-form mosaics in walkways and plazas, such as in Praça Alfândega and the inner courtyard of the Catedral Metropolitana (Philipp et al. 2009).

3.2.4. Basic Dikes (Diabase)

Diabase dikes appear as tabular bodies between 1 and 4 meters thick, cutting through granite with straight to interlobate contacts. The structure is massive, and the fine-grained equigranular texture is sometimes subophitic, with glassy remnants. The basic composition includes plagioclase, clinopyroxene, and opaque minerals. Diabase was mainly used in Portuguese mosaic pavement in public walkways and squares, such as in Praça Alfândega and the sidewalk of Palácio Piratini (Philipp et al. 2009).

3.2.5. Limestone

The white limestone used in the base of the external façade of Palácio Piratini originates from the Jura region in France. It is notable for its marine fossils from the Jurassic period, such as corals, bryozoans, and mollusks (including cephalopods, gastropods, and bivalves) (Philipp et al. 2009). Due to its low cohesion, high porosity, and high reactivity to chemical weathering by rain and cleaning water, the limestone blocks show significant surface wear—especially on staircase steps and the entrance floor of the palace.

3.3 Geotrail

To present the geotrail, a printed brochure was created to guide visitors through the Centro Histórico of Porto Alegre (figure 6), starting at Palácio Piratini and ending at the Farol Santander. The self-guided route highlights intersections between geology and architecture at six key points:1. Palácio Piratini – French Jurassic limestone with marine fossils; foundation built with Ponta Grossa Granite blocks; Portuguese pavement featuring wave patterns made with basalt and quartz (limestone) fragments;

2. Catedral Metropolitana – External façade and internal columns made of Ponta Grossa Granite blocks; interior flooring in Viamão Granite;
3. Júlio de Castilhos Museum – Façade composed of eolian sandstones from the Botucatu Formation and base in Ponta Grossa Granite blocks;
4. Praça Marechal Deodoro – Rhyolite, syenogranite, and diabase mosaics in the paving and on the monument;
5. Praça da Alfândega – Pavement mosaics composed of regular rhyolite and diabase fragments in sidewalks and pedestrian walkways;
6. Farol Santander – Broad range of finishes in Ponta Grossa Granite blocks on the façade, with various ornamental elements sculpted in granite.

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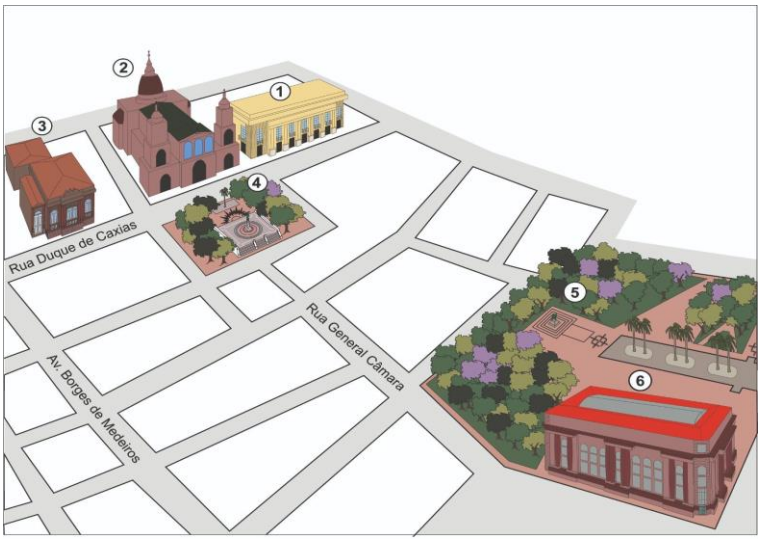

Figure 6. Illustrative map showing the tourist sites featured in the geotrail.

4. CONCLUSION

The Centro Histórico of Porto Alegre is home to a valuable architectural ensemble composed of buildings and squares that incorporate regional geological materials in their structural and landscape elements. Among the most prominent are blocks of syenogranite from Ponta Grossa Granite, rhyolites and diabases from intrusive dikes, and eolian sandstones from the Botucatu Formation. This lithological diversity provides insight into the evolution of urban planning and the city's sociopolitical symbolism, integrating the use of local rocks with the constructive influences of the Portuguese colonial model and European architectural movements (German, Polish, Italian), including Classicism, Neoclassicism, Eclecticism, Art Deco, and French Art Nouveau.

The Geotrail of Porto Alegre's Centro Histórico offers an educational and touristic route that highlights the city's history and its geocultural heritage. The six selected points demonstrate the value of associating concise petrographic descriptions with architectural context, promoting heritage awareness and engaging diverse audiences—from students to occasional visitors. The next phases of the project include expanding the route to other historic areas of the city, creating an interactive website with detailed content, and promoting the trail during cultural events such as Museum Night, Geologist Day, and Porto Alegre's anniversary. These actions aim to consolidate urban geotourism as a tool for valuing and preserving geohistorical heritage, while fostering ongoing research and active community involvement.

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Diagramado por Caroline Figueiredo Rocha (PET-GEOLOGIA)